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Governance of Emerging Space Challenges

The Benefits of a Responsible Cosmopolitan State Policy

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To Theodor,
I wish you more cosmopolitan justice in the world in which you grow up.

Preface

Our research project began several years ago, with the motivation of applying cosmopolitan theoretical thinking to the practical space politics of a nation state. We began with planetary defense as a case study, then added space mining, as we believed that profits made in space could one day fund global projects related to global security. This went well, as our Ministry of Transport (responsible for the space sector in Czechia) agreed that such mining has the potential to boost national industry. At that time, ideas about global taxation were still in the realm of dreams, and discussion over space mining was focused on how to be the first to grab the most. As we were finishing the book, G7+G20 accepted the unprecedented global taxation regime for international corporations, and space community scholars were openly talking about the need for global (launch) tax to clear in-orbit debris with the support of economic studies proving its necessity. The ongoing Starlink deployment and the surge of close proximities between satellites only proved the case.

The dynamics surrounding orbital debris led to the idea of adding other breakthrough scientific projects to our research, and especially the laser technologies on which the Czech Republic has historically had a strong focus. The question of how to govern such cases from the perspective of a small state the size of the Czech Republic very quickly transformed into a question about how small states in general can (1) deploy large, security-sensitive technical systems such as high-power lasers, with possible implications to global security despite their civilian purpose in deorbiting debris or in accelerating nano-probes to relative speeds, (2) influence the legal debate over space mining and participate in possible industrial opportunities related to space mining, and (3) participate in planetary defense efforts or be assured that planetary defense policies will cover their territory if the space powers decide to act. The central question was how all these space policies could be governed in a cosmopolitan way and how small states could be active in such discussions.

By the end of the project, we had found several enlightened people in the state administration and political sphere who would play key roles in triggering certain policies. However, as one would expect, we also found a lot of people deeply convinced that their realist perspective of the world *reflects the world as it is.* We would like to dedicate this book especially to those skeptics, because the concept of the

responsible cosmopolitan state is not about cosmopolitan utopian visions, but about a very tangible policy approach driven by values built on political reality. The policies we discuss here are inspired by our reading of the responsible cosmopolitan state concept and are realizable by those who can find the courage, have some imagination, and are determined to lead others in transforming the world into a better place.

We wish those individuals a pleasant reading.

Prague, Czech Republic Nikola Schmidt

Acknowledgments

We would like to thank all the people who enabled our research project, *Multidisciplinary analysis of planetary defense from asteroids as the key national policy ensuring further flourishing and prosperity of humankind both on Earth and in Space*. Above all, we are grateful to Vaclav Kobera from the Czech Ministry of Transport for motivating us to pursue the project in the first place. We are also grateful to Martin Buncek, the director of the Technological Agency of the Czech Republic that provided us funding, for his immense confidence in such a risky project and continuous support during its realization. He kept us focused on the target and identified critical bottlenecks along the way. We must also mention people such as Ondrej Rohlik and Vaclav Nesladek from the Ministry of Transport, who helped us get oriented in the maze of state administration and at the international level.

Finally, I thank Petr Bohacek, who turned our research into practical policy; Martin Svec, for his dedication to submitting perfect texts on international law a minute before twelve; and all of our other colleagues who contributed to the project. During this time, we even received magical ideas from Pete Worden, the director of Breakthrough Initiatives, who worked with us on concepts related to large technical systems. Finally, I thank my wife for her confidence in our work and continuous support during the nighttime writing of our thoughts.

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Petr Fatka defended his dissertation, which dealt with genetically related asteroids, and received his PhD degree from Charles University in Prague in 2020. Since then, Petr has been holding the position of postdoctoral researcher in the Interplanetary Matter Department at the Astronomical Institute, Czech Academy of Sciences, Ondřejov. Apart from photometric observations of asteroids with local and remote (La Silla observatory, Chile) telescopes, Petr continuous his search for asteroids that underwent a disruption within the last few million years and performs their further study using, e.g., *n*-body simulations considering effects on their orbits caused by different non-gravitational forces. Petr's recent discovery of four asteroids that underwent multiple non-collisional disruptions in the past was published in *Icarus* journal and his latest finding of the youngest known break-up event of a near-Earth asteroid was submitted to *Monthly Notices of the Royal Astronomical.*

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Nikola Schmidt was, while working on this project, a research fellow at the Institute of Political Studies, Faculty of Social Sciences, Charles University, Czech Republic and currently heads the Center for Governance of Emerging Technologies at the Institute of International Relations, Prague, Czech Republic. He studied sociology at Charles University Prague (BA), and international relations and security at the Metropolitan University Prague (MA). He received his PhD from Charles University in 2016. He participated in a European Space Agency and NASA-funded planetary defense team project organized by the International Space University in 2015. The subject of his professional interests varies between international relations theory, science and technology studies with focus on space, and cyber and the general relation between technology, politics, and global governance. This book is a result of a multidisciplinary project he led for 4 years with participation from astronomers, space engineers, international lawyers, and political scientists. The objective was to devise a strategy for planetary defense and asteroid mining policy as key topics of a cosmopolitan responsible state. He has edited and authored a number of recent works, including the Springer volume *Planetary Defense: Global Collaboration for Defending Earth From Asteroids and Comets*, as well as articles in *Acta Astronautica*, *Space Policy*, *New Space*, *Alternatives*, and *Bulletin of the Atomic Scientists*. Prior to re-entering academia, he founded and led two software development companies and worked on a nongovernmental organization-driven food facility project in Afghanistan.

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Republic or the European Commission, such as InDiv-EU: Integrating Diversity in the EU (Horizon 2020), Secure Intelligent Methods for Advanced RecoGnition of Malware and Stegomalware (Horizon 2020), and Benefits of Deploying Smart Measurement for Company and Regulator (TAČR). He is an author of chapters and publications in various journals such as the *European Journal of Risk Regulation* and *Oil, Gas & Energy Law*.

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Introduction

Nikola Schmidt

This book follows our attempt to devise and recommend a policy of cosmopolitan responsibility related to three space topics: planetary defense, space mining, and breakthrough technologies with a focus on lasers.

Cosmopolitanism is a word derived from Ancient Greek *kosmopolitês*, formed from *kosmo* (world, universe) *and politês* (citizens); as such it is used nowadays to define the term "citizens of the world." Our reading of responsible cosmopolitan policy is based on the concept of the responsible cosmopolitan state by Brown (2011) and the following broader study of actual responsible cosmopolitan policies in the current world (Beardsworth & Shapcott, 2019). In general, we can say that the responsible cosmopolitan state reflects its actions towards all humans as citizens of the world. Responsibility, as we elaborate on the concept in detail in chapter "Responsible Cosmopolitan State in Space Politics", is understood as the capability and freedom to make conscious decisions based on complex knowledge of our world, with reflection of the decisions' broad consequences on nature and people's lives.

The concept of the responsible cosmopolitan state is an interesting turn of several cosmopolitan thinkers who argue that cosmopolitanism suffers from the idea to change the global political landscape by depicting nation states as illegitimate and proposing a new utopian cosmopolitan order that would replace the current international system of nation states. Instead, they propose to focus on policies that can be implemented by nation states with cosmopolitan values in mind, as guidance. Therefore, this approach to cosmopolitanization of the world is not utopian, but rather reflects a realist political landscape, which certain states have been already changing by introducing concepts such as Responsibility to Protect, proposing

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particular international legal regimes, or securing people's dignity in humanitarian efforts, etc., with the aim of promoting cosmopolitan values. We do the same.

Post-World War II foreign policy has been distinguished by its multilateralism, development of international organizations, and an overall emphasis put on developing relations and international liberal order between states, so as to avoid another catastrophic world war. The difference between cosmopolitan responsibility and current multilateral international relations is the fact that the former is driven by moral principles, while the latter by a specific perspective on international system building, binding superpowers together and giving small powers voice. Moreover, the development of liberal democratic order in the second half of the twentieth century was also driven by the idea of economic interdependency (Keohane & Nye, 1977) as an approach that would spread democracy. It failed (Deneen, 2019). The failure was based precisely on the incorrect presumption that we can build an equal world based on equal rights and material inequality. Cosmopolitan responsibility, in the sense of responsible cosmopolitan state foreign policy objectives, therefore, does not challenge, exchange, or diminish all principles of multilateralism, but rather, with this failure in mind, it provides moral and ethical guidance for future multilateral system evolution, and returns to the core of cosmopolitan thought, on which modern liberal democracy (as a value-oriented political system with emphasis on peoples' equality) is actually clearly built. There are various examples in which this policy has been already successful.

First and foremost is definitely the concept Responsibility to Protect. Despite all its imperfections, R2P changed how we perceive our global responsibilities and, as such, slowly changed the basis of contestation between foreign policies in general. Remember in what world we lived at the end of the nineteenth century. European powers were dividing Africa according to their interests in colonization efforts; unimaginable atrocities were conducted in the name of kings, as in the case of Congo. Whole civilizations were wiped out, as in the case of the Kingdom of Benin in today's Nigeria. The Second World War, only a couple of decades later, changed our imagination as to what a state can do to its own population in modern times in the heart of Europe, if it is sophistically organized and motivated by gruesome ideas. Rwanda in the 1990s showed what can happen in a medium developed state, if the international community stands back and abandons the failing state to its own fate. The developments in Afghanistan after the harsh pullout in August 2021 will show us certainly another image of cruelty, which we can imagine due to our knowledge of Taliban practices from their previous governance, but we stand calm, silent, and remote, once again.

The experience with Rwanda was a crucial moment for rethinking the responsibilities within the international community, as we realized that our responsibilities must cross borders and that national sovereignty is not only about our own self-governance but also concerns our global responsibility as well. Our moral obligations changed. What legitimacy could a state have, if it is aware of atrocities and does not intervene? These questions were the trigger for the birth of Responsibility to Protect, a concept that remains debatable, due to its legitimization of possible military intervention, and, as any intervention brings death, how could we talk about

fulfilling moral responsibility? Therefore, despite the fact that R2P remains debatable, it has changed how we perceive the role of a state in the global village of states. At the same time, as we can see in the Myanmar case in 2021, R2P provided people with moral arguments by which to challenge their despotic government, arguments used as a call to the international community to stop the atrocities, arguments written on posters used during the riots, as a message to the world.

This book is meant to serve as an inspiration for those who share the idea that uniting the world is worth the efforts. We propose a method through techno-scientific space projects as one of the ways towards sustainable peace and a cosmopolitan order. The space scientific community is unique in its conviction about space being a unifying factor; however, sometimes the space community tends to think that "awareness building" is enough. The asteroid threat awareness that floats somewhere between comics (dinosaurs did not have space agency), panic (if we do not act we will be extinct), and unnecessary securitization (we must have planetary defense policy or others will do it on their own) will not help us to develop proportional planetary defense policy equally serving all people on the planet. Without moral cosmopolitan ideas encoded in states' foreign policies, we will not build an equal planetary defense system on the planetary scale, definitely not sustainably; we will not mine space resources with benefits shared across humankind; we will not travel to the stars without causing international security disturbances by building huge space propulsion lasers; and we will not cleanse our orbit of the constantly growing debris, to even have satellites there. However, at the same time, we are convinced that all these mentioned cases represent a great opportunity to develop cosmopolitan-driven foreign policies covering complex techno-scientific projects, creating what we called complex *technological interdependence* (Schmidt, 2019a) bringing us closer to cosmopolitan ideals.

The theoretical part of the book lays down the groundwork for our thinking in the following case-oriented chapters. Chapters "Reconciling Cosmopolitan Theory and Policy Practice? Responsible States as a Transitional Category" and "Cosmopolitan Visions Under the Critical Lens of Realist(ic) Geopolitics" are meant to show the underlying conflicts in the theoretical discussions between cosmopolitans and realists, not necessarily all-encompassing but certainly showing the different angles of authors' perspectives. We intentionally added the realist perspective, not to deconstruct our argument, but to let the reader form his/her own opinion of the responsible cosmopolitan policy, whether from the perspective of its feasibility or integrity in contrast to the realist criticism. Because we think that the theoretical debate can lead to another irresolvable deadlock, we added chapter "International Security Regimes, Space and Responsible Cosmopolitan States" about the theory of international regimes, to show that cosmopolitan ideas are not coming from a practical limbo, but that some regimes are not only enabled by international law but also by normative commitments producing normative frameworks and yet still influence international politics towards cooperation.

The second part of the book focuses on the idea of responsible cosmopolitan state. We decided not to stay in the waters of theory, to avoid the criticism that we are still utopians, but decided to work on a thorough legal analysis of international

space law in chapter "International Space Law as the Transiting Path to Cosmopolitan Order", to show it is cosmopolitan per se. The objective was to show the reader that states are not in a situation where they have to introduce some brave cosmopolitan ideas into a functioning, decades-long international regime regulating space, but, on the contrary, that current international space law provides them with exactly the cosmopolitan instruments and arguments to continue in cosmopolitan politics in space. The following chapter "Responsible Cosmopolitan State in Space Politics" then elaborates on the concept of responsible cosmopolitan state from a more theoretical perspective; again not necessarily all-encompassing theory is offered, but rather an attuning text that could help the reader understand how we perceive cosmopolitan responsibilities in relation to the space cases we selected for this book. Here, we focus on the deeper analysis of the concepts of "responsibility," as a complex philosophical problem, and "sovereignty," where we argue against the meaning of radical political autonomy, but rather link it to responsibility, by saying that sovereignty can be understood as autonomy. Again, not autonomy as complete freedom of decision, but autonomy as responsibility, where knowledge meets capacities to act (or not to act) while taking into consideration possible consequences, globally, on all peoples and nature.

When it comes to planetary defense, extensive research is underway by astrophysicists, astronomers, engineers, and planetary scientists within NEO (Near-Earth Object) programs worldwide, to characterize the threat of asteroids which is shared within IAWN[1] and to propose a plethora of deflection methods. All space agencies of significant space powers (USA, Russia, ESA, Japan, China) have a dedicated program that collects data from observation systems or designs a mission of asteroid deflection. The budget of the NEO program in the USA has grown more than tenfold in the last 20 years and led to the establishment of a dedicated Planetary Defense Coordination Office in 2015. The UN working group SMPAG[2], dedicated to the preparation of a planetary defense mission, meets semiannually and prepares key documents for member states to adopt, actually coining the policy for the near future. NASA and ESA with its member states agreed to proceed with a planetary defense test mission DART and HERA respectively. Therefore, defending the planet is not in the hands of militaries but rather in the hands of scientists capable to develop high-end technology for space travel, navigation, and precise impact to nudge asteroids from a collision course.

As we argued in one of our previous volumes (Schmidt, 2019b), planetary defense itself is a great opportunity for humanity to unite around a single problem with which we are capable of dealing. We argued that planetary defense is not about the probability of asteroid impact, but rather about the ethical responsibility to act in a situation in which we know we are technically capable of detecting an asteroid on a collision course and technically capable of developing a deflection mission to avoid the impact. Therefore, when one asks how probable it is, the answer is that the

[1] International Asteroid Warning Network.

[2] Space Mission Planning Advisory Group.

statistics are irrelevant, when a single asteroid could wipe out life on our planet and we have the capabilities to be prepared. In fact, given current knowledge about asteroid orbital paths, we know that an extinction-event-sized asteroid will not hit Earth, with 99% probability, in the coming decades; however, small asteroids capable of annihilating a city are hitting the Earth once in a decade, and though a small asteroid will not threaten a single state, it will threaten a group of states along the risk corridor. Simply put, asteroids will threaten the Earth, and, as such, it is not a national security concern, but a humanity/biosphere cosmopolitan security concern. These ethical perceptions should be the driver for cooperation that is still mainly limited to the scientific community. Planetary defense offers a great opportunity for humanity to prepare together for an inherently global threat: as current political representations do not reflect the threat as being imminent, scientists have the opportunity to create social structures of epistemic communities that will later be necessary for the answer. These social structures can be built with principles of cosmopolitan responsibility in mind and at the beginning of global planetary defense policy governance. We address this topic with some fresh ideas concerning global governance of planetary defense in chapter "Addressing Global Governance Gaps in Planetary Defense".

Space mining is another topic we address here, which is hot enough to give rise to international diplomatic conflict. Some countries have already introduced national laws that legitimize mining by their companies (Luxembourg, the USA, the UAE). Since then, the debate has been really harsh, due to the lack of consensus over its legality based on the Outer Space Treaty. Some scholars do not perceive the Outer Space Treaty as a burden to nationally driven efforts (Wrench, 2019), particularly a ban on appropriation of the mined material, which is an argument of many who call for following a neoliberal approach and tradition of Western colonization. This "new frontier" approach has been harshly criticized, not only because it goes against the cosmopolitan tradition in outer space, but mainly because it is simply dangerous and conflict prone (Billings, 2017). In our opinion, such incentivization of investors would violate the cosmopolitan nature of the big five treaties, missing the opportunity of setting matters up better, with a notion of solidarity in mind (Švec et al., 2020), and actually missing the opportunity of humanity to develop a new governance framework, where a concept of territory is not relevant. In the end, businesses will not be willing to go against international law for the sake of business sustainability, and the lack of current interest among the biggest mining companies proves the point. The whole discussion behind space mining is a good example of the clash between an ethically justifiable approach and general neoliberal intentions and, as such, another great example that could become a constitutive driver for new governance frameworks based on responsible cosmopolitan state principles. We show that national space mining laws can be inspired by cosmopolitan values in chapter "Space Mining: Attempts to Materialize Cosmopolitan Ideas Enshrined in International Space Law". Therefore, if we live in a world where states are still actors with power to break some political deadlocks, there is still a responsible cosmopolitan way to adopt national space mining policies.

The third topic we cover is the usage of high-powered lasers that can be used also for Breakthrough Initiatives' 200 GW Starshot system or to deorbit orbital debris. The biggest obstacles to the progress of such projects are usually threefold: technology, funding, and policy. Surprisingly, Starshot's biggest obstacle lies not in building a huge laser, but in not hitting hydrogen molecules floating in the interstellar space. The issue of technology in these cases has more to do with funding, as the technology is literally available but needs to be scaled up. Actors such as Breakthrough Initiatives will proceed thanks to philanthropist funding, which has been responsible for scientific revolutions (especially in astronomy) for centuries, and the policy will (have to) follow, because especially in the case of Breakthrough Initiatives, their visions are funded by Silicon Valley billionaires. Therefore, funds in the case of Starshot might not be an obstacle; however, billionaires are not interested in orbital debris: they want states to secure the orbits for their mega constellations. On the other hand, current discussions related to mining in space are very serious, including years-long, UN-driven working groups focusing on the topic, because if a company funded by most of the world's wealthiest people succeeded, they would have enough resources out of the Earth to fund projects in space beyond terrestrial governance, and they are openly headed in that direction (Amazon/Blue Origin project, SpaceX and global Starlink constellation as a funding source for Mars colonization efforts, based on already coined libertarian governance principles for a Mars colony, in the terms and conditions of Starlink, signed by millions of people). Therefore, we will not approach the Starshot project as an example of a super-powerful laser capable of eliminating all satellites, because it will not do so. Starshot will be strictly designed to propel nanoprobes to Proxima Centauri at 20% of light speed; however, despite its low dual-use capabilities, it will be perceived as dual-use technology in any case. Explaining the sincere intentions, justifying its construction, and securing its operation will be challenges that cannot be met by force, but by mutual understanding – functioning policy in which all actors have deep confidence. Therefore, Starshot is another example of why high-energy systems deployed in or towards space can have constitutive effects in new frameworks of global governance in which responsible cosmopolitan state principles could enjoy a pragmatic advantage. We divided this topic into two chapters, with the one that focuses on laser governance in space in general discussed in chapter "Peaceful Use of Lasers in Space: Challenges and Pathways Forward".

Beside planetary defense, space mining, or interstellar travel, the current situation with continuous deployment of the mega constellation Starlink by reusable rockets of the SpaceX company is a crystal-clear revolution in space access, not a dream, but a reality we are observing several times a month. Right now, we are opening gates to space by an unprecedented decrease of costs of access and developing security-sensitive technologies that need transparent governance to be even peacefully deployed. SpaceX is deploying thousands of new satellites and others plan to follow. Many years ago, we already knew that low Earth orbit could be turned into useless area, due to two or three collisions between satellites. Right now, we are deploying thousands of them and prepare for tens of thousands. Ground-based lasers will be absolutely necessary to deorbit small pieces; to avoid further

collisions and maintain operations of scientific, commercial, or national security satellites; and to build bigger structures in space. Moreover, so far, we have had a problem of dysfunctional single satellites; but, henceforth, the world will have to deal with thousands of dysfunctional satellites capable of destroying other operating space assets by a single hit. We do not have comparably practical technology to deorbit hundreds of millions of small pieces. This situation is so unique and serious that the possibility to lay down a governance framework to secure orbits, Earth, and our move to the solar system for future human flourishing in space is a clear necessity. NASA recently selected SpaceX Starship for a Moon landing this decade – a reusable ship capable of carrying 200t to the Moon for a fraction of the price of other options. This revolution enables visions of possible infrastructures in space that were unimaginable just months ago, but we need to have clean orbits to proceed. We address the orbital debris problem as a cosmopolitan issue in chapter "Cosmopolitan Approach to the Issue of Orbital Debris".

Space offers a plethora of challenges humanity is beginning to understand, considers natural hazards, and slowly socially constructs into security threats; however, all of these challenges will require dual-use large technical systems, and we are getting to the age in which humanity will be able to deploy them in space. We slow the progress of floods by dams in security measures; we use them for drinking water reservoirs for practical means as well. Large technical space systems will be used the same way; however, the first laser system deployment to deorbit orbital debris (space or ground) will require a serious debate at the UN to develop confidence as to its purpose. Confidence can be achieved by cooperation. Such dynamics are well known to the space community, and every single project the community talks about is surrounded by these cooperative, constitutive concepts such as confidence-building measures, deconflicting instruments, and any other new ideas based on the inherently cosmopolitan Outer Space Treaty. Discussion over the most proper method of deorbiting orbital debris will quickly come to settle on lasers, simply because of their simplicity, capability, maturity, and, due to the cooling, actually even necessary and possible deployment on the ground. The practicality of lasers to deal with orbital debris can be a constitutive driver for responsible cosmopolitan policy. In contrast to planetary defense, this is an imminent challenge we need to address right now.

The following book will provide you with our perception as to why we think that the four selected and timely cases (based on three topics: defense, economy, sensitive technologies), with a potential to develop a responsible cosmopolitan governance framework that would have been unimaginable just a decade ago, might be the key to getting past the gridlock of global governance (Hale et al., 2013; Hale & Held, 2017). Not because we think it is a good idea, but because circumstances will force states to do so. If that task is to be achieved with responsibility in mind, we should approach it with a certain measure of belief that we can change the world. The concept of responsible cosmopolitan state is precisely about encoding that change in a foreign policy of dedicated state.

The differing directions of various national foreign policies can be plainly divided into centripetal and centrifugal approaches when fulfilling national

interests. The former strictly focuses on short-term gains for the nation state, sometimes without hesitation as to the expense to others, while the latter understands one's interests in the complex of others' interests, shares expenses, and depicts interests as complementary. A responsible speech by a politician usually takes into consideration the broader (and international) consequences of decisions and depicts national interest in a complex world situated in networked interdependencies, while common far-right or populist arguments usually focus on "our own" gain that is easy to explain, easy to obtain, and easy to lose thereafter. R2P contributed to the latter perception of centrifugal interests, which, we would argue, created a new era in which these two perceptions contest. What we consider to be the main change is that it is not states, but these perceptions of national interests, that are the contested center of international ideological differences. When a contest is about a conceptualization of what "national interest" means concretely, before that interest is translated into a foreign policy, the discussion is purely philosophical and emanates from the basic moral principles with which one prefers to be associated. Moral cosmopolitanism is such a philosophical source of ideas and argues that we should focus on human beings, their virtue, and universal status in mutual equality and generality, which means everybody matters (Beardsworth, 2011, p. 24). Space, with its perspective on humanity being situated on a planet rather than in geographically divided states, provides us with a great new opportunity to put these principles in practice.

Space is a very special place, inhospitable, requiring high-end technologies for survival, and having different and various physical conditions (orbit, other planets, moons). All these conditions will have a direct impact on the way we live, interact, and govern human society in space. Therefore, we are driven by a conviction that a merely realist anarchy in space will not be beneficial to anybody and thus the characterizing of interest as centrifugal will provide gains to everybody.

Finally, contest in the sense of business competition that proves to bring flourishing to society and business is nothing other than a regulated contest. The debate is not about whether or not business should be developed, but how it should be regulated to properly distribute benefits to the society. As we argue in depth in the book, the initial idea behind the free market was meant to deliver fair trade, not only free trade. In that perspective, our goal was to identify key principles that small states can advance at the national and international level related to our four topics that can contribute towards cosmopolitanism. If one national state or a group of like-minded states can develop space governance policies that can be considered as a responsible cosmopolitan policy, they will behave as a responsible cosmopolitan state. Take a policy that reflects centripetal interests in, e.g., gains of local/national industry (which is usually not national at all) while still reflecting cosmopolitan principles, in allowing the industry to grow on the basis of transparent and predictable principles alongside the industries of other states. Such a policy proposes practical moves in the realist world, while it does not provide utopian visions of perfect societal organization. Building laser systems for orbital debris could proceed smoothly if the world can come to a consensus as to how to build and operate them, or it could become a reason for war; therefore, the main interest of all is quite clear – to build

these systems as an international community: all together is the only way. The lightness and elegance of this idea is what we have found intriguing for our cases.

Our work was driven by a conviction that even a small state can make a significant difference, if it is courageous enough. All three of the topics we mentioned above and plan to discuss here – planetary defense, space mining, and high-power lasers for security (debris) and science (propulsion) – definitely can be approached by more than one responsible cosmopolitan policy that will still be responsible from the cosmopolitan perspective. Our perspective is not, therefore, exhaustive. We are aware of other perceptions that can fulfil the principles of a responsible cosmopolitan state, which might not be covered in the following text. In some cases, we are going really deep in our analysis (chapter "Space Mining: Attempts to Materialize Cosmopolitan Ideas Enshrined in International Space Law" on space mining), while in some others, we might only depict the responsible cosmopolitan policy direction (chapter "Cosmopolitan Approach to the Issue of Orbital Debris" on debris). However, our goal was to nourish the national debate on how such a small state like the Czech Republic can be contributive in the current breaking discussions over the role of humanity in space in the coming decades.

To summarize the book in a nutshell, it is divided into four parts: theory, responsible cosmopolitan state conceptualization, cases, and technology. In Part I, the theoretical section, we begin by introducing the reader to the core of cosmopolitan thought in relation to the responsible cosmopolitan state (chapter "Reconciling Cosmopolitan Theory and Policy Practice? Responsible States as a Transitional Category"), then deal with current instruments establishing international regimes (chapter "International Security Regimes, Space and Responsible Cosmopolitan States"), and close with a realist critique, to have a realist perspective included in the book for readers, balancing cosmopolitan arguments with a classical realist rejection of their ideas (chapter "Cosmopolitan Visions Under the Critical Lens of Realist(ic) Geopolitics"). In Part II, setting out our reading of the responsible cosmopolitan state concept, we begin with a courageous attempt to characterize international space law as cosmopolitan, which is definitely difficult, due to the common fact that international law regulates relations between states; however, it still follows clearly cosmopolitan values (chapter "International Space Law as the Transiting Path to Cosmopolitan Order"). We then follow with a chapter that builds on these premises and dives into the depths of philosophy, to interpret concepts of responsibility and sovereignty for responsible cosmopolitan states willing to purse responsible cosmopolitan (foreign) policy in our four cases (chapter "Responsible Cosmopolitan State in Space Politics"). Part III then studies our four cases in detail (based on three topics as explained above), not necessarily consistently, but from the perspective of the respective authors; we begin with planetary defense, a case helping us to fill certain legitimacy gaps in global governance (chapter "Addressing Global Governance Gaps in Planetary Defense"). We continue with space mining, a case providing us with opportunity to characterize national space mining laws in a purely cosmopolitan way (chapter "Space Mining: Attempts to Materialize Cosmopolitan Ideas Enshrined in International Space Law"). We then introduce our own international policy initiative Peaceful Use of Lasers in Space, with related

debates on global governance and its gaps, to introduce a policy enabling civilian use of lasers in space (chapter "Peaceful Use of Lasers in Space: Challenges and Pathways Forward"), and finally we close this part with a more philosophical reading of orbital debris (chapter "Cosmopolitan Approach to the Issue of Orbital Debris"). Finally, in Part IV we summarize the technological readiness for our cases and begin with planetary defense (chapter "Technology Readiness and Small States' Contributions to Planetary Defense"), space mining (chapter "Asteroid Prospecting and Space Mining"), and usage of high-power lasers in general, summarizing both cases of propulsion and debris removal (chapter "High-Energy Systems Today and Tomorrow").

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References

Beardsworth, R. (2011). *Cosmopolitanism and international relations theory*. Polity.

Beardsworth, R., & Shapcott, R. (2019). *The state and cosmopolitan responsibilities*. Oxford University Press.

Billings, L. (2017). Should humans colonize other planets? No. *Theology and Science, 15*(3), 321–332. https://doi.org/10.1080/14746700.2017.1335065

Brown, G. W. (2011). Bringing the state back into cosmopolitanism: The idea of responsible cosmopolitan states. *Political Studies Review, 9*(1), 53–66. https://doi.org/10.1111/j.1478-9302.2010.00226.x

Deneen, P. J. (2019). *Why liberalism failed*. Yale University Press.

Hale, T., & Held, D. (2017). *Beyond gridlock*. Wiley.

Hale, T., Held, D., & Young, K. (2013). *GRIDLOCK: Why global cooperation is failing when we need it most*. Polity.

Keohane, R. O., & Nye, J. S. (1977). *Power and interdependence: World politics in transition*. Little, Brown.

Schmidt, N. (2019a). The political desirability, feasibility, and sustainability of planetary defense governance. *Acta Astronautica, 156*(March 2019), 416–426. https://doi.org/10.1016/j.actaastro.2018.06.037

Schmidt, N. (Ed.). (2019b). *Planetary defense – Global collaboration for saving Earth from asteroids and comets* (1st ed.). Springer. https://doi.org/10.1007/978-3-030-01000-3

Švec, M., Bohacek, P., & Schmidt, N. (2020). Utilization of natural resources in outer space: Social license to operate as an alternative source of both legality and legitimacy. *Oil, Gas & Energy Law Journal (OGEL), 18*(1), 0–19.

Wrench, J. G. (2019). Non-appropriation, no problem: The outer space treaty is ready for asteroid mining. *Case Western Reserve Journal of International Law, 51*, 437.

Part I
Perspectives on Cosmopolitan Responsibility

Reconciling Cosmopolitan Theory and Policy Practice? Responsible States as a Transitional Category

Pavel Dufek

1 Introduction

The academic philosophical discourse on cosmopolitanism, global (in)justice, global democracy and countless global (or even extra-terrestrial) challenges to humanity – in short, global political theory (Brooks, 2020; Held & Maffettone, 2017) – may leave the uninitiated wondering about its practical relevance. For no matter how inventive, well-argued or strongly motivated these scholarly contributions are, one can hardly miss their remoteness from what is realistically expectable in world politics. Take, for instance, Thomas Pogge's well-known arguments on behalf of 'minor reforms' of international law as first steps towards eliminating global injustices. Pogge suggests abandoning certain privileges granted to governments of internationally recognised sovereign states, such as the right to use natural resources found in their territory as they see fit, the right to borrow money from abroad or the right to purchase arms for purposes of 'self-defence' (Pogge, 2005, p. 109, 2008, p. 119). On the one hand, Pogge's appeal is realistic in the sense that it does not demand large-scale societal transformations – all we need, at least for starters, are a couple of tweaks in extant international law, plus, arguably, the annual global transfer of funds from the rich to the poor, a couple of hundred billion dollars, perhaps, to kick-start the eradication of world poverty (Pogge, 2010, p. 54). On the other hand, it is unlikely that the very actors in question – sovereign states,

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among them especially the great powers – will voluntarily saw off the branch they have been sitting on quite comfortably for decades. What, then, is there to say about ambitious cosmopolitan proposals which are part and parcel of the work of professional political philosophers, such as global equality of opportunity (Caney, 2005; Moellendorf, 2006), open borders (Carens, 2013) or global climate justice (Caney, 2020)? What is the point and purpose of academic normative theorising about world politics? The kind of scepticism voiced among others by Bohumil Doboš (see chapter "Cosmopolitan Visions Under the Critical Sight of Realist(ic) Geopolitics") in part feeds off precisely such kind of practical concerns.

The present chapter generally assumes that this criticism may be based on a misconception about what cosmopolitanism, understood as a broad moral conviction grounding a varied set of approaches to political theorising about world politics, is meant to provide and achieve. My implicit point is thus that cosmopolitan political theorising has some value independent of whether it can offer decision-makers neat what-to-do checklists or whether it has an immediate response to the realist 'objection from the existence of great powers'. Moreover, the idea of a responsible cosmopolitan state (henceforth also RCS) promises a fruitful middle ground between utopian theorising and acquiescence to the status quo. It does not follow that the RCS is the magic bullet that cosmopolitan theory can easily fire into political practice. I will, however, try to show that a perspective that is neither missionary nor thoroughgoingly sceptical is precisely the in-between approach that philosophical reflection on (world) politics should be looking for if it is to retain both a critical edge and practical relevance. Because the theorist's point of view is necessarily different from that of the decision-maker, she might notice things which elude those acting in the line of duty. One of my partial goals in this chapter is to show how a set of practically oriented considerations related to responsible cosmopolitan states nevertheless invites more ambitious utopian theorising through the back door.

2 What Is the Point of Theorising About World Politics?

To better appreciate what contribution to political practice cosmopolitan theorists may be expected to provide, it is worth discussing what political theory is *capable* of providing in the first place. (1) For many (Rawls, 1999, pp. 136–137), it must aspire to identify the desired goals of political activity (*what we ought [not] to strive for*) and the corresponding criteria of the evaluation of such activity (*which types of actions, structures or institutions are right/wrong, just/unjust etc.*). Here, it is at its most utopian, not only envisioning what is the desired institutional framework but also criticising the status quo for not living up to the ideal. This goal-setting task often requires (2) conceptual investigation, that is, the clearing up of confusions about the meanings of basic political concepts and their relationship to political reality, as well as the justification of which of the competing interpretations of a given concept is preferable. Notions such as freedom, peace, justice, solidarity, security and universal prosperity would surely receive approval from all sides of the

political spectrum, yet it is doubtful the meanings ascribed to them by the respective actors would be equivalent. The same goes for their opposites such as injustice or insecurity. At the very least, then, political theory helps to avoid talking past each other; in the best scenario, conceptual investigation discovers reasons to prefer one interpretation of a concept over others. (3) Clearing up the meanings of concepts facilitates thinking about specific institutional arrangements. These will still be idealised in the sense that although they are meant to orientate our actions in the real world, they do not constitute pieces of immediate political/policy advice. The idea of relational sovereignty which underpins the concept of the RCS could be understood as such a type of institutional arrangement.

(4) Somewhat less obviously, political theory might or might not be capable of recommending what we should do *here and now*. This is less obvious because this type of immediate practical advice requires incorporating at least some features of the current world which would arguably not be present in the idealised state of society as theorised under (1), (2) or (3) (such as poverty, exploitation, selfishness, power inequality, weakness of will and a host of other 'bad facts'; cf. (Estlund, 2019)). Moreover, theorists offering such advice must be aware of the hard, factual constraints of political action, such as the widely diverging interests, preferences and identities of major players in global politics, or (less obviously) the dictates of international law (let me call these 'constraining facts'). Accordingly, this approach requires a different type of knowledge than the kind political theorists usually possess; competence in matters of a great many social sciences, the humanities and possibly also the natural sciences may prove necessary for sound political advice.

It might be objected that the way political theorists understand their vocation is hardly relevant for practical politics. However, the struggle over meanings of words is central to both worlds. When the prime minister of an EU member state announced that the future would belong to *illiberal*, *national democracy*, as opposed to declining *liberal democracy* (Orbán, 2014), he probably had in mind particular images of what those notions stood for, and the fact that those images are still shared by many voters helps him stay in power (and alienate much of the rest of the EU). Article 2 of the Treaty on European Union states that the EU is based on the values of human dignity, freedom, democracy, equality, non-discrimination, tolerance, justice, solidarity and so on; yet what these words entail is not quite clear.[1] Does 'equality between women and men' require legislated quotas on party candidate lists or even reserved seats in legislative bodies? What follows from the non-discrimination principle in matters of hiring? Does human dignity prohibit lending oneself to being tossed by other people for fun (and being paid handsomely for it)?[2] The related political action often takes intellectual inspiration from seemingly distant philosophical debates. As students of the history of political thought have amply demonstrated, it is through the reconceptualisation of basic elements of political language

[1] See https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:12012M002&from=EN

[2] See, e.g. the discussion in Rosen (2012, Chapter 2).

which are employed to describe and evaluate the social reality that political theory has participated in real-world social and political struggles (Skinner, 2002).

3 Toning Down Cosmopolitan Idealism: The Idea of a Responsible Cosmopolitan State

Moving from tasks (1) to (4) outlined in the previous section involves increasing attention to bad and/or constraining facts which accompany real-world political action.[3] Insofar as cosmopolitanism wants to be not only philosophically true but also practically useful, it needs to tone down its idealist pretensions and take seriously world politics as it is – including the persevering role of territorial states. This is the perennial lesson of political realism, whatever particular shape it acquires: ignoring how the world is, on behalf of narratives about how it should be, will likely result in misleading guidelines for political action.

Interestingly, the global scope of many looming threats and challenges has led many cosmopolitan political theorists to develop normatively highly ambitious visions of how global political institutions *ought to* be organised. A wealth of distinct models of different kinds have been devised by political theorists, to the effect that even the typologies of these positions do not overlap (Kuyper, 2015; Macdonald, 2017; Marchetti, 2012). For example, a lot of energy has been invested into exploring what democracy might mean and require beyond the state, ranging from the idea of a *global demos* (Valentini, 2014) through multi-level cosmopolitan citizenship (Archibugi, 2008) to functionally defined transnational *demoi*, basically a flexible set of stakeholders whose composition varies according to the issue at stake (Besson, 2009; Macdonald, 2008). Others are less enamoured with the prospects of democracy and invest their hopes in the cosmopolitan potential of international and/or supranational law, be it the pluralist, polycentric narrative (Krisch, 2010) or the integrative promise of global constitutionalism (Belov, 2018; Dunoff & Trachtman, 2009). Still others believe in the legitimising capacity of supranational or global *public reason*, thus putting into use a central concept of much of contemporary philosophical thinking about legitimacy (Sadurski, 2015). Finally, output-oriented visions of the transnational cooperation of technocratic elites should be mentioned, due to their importance for thinking about the EU as the archetype of governing beyond the state (Majone, 1996; Scharpf, 1999).

Note that the 'loser' is almost always state sovereignty, together with national allegiances and the territorial demarcation of political communities. This is what makes such visions utopian, for they disregard the continuing capacity of states to alter the availability of such trajectories, not least by reclaiming sovereignty (think of Brexit), as well as the emotional patriotic bond cultivated by the states among

[3] This is the prominent understanding of the distinction between ideal and non-ideal theory, which is an important element of the methodology of political theory; see Stemplowska and Swift (2012).

their citizenries. In order to remain practically (politically) relevant for the here and now, cosmopolitan political theory must find a way of reconciling its moral ideals to world politics as it is. In other words, if it is to provide plausible and sound political guidelines, it needs to realistically come to terms with the continuing importance of territorial states for world politics. The recent turn in global political theory to the idea of a 'responsible cosmopolitan state' (Brown, 2011), 'cosmopolitan responsible state' (Beardsworth & Shapcott, 2019, pp. 8–9), or 'statist cosmopolitanism' (Ypi, 2008) is meant to achieve precisely that.[4] Upon suitable adjustments to their normative equipment, including foreign policy goals, states are potentially the primary *agents* of cosmopolitan political goals, even though they may be joined by a plethora of other actors, depending on the issue at hand and the resulting constellation of interests ('stakes') (Archibugi & Held, 2011; Ypi, 2012). The idea of an RCS is primarily aimed at smaller and mid-sized states which are not directly involved in great-power politics. As such, they can be expected to have more significant room for the incorporation of elements of cosmopolitan political morality and the corresponding practical goals in their behaviour in world politics.

The next two sections are devoted, first, to explaining how a political theory of RCSs may help deflect the neorealist geopolitical challenge and, second, to discussing certain blind spots of the concept of RCSs itself, as seen against the theoretical background outlined in the previous sections. I should emphasise that my own sympathies ultimately lie with a certain conception of a cosmopolitan state, even though I am probably less sanguine than most theorists sympathetic to the model about its immediate practical prospects (Dufek, 2013; Dufek & Mochtak, 2019). As in many other spheres of human activity, not all good things necessarily go together in world politics. At the same time, I see no reason to believe that good things can never happen in tandem, as Doboš's (neo)realist geopolitics seems to imply (see chapter "Cosmopolitan Visions Under the Critical Sight of Realist(ic) Geopolitics"). As William Scheuerman (2011) has stressed, the realist tradition in international relations harbours much more progressive musings than the neorealist narrative wants to allow. One important motivation for this belief is the awareness of collective action problems to which I shall keep coming back.

4 RCSs Against Neorealist Reductionism

Combining the first three tasks of political thinking discussed in Sect. 2, global political theory may be said to be primarily concerned with the question of 'how best to design the fundamental institutions through which political power is constituted, controlled and distributed within global society' or 'which existing such institutions are worthy of ongoing support, and on what basis' (Macdonald, 2017, p. 76). These are, of course, *normative* questions, but that is hardly something to be

[4] Compare also the related legal/constitutionalist-centred perspective in Somek (2014).

ashamed of. When neorealist geopolitics offers political or policy advice, it does so on the basis of its own preferred normative criteria, these telling neorealist theorists which of the myriad of bare facts about world politics to prioritise or at least take into account. Neorealist geopolitics thus responds to the very same question as the most utopian of cosmopolitan visions; it just employs idiosyncratic standards with respect to what is a good or convincing answer. In the most general terms, these standards amount to peculiar interpretations of *rational self-interest*. The problem is not with self-interest as such, because the notion is an empty vessel which needs to be filled with content if it is to be analytically and/or normatively useful. The neorealist is right to the extent that cosmopolitan guidelines of political action are currently unlikely to be shared by the decisive actors of world politics. However, this is not an ontological or even anthropological fact: we *know* that the interests, preferences and identities of collective actors can and do change, so that what is deemed 'rational' and 'irrational' by them changes accordingly. I do not think there is anything incredible about this claim; if there was, then constructivism would not be a thing in the study of international relations or elsewhere.[5]

Accordingly, to claim that the conduct of states follows solely rational self-interest and imply that self-interest necessarily results in power conflicts is to overlook the modifying role played by norms. Prominent among them is international and/or supranational law, including rapidly expanding areas like human rights law, trade law and environmental law, as well as the more established ones (e.g. the law of the sea).[6] It is to be expected that outer space will also be increasingly covered by an ever denser network of international and/or supranational legal regulations, perhaps more overtly imbued with cosmopolitan intent. I am far from arguing that international law will solve the problem of power politics any time soon; that would certainly be naïve. At the same time, it would be a mistake to assume that international law which imposes on its subjects obligations which are in principle enforceable is completely inert with respect to the subjects' conduct in world politics. International law in some form or other has accompanied inter-society relations since ancient times (Kingsbury & Straumann, 2010; Shaw, 2018, Chapter 1), which means that it has always provided an alternative normative framework of conduct to that of rational self-interest understood in the (neo)realist geopolitical way (i.e. as pertaining to actors who look solely for unilateral gains and benefits, judged against the background of a zero-sum view of world politics). Pointing out instances of states' ignorance of international law on behalf of their selfish interests may ultimately undermine the sceptic's position, because it is not difficult to identify instances of their submitting to the values embodied in international law *in defiance* of immediate unilateral gains (trade law is a textbook example here). At the very least, the very fact of the existence of impartial rules of conduct, which often entail

[5] See prototypically Wendt (1992).

[6] Those embedded in the tradition of Roman law might want to distinguish between public and private variants of international law; I do not think this affects my explication in any way. For reasons of simplicity, I will use the term 'international law' as covering all the modalities of extra-statal law, including 'supranational', 'cosmopolitan', 'global' etc. law.

penalties or punishments for noncompliance, becomes an input to the calculation of self-interested gains. Put more ambitiously, rather than merely 'a simple set of rules', international law may grow into 'a culture in the broadest sense in that it constitutes a method of communicating claims, counter-claims, expectations and anticipations as well as providing a framework for assessing and prioritising such demands' (Shaw, 2018, p. 67).

One core motivation for perceptiveness towards extra-statal sources of norms of conduct is the realisation that the sustenance of state capacities themselves is preconditioned by events which take place beyond state borders. The institutional structure of which international law is a central part renders these events at least partly predictable, allowing individual actors to adjust to expected scenarios.[7] Perhaps even more importantly, shared rules of conduct allow for more effective coordination in cases where *collective action* is required. In particular, if there is disagreement about the required, permitted or prohibited course of action, and if the action that is permitted or required cannot be pursued unilaterally if the given goals are to be achieved, impersonal rules may greatly help coordinate on an effective response. Climate change and the threat of asteroid impact are paradigmatic examples of existential import; for many states, however, more 'mundane' issues such as mass migration, rules of world trade, intellectual property rights or the impact of global financial transactions raise more immediate concerns.

If a positive impact is to be achieved, then international law obviously requires that the most powerful actors accept it as authoritative and take seriously the resulting duties and limitations on unilateral conduct that it imposes – in other words, international law needs to enjoy sociological legitimacy. Rejecting that this is how things work in world politics represents another piece of the neorealist geopolitical challenge. However, scholars of neither international law nor world politics unanimously share this scepticism. It might be the case that less powerful or outright weak states have more direct interest in there being external constraints on the conduct of the powerful,[8] which again renders weaker states as primary candidates for the role of agents of cosmopolitan political morality. Whether great powers share this interest or not is a *contingent* rather than conceptual matter. Accordingly, the cosmopolitan argument is that collective action problems arising from empirical realities of the twenty-first century increasingly put great powers under pressure to accept such self-imposed constraints and comply with them.

[7] Making it possible for an agent to form stable expectations about the likely behaviour of others, as well as about *their* expectations regarding one's own behaviour, is perhaps the greatest benefit of stable social rules in general. See, e.g. Bicchieri (2006).

[8] The *Melian dialogue* as recounted in Thucydides' *History of the Peloponnesian War* is a classic example.

5 Pitfalls of Bringing the State Back in Global Political Theory

Some political theorists have insisted that states as we know them – territorially based, claiming jurisdiction over their territory, bonded by common feelings (of nationality or otherwise) – need to remain the primary actors of world politics as well as the central subject matter of political theorising, at least for the foreseeable future. However, there is a decisive difference between, on the one hand, the work of John Rawls (1999), David Miller (2007), Michael Walzer (1994), Robert Dahl (1999), Michael Blake (Blake, 2013a) and others and the concept of a responsible cosmopolitan state on the other, in that the former never construed states as primarily efficient means to achieving cosmopolitan (non-statist) goals. It might ultimately be true that even the former are susceptible to the cosmopolitan label, insofar as the moral egalitarian plateau which Western political theory has almost universally accepted implies that 'we are all cosmopolitans now' (Blake, 2013b; Kymlicka, 2002, pp. 2–3). While the positions of Rawls et al. are normally labelled as 'statist' or 'nationalist' to mark their opposition to cosmopolitan political theory (Brock, 2009; Hutchings, 1999), their theories do indeed incorporate fundamental elements of universal (= cosmopolitan) moral concern such as the importance of basic human needs or rejection of economic exploitation between countries.[9] But their 'cosmopolitanism' is reluctant and mostly forms an appendage to essentially particularistic normative-political visions.

In contrast, for RCSs, cosmopolitan values, principles, and goals are paramount, with cosmopolitan states taking up the role of the foremost agents of cosmopolitan morality. The suggestion that states could become the flagbearers of ideals which seemingly contradict the nature of sovereign stateness indeed represents a major change of focus in a literature which used to rather begrudgingly accept the state as an unfortunate remnant of a particularistic past, one which needs to be dealt with by non-ideal theory. I count myself among those who applaud the shift in focus, for any political theory which aims to guide political action needs to accommodate, in a *non-ad hoc manner*, the actor around whom the current architecture of the world order has been erected. However, even though this is a move in the right theoretical direction, certain questions linger which indicate that there is still a lot of work ahead for both cosmopolitan theory and practice. In the remainder of this section, I discuss two such issue areas: the motivational plausibility of the RCS model and the kind of reconceptualisation of sovereignty the model officially requires. In the concluding section, I explain why RCSs represent, in my view, a transition stage on the route towards global political authority.

[9] In this sense, they must not be confused with the 'everyday nationalism' and state-worshipping which politicians so often use to mobilise the masses.

5.1 Motivational Issues

The trouble with reasonably functioning democratic countries is that decision-makers qua political representatives are normally expected to be sufficiently (if not fully) responsive to the interests, preferences, identities etc. of those they represent – that is, the citizenry at large or some subset thereof. Also, they are normally held accountable for their actions by those represented, via elections or otherwise. The problem should be obvious: all the talk about cosmopolitan sentiments, responsibilities or duties of states may quickly hit a wall of self-regarding demands and preferences on the part of the citizenry. Suppose one such cosmopolitan duty concerned the accommodation of migrants from poor countries, theorised by some cosmopolitans as a part of the topic of global (in) justice (Carens, 2013). It seems likely that any government which significantly opened its borders in compliance with these moral ideals (think of EU-type 'redistributive' immigration policies on steroids) would face a backlash from citizens. Brexit could also be construed as an example of a momentous domestically driven political decision which rejected the bindingness of cosmopolitan values and universal responsibility upon which the EU's identity supposedly rests (Beck & Grande, 2004).[10] The crucial point, however, is that governments which disregarded the will of the country's citizens would, as governments of democratic countries, be acting *illegitimately*.[11]

The more ambitious the cosmopolitan goals are, the less likely it is that democratic countries will be able to play their part on the basis of their internal motivational resources. Also, the *more* likely it is that these goals, as translated into policy priorities, will trigger a backlash of particularistic sentiments which are still deeply embedded among citizens: they are '*felt* and *lived* rather than learnt' (Ulaş, 2017, p. 666 emphasis in original) or theorised. On the face of it, the RCS vision cannot do without the systematic, intensive cosmopolitan education of citizens. But we know that the EU itself struggles with creating the kind of shared identity which would ensure pan-European loyalty and solidarity even in times of crises. Yet the centralisation – here, Europeanisation – of school curricula remains a highly sensitive topic among EU member states, seemingly infeasible in the short and mid-term. Although there might be objective moral and factual reasons for wanting to go the RCS route, this is still quite remote from citizens *internalising* these reasons so that they inform and direct their deliberations and decisions on difficult political topics. In more technical terms, *justifying reasons* are not necessarily also *motivating reasons*, which constitutes a problem for non-ideal theory aiming to guide us here and now (Alvarez, 2020). At the very least, cosmopolitan education is a lengthy process with delayed payoffs. Any state which aspires to set the avant-garde

[10] Compare also Article 2 of the (consolidated) Treaty on European Union.

[11] For instance, the Czech constitution (Art. 65[2]) states that the President of the country can be tried for treason, which 'is deemed to mean any conduct of the President of the Republic directed against the *sovereignty* and *integrality* [sic] of the Republic as well as against the democratic order of the republic'. Italics added; see https://public.psp.cz/en/docs/laws/constitution.html

cosmopolitan pace *and* wants to remain a democracy needs to grapple with the challenge of adequate education, preferably in some level of coordination with other similarly minded actors.

5.2 Which Sovereignty?

It might be objected that while I show some sensitivity to variations in the globalist position and the numerous novel conceptions of democracy which accompany global democratic visions, I do little justice to what the notion of a 'sovereign state' might stand for. Indeed, up to now I have been rather silent about the conceptual background of a responsible cosmopolitan state. *Sovereignty* understood as the highest, ultimate, supreme authority in a given realm (usually the territory of a state) has long been the bogeyman of not only cosmopolitan political thought. As such, it has been accordingly either roundly rejected (Arendt, 1961, p. 163; Maritain, 1951, pp. 49–53) or variously disaggregated and retheorised so that it could become compatible with cosmopolitan goals *without* the need for a simultaneous global replication of sovereign stateness (Caney, 2005, Chapter 5; Keating, 2001). In international legal and political practice, a counterpart development resulted in the *Responsibility to Protect* doctrine (R2P) at the beginning of the new millennium, which is often understood as opening a new chapter in the history of state sovereignty (Evans, 2008; Orford, 2011). Also, the political trajectory of the European Union has been hailed as evidence of the viability of a post-sovereign (post-national, post-statist) political order in which sovereignty still has its place, albeit in a dispersed, pooled, relational etc. form (Beardsworth & Shapcott, 2019; Habermas, 1998; Pogge, 1992).

However, post-sovereign approaches to sovereignty rest on a misconception about what the point of the concept is. Cosmopolitans tend to equate sovereignty with *state sovereignty* and argue that in its 'traditional' form, it is neither empirically adequate as a description of the current realities of the globalised world nor morally sustainable once balanced against cosmopolitan ideals such as human rights or global justice. But such a construal of sovereignty takes the concept as representing some quantifiable good that real-world entities such as states may possess in different degrees. The quality of 'being sovereign' would then imply both exclusive possession of the good inwards ('internal sovereignty') and the unconstrained ability to express and perhaps realise state goals outwards ('external sovereignty'). This understandably triggers both descriptive and normative criticism of the concept of sovereignty. But the victory comes cheap, as none of the assumptions are conceptually necessary. Sovereignty neither describes or requires empirically or morally unconstrained action, nor represents a good that can be variously added to, subtracted from or distributed among actors, nor pertains exclusively to states. But I do not follow those who speak about *different types* of sovereignty either (Krasner, 1999). Rather, I suggest understanding the concept as capturing a particularly modern way of allocating the authority to set up binding criteria of right and wrong political action, of desirable and undesirable political goals (Belling, 2019). Under

this construal, sovereignty presupposes a *subject* which articulates the desired criteria. This is why the concept of sovereignty has been so amenable to *democratic* interpretations, which in turn renders the idea of *popular sovereignty* among the core defining elements of democratic political rule. Precisely because a democratic people is sovereign, it can give unto itself the basic rules of social cooperation (i.e. the constitution, in liberal democracies at least).

Seen from this angle, calls for a dispersion of sovereignty away from the state level leave political theory with few options, because we still need to identify the subject of sovereignty. (A) Insofar as cosmopolitan values, principles and goals are to be retained, one possibility is to accept the normative superiority of a cosmopolitan moral order which precedes the existence of individual political units and largely determines the criteria of right and wrong political action. Since the mid-twentieth century, the prominent expression of such higher order has been *human rights*, which are usually networked to a host of further cosmopolitan ideals such as fair treatment or equality of opportunity. However, human rights never come into the human world as some unchangeable *eidos*. Even as positivised *international human rights* (Alston & Goodman, 2013; Donnelly, 2013), they need to be *interpreted*: that is, their meaning and content have to be specified and applied to particular cases. For our present purposes, this means that whoever provides an authoritative interpretation of human rights becomes the sovereign in the realm of human rights and, by extension, in any realm where human rights themselves are supposed to possess supreme normative authority.[12] (B) The other option is to supplement the 'cosmopolitisation' of political morality with an analogous move on the *demos* side, so that the link between legitimacy and democracy remains strong. This is where philosophical attempts to substantiate the possibility (or even current existence) of a *global demos* find their sweet spot, for they help maintain the link between cosmopolitan moral goals and a global subject which is supposed to articulate them.

Nonetheless it should be clear that whichever conception of democratic subjectivity is ultimately preferred, it will not be easily incompatible with the idea of a responsible cosmopolitan state – for the simple reason that the point of cosmopolitan political morality is to move away from the state level as the decisive locus of authority. What matters, then, is that RCSs are required to become *cosmopolitan* states, rather than them remaining as cosmopolitan *states*. This means that they would become primarily accountable to guardians of cosmopolitan goals and values, rather than directly the wishes and demands of their citizens. In turn, the motivation problem kicks in again. It seems to me that a possible way out is to reduce the normative expectations placed on the shoulders of RCSs, that is, to admit a healthy dose of non-utopianism (realism, if you wish) into cosmopolitan political morality, as discussed in Sect. 3.

[12] Hence the polemical label of (international) *juristocracy* (Hirschl, 2004): courts and international courts are precisely those bodies which make such authoritative interpretations.

6 Conclusion: Responsible Cosmopolitan States as a Transitional Stage

Assuming we are aware of the obstacles discussed in the previous section, and accordingly avoid overloading RCSs with unrealistic expectations, small and mid-sized states may indeed become key agents of a different future for humankind. There is a strong constructivist element in this vision, because it takes as granted the malleability of actors in world politics (Dufek, 2013, p. 204). The idea of an RCS can then inform reflection on further salient questions of world politics, such as possible ways of improving legitimacy in various areas of governance beyond state borders. Frameworks of decision-making regarding the space-policy challenges of orbital debris removal, planetary defence against asteroid and comet impact and space exploration and the exploitation of space resources – an area where advanced science and politics inevitably meet – are one such fruitful area of research (Boháček et al., 2021). But it is crucial not to lose track of the larger cosmopolitan goals which transcend the individual political strategies of a few countries. As students, analysts and theorists of world politics, we cannot but remain at least partly utopian (idealistic) in an important sense which I want to specify in this concluding section.

The cosmopolitan ideal certainly does not consist in a bunch of lesser actors engaging in a progressive yet ultimately futile sideshow. There must be the aspiration to make international law truly cosmopolitan and to turn over strongly self-regarding great powers to the party of the good. At the very least, the future of humanity must be envisioned by cosmopolitans as one inhabited by political bodies that are in their majority aware of their cosmopolitan responsibilities/duties and willing to discharge these duties, as well as assisted in this by enforceable legal or political norms. In short, the ideal points to a kind of *system* of responsible cosmopolitan states which perseveres over time and does not fall prey to purely self-regarding adventures of a random great power.

If we are after such *robustness*, however, then a host of intriguing questions about the shape of such a system arise. Suppose for the sake of argument that cosmopolitan innovators are, within some reasonable timeframe, successful in diffusing their values and motivations across the globe, so that the desired cosmopolitan norms have been internalised by a great many actors. It is plausible to assume that the problem of collective action, especially as regards the provision of public goods and the related threat of free riding, will thus have been mostly solved (Gaus, 2008, pp. 84, 102). Nonetheless, there are *practical/pragmatic* reasons why a world populated by responsible cosmopolitan states remains vulnerable to a tilt towards a world state. For one, the transactional costs of exchanging and pooling knowledge and executive capacities among formally independent actors who otherwise share the same set of cosmopolitan values and goals come as unnecessary and even counter-productive, when compared to the globally centralised alternative (Ulaş, 2017, p. 667). Moreover, types of action which require concerted effort on the part of many parties – the bundle of climate change goals representing a fitting example – seem to call for the deliberate *creation* of a centralised coordinating authority, so

that at least a part of the epistemic, administrative and enforcement burden can be shifted to another agent.

The idea of a centralised global political authority with legitimate coercive power usually brings disquiet to political theorists. Accordingly, one major motivation behind the sophisticated visions of global political rule mentioned in Sect. 3 is precisely to avoid the world-statist spectre, which seems to threaten global despotism, global paternalism and other bad stuff. I have argued in earlier texts that as long as such cosmopolitan normative visions are morally highly ambitious, the world-statist alternative seems practically more robust and conceptually more consistent than numerous multi-level visions of global rule (Dufek, 2013, 2019; Scheuerman, 2011, 2014). It is worth noting that besides normative reasons (Cabrera, 2004; Ypi, 2013), also certain empirical trends and fairly uncontroversial assumptions about the nature of the actors of world politics have been cited by proponents of the world-statist alternative. For example, legal theorist Joel Trachtman argues that because of the increasing density and scope of international law, international organisations will gradually take up and perform governmental functions. Functional necessities arising from globalisation and transnationalisation render such development 'necessary' in Trachtman's view, which is why he thinks that 'the future of international law is global government' (Trachtman, 2013, p. 3).[13]

I am not trying to make a prediction about the future à la Trachtman or Wendt. My point is more modest and takes us back to the roles political theory can play, as discussed in Sect. 2. Earlier I pointed out that the idea of a responsible cosmopolitan state allows political theorists to keep providing normative guidelines while staying in close touch with present-day political realities. As it turns out, however, there are reasons to believe that, normatively speaking, an RCS is mainly a *transitional stage* towards a globally centralised political authority, rather than an end in itself. After all, RCSs need to tie their foreign policy to some set of criteria which transcend the bare facticity of world politics. Even though it might be found awkward as regards the provision of useful policy/political advice here and now, (cosmopolitan) political theory remains unmatched in the task of exploring the limits of the politically possible. If what I say here holds water, then the 'practical' idea of a responsible cosmopolitan state inevitably contains the seeds of highly utopian political thinking.

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[13] The modern *locus classicus* concerning the empirical inevitability of the emergence of a world state is Wendt (2003).

References

Alston, P., & Goodman, R. (2013). *International human rights*. Oxford University Press.

Alvarez, M. (2020). Reasons for action: Justification, motivation, explanation. In E. N. Zalta (Ed.), *Stanford encyclopedia of philosophy*. https://plato.stanford.edu/entries/justice-climate/

Archibugi, D. (2008). *The global commonwealth of citizens: Toward cosmopolitan democracy*. Princeton University Press.

Archibugi, D., & Held, D. (2011). Cosmopolitan democracy: Paths and agents. *Ethics & International Affairs, 25*(4), 433–461. https://doi.org/10.1017/S0892679411000360

Arendt, H. (1961). What is freedom? In *Between past and future: Six exercises in political thought*. Viking Press.

Beardsworth, R., & Shapcott, R. (2019). *The state and cosmopolitan responsibilities*. Oxford University Press.

Beck, U., & Grande, E. (2004). *Das Kosmopolitische Europa: Gesellschaft und Politik in der zweiten Moderne*. Verlag.

Belling, V. (2019). *Smrt suveréna?* Centrum pro studium demokracie a kultury.

Belov, M. (2018). *Global constitutionalism and its challenges to westphalian constitutional law*. Bloomsbury Publishing. https://books.google.at/books?id=nDNWDwAAQBAJ

Besson, S. (2009). Institutionalising global demoi-cracy. In L. H. Meyer (Ed.), *Legitimacy, justice and public international law* (pp. 58–91). Cambridge University Press. https://doi.org/10.1017/CBO9780511691720.003

Bicchieri, C. (2006). *The grammar of society: The nature and dynamics of social norms*. Cambridge University Press.

Blake, M. (2013a). *Justice and foreign policy*. Oxford University Press.

Blake, M. (2013b). We are all cosmopolitans now. In *Cosmopolitanism vs. non-cosmopolitanism: Critiques, defenses, reconceptualisations* (pp. 35–54). Oxford University Press.

Boháček, P., Dufek, P., & Schmidt, N. (2021). Peaceful use of lasers in space: Context-based legitimacy in global governance of large technical systems. *Alternatives: Global, Local, Political, 46*(3), 63–85. https://doi.org/10.1177/03043754211039624

Brock, G. (2009). *Global justice: A cosmopolitan account*. Oxford University Press.

Brooks, T. (2020). *The Oxford handbook of global justice*. Oxford University Press.

Brown, G. W. (2011). Bringing the state back into cosmopolitanism: The idea of responsible cosmopolitan states. *Political Studies Review, 9*(1), 53–66. https://doi.org/10.1111/j.1478-9302.2010.00226.x

Cabrera, L. (2004). *Political theory of global justice: A cosmopolitan case for the world state*. Routledge.

Caney, S. (2005). *Justice beyond borders. A global political theory*. Oxford University Press.

Caney, S. (2020). Climate justice. In E. N. Zalta (Ed.), *Stanford encyclopedia of philosophy*. https://plato.stanford.edu/entries/justice-climate/

Carens, J. (2013). *The ethics of immigration*. Oxford University Press.

Dahl, R. A. (1999). Can international organizations be democratic? A skeptic's view. In I. Shapiro & C. Hacker-Cordón (Eds.), *Democracy's edges* (pp. 19–36). Cambridge University Press.

Donnelly, J. (2013). *Universal human rights in theory and practice*. Cornell University Press.

Dufek, P. (2013). Why strong moral cosmopolitanism requires a world-state. *International Theory, 5*(2), 177–212. https://doi.org/10.1017/S1752971913000171

Dufek, P. (2019). Why a world state is unavoidable in planetary defense: On loopholes in the vision of a cosmopolitan governance. In N. Schmidt (Ed.), *Planetary defense* (pp. 375–399). Springer. https://doi.org/10.1007/978-3-030-01000-3_24

Dufek, P., & Mochtak, M. (2019). A case for global democracy? Arms exports and conflicting goals in democracy promotion. *Journal of International Relations and Development, 22*(3), 610–639. https://doi.org/10.1057/s41268-017-0114-0

Dunoff, J. L., & Trachtman, J. P. (2009). *Ruling the world? Constitutionalism, international law, and global governance*. Cambridge University Press.

Estlund, D. (2019). *Utopophobia: On the limits (if any) of political philosophy*. Princeton University Press.
Evans, G. (2008). *Responsibility to protect: Ending mass atrocity crimes once and for all*. Brookings Institution Press. http://site.ebrary.com/lib/cuni/docDetail.action?docID=10338435
Gaus, G. (2008). *On philosophy, politics, and economics*. Thomson Wadsworth.
Habermas, J. (1998). *Die Postnationale Konstellation. Politische essays*. Suhrkamp Verlag.
Held, D., & Maffettone, P. (2017). *Global political theory*. Wiley.
Hirschl, R. (2004). *Towards juristocracy: The origins and consequences of the new constitutionalism*. Harvard University Press.
Hutchings, K. (1999). *International political theory: Rethinking ethics in a global era*. SAGE.
Keating, M. (2001). *Plurinational democracy: Stateless nations in a post-sovereignty era*. Oxford University Press.
Kingsbury, B., & Straumann, B. (2010). State of nature versus commercial sociability as the basis of international law: Reflections on the Roman foundations and current interpretations of the international political and legal thought of Grotius, Hobbes, and Pufendorf. In S. Besson & J. Tasioulas (Eds.), *The philosophy of international law*. Oxford University Press.
Krasner, S. (1999). *Sovereignty organized hypocrisy*. Princeton University Press.
Krisch, N. (2010). *Beyond constitutionalism: The pluralist structure of postnational law*. Oxford University Press.
Kuyper, J. (2015). Global democracy. In E. N. Zalta (Ed.), *Stanford encyclopedia of philosophy*. https://plato.stanford.edu/entries/global-democracy/
Kymlicka, W. (2002). *Contemporary political philosophy*. Oxford University Press.
Macdonald, T. (2008). *Global stakeholder democracy: Power and representation beyond liberal states*. .
Macdonald, T. (2017). Global political theory. In D. Held & P. Maffettone (Eds.), *Global political theory*. Wiley.
Majone, G. (1996). *Regulating Europe*. Routledge.
Marchetti, R. (2012). Models of global democracy: In defence of cosmo-federalism. In D. Archibugi, M. Koenig-Archibugi, & R. Marchetti (Eds.), *Global democracy: Normative and empirical perspectives* (pp. 22–46). Cambridge University Press.
Maritain, J. (1951). *Man and the state*. University of Chicago Press.
Miller, D. (2007). *National responsibility and global justice*. Oxford University Press.
Moellendorf, D. (2006). Equality of opportunity globalized? *The Canadian Journal of Law and Jurisprudence, 19*(2), 301–318. https://doi.org/10.1017/S0841820900004124
Orbán, V. (2014, July 26). *Speech at the XXV. Bálványos Free Summer University and Youth Camp, on-line*. Băile Tuşnad. https://budapestbeacon.com/full-text-of-viktor-orbans-speech-at-baile-tusnad-tusnadfurdo-of-26-july-2014/
Orford, A. (2011). *International authority and the responsibility to protect*. Cambridge University Press.
Pogge, T. (1992). Cosmopolitanism and sovereignty. *Ethics, 103*(1), 48–75. https://doi.org/10.1086/293470
Pogge, T. (2005). A cosmopolitan perspective on the global economic order. In G. Brock & H. Brighouse (Eds.), *The political philosophy of cosmopolitanism* (pp. 92–109). Cambridge University Press.
Pogge, T. (2008). *World poverty and human rights* (2nd ed.). Polity.
Pogge, T. (2010). *Politics as usual*. Polity Press.
Rawls, J. (1999). *The law of peoples: With "the idea of public reason revisited"* Harvard University Press.
Rosen, M. (2012). *Dignity: Its history and meaning*. Harvard University Press.
Sadurski, W. (2015). Supranational public reason: On legitimacy of supranational norm-producing authorities. *Global Constitutionalism, 4*(3), 396–427. https://doi.org/10.1017/S204538171500012X
Scharpf, F. W. (1999). *Regieren in Europa: Effektiv und demokratisch?* Campus Verlag.

Scheuerman, W. E. (2011). *The realist case for global reform*. Polity.
Scheuerman, W. E. (2014). Cosmopolitanism and the world state. *Review of International Studies, 40*(3), 419–441. https://doi.org/10.1017/S0260210513000417
Shaw, M. (2018). *International law*. Cambridge University Press.
Skinner, Q. (2002). *Visions of politics*. Cambridge University Press.
Somek, A. (2014). *The cosmopolitan constitution*. Oxford University Press.
Stemplowska, Z., & Swift, A. (2012). Ideal and nonideal theory. In D. Estlund (Ed.), *The Oxford handbook of political philosophy* (pp. 373–389). Oxford University Press.
Trachtman, J. P. (2013). *The future of international law: Global government*. Cambridge University Press.
Ulaş, L. (2017). Transforming (but not transcending) the state system? On statist cosmopolitanism. *Critical Review of International Social and Political Philosophy, 20*(6), 657–676. https://doi.org/10.1080/13698230.2015.1048071
Valentini, L. (2014). No global demos, no global democracy? A systematization and critique. *Perspectives on Politics, 12*(4), 789–807. https://doi.org/10.1017/S1537592714002138
Walzer, M. (1994). *Thick and thin: Moral argument at home and abroad*. University of Notre Dame Press.
Wendt, A. (1992). Anarchy is what states make of it: The social construction of power politics. *International Organization, 46*(2), 391. https://doi.org/10.1017/S0020818300027764
Wendt, A. (2003). Why a world state is inevitable. *European Journal of International Relations, 9*(4), 491–542. https://doi.org/10.1177/1354066103040001
Ypi, L. (2008). Statist cosmopolitanism. *Journal of Political Philosophy, 16*(1), 48–71. https://doi.org/10.1111/j.1467-9760.2008.00308.x
Ypi, L. (2012). *Global justice and avant-garde political agency*. Oxford University Press.
Ypi, L. (2013). Cosmopolitanism without if and without but. In G. Brock (Ed.), *Cosmopolitanism vs. non-cosmopolitanism: Critiques, defenses, reconceptualisations* (pp. 75–91). Oxford University Press.

International Security Regimes, Space and Responsible Cosmopolitan States

Ondřej Ditrych and Nikola Schmidt

1 Introduction

This chapter provides an overview of international regime theory, with a view to developing ideas and proposals concerning the formation of a new international cooperative security regime for outer space. While international regime theory may be considered to concern itself with certain fundamental normative commitments, above all the value of international cooperation for general welfare, as discussed in more detail below, the concept of regime is very much a *status quo* heuristic device. The theory as developed to date therefore does not provide much inspiration for critical and normative interrogations of the international. Notable exceptions of critical investigations of regimes include Keeley (1990)'s exploration of disciplinary power entailed in regimes' operation, which drew on the social theory and history of Michel Foucault, or Gale (1998)'s concept of international regimes as vehicles of hegemony, inspired by Antonio Gramsci. Agnew (2005) is a rare case of using the concept of regime for a critical examination of the international. The theory does provide, on the other hand, a wealth of insights into the formation and (to a somewhat lesser extent) effective operation of international regimes, of which this chapter seeks to provide a concise overview.

Regarding structure, the second section includes the definition of international regimes. The third section discusses ontological (*what is*) and normative (*what ought to be*) commitments or wagers comprised in international regime theory and its various streams. The fourth section provides an overview of the emergence and evolution of the theory as a distinct formation of knowledge, genealogically tracing how it has been conditioned or 'made possible'. The fifth section recounts the key

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insights from international regime theory to date. The concluding section relates them to the prospects of regimes governing space activity and to the notion of responsible cosmopolitan state explored in the previous chapter.

2 International Regime: Definition

The concept of international regime has little in common with how 'regime' is used in relation to domestic political orders, which can be classified as liberal, authoritarian, hybrid etc., in political science (and, often derogatorily, in general political discourse). In international politics, it is meant to capture and structure the research of institutionalised cooperation, regulation, prohibition and social learning. In what is often termed as the consensual definition in the field, international regimes are conceived as composites of principles, norms, rules and decision-making procedures, around which actors' expectations converge in a given area of international relations (Krasner, 1983: 2). In this definition, principles stand for factual and theoretical statements (e.g. that global welfare is conditioned on free trade), norms for behavioural standards, rules for specific prescriptions or proscriptions and procedures for predominant practices of making and implementing collective choices.

To some, the definition is too broad and vague. Strange (1982) formulated an early challenge to the concept of international regime by warning against 'five dragons' that should be watched for, including the concept's imprecise nature and concealing bias. A decade later, Milner argued that the consensual definition notwithstanding, the concept of international regime is *essentially contested* (1993: 494), expressing scepticism as to the insights produced by regime theory, while advocating for a return to the concept of 'institution' that previously had more traction in the research on international cooperation. Yet some others have seen the conceptual breadth as useful in opening numerous avenues of inquiry into international cooperation and organisation, while providing an essential link to a variety of perspectives that put emphasis on different drivers of emergence, persistence and effectiveness of regimes, from rational interests to structural power relations, social norms and customs or specialised knowledge.

Noting that regimes cannot be recognised based on rules alone, since some institutionalisation is necessary for an international regime to be considered to be in place, or by patterned behaviour, which can emerge even in the absence of such institutionalisation in a certain issue area, Levy et al. (1995) propose, in response to criticism pointing to the concept's vagueness, to detect the presence of international regimes with a view to the degrees of formality and convergence of mutual expectations. Where there is low formality and convergence, no regime is in place; high values in both criteria indicate the presence of a classic regime featuring widespread behaviour consistent with rules and violations that are but exceptional – and when occurring, the injured parties refer to the rules and violators do not deny their existence. (The other two types are dead letter regimes and tacit regimes. The case example of the latter, informal but featuring significant convergence, is the balance

of power system in Europe in the nineteenth century.) In their modification of Krasner's definition, international regimes are social institutions consisting of agreed-upon principles, norms, rules, procedures and programmes that govern the interactions of actors in specific issue areas (Levy et al., 1995: 274). In that sense, international regimes are different from organisations as material entities, from the broader structure of international society defined by general principles of conduct across domains or from the world order, as the sum of all institutional arrangements operating at the international level.

In other words, an international regime is a composite of authoritative ideas, conventions, rules or epistemic practices that govern activities in a particular issue area (Meiches & Hopkins, 2013), facilitating the emergence of habits and shared expectations about others' future behaviour (cf. Hasenclever et al., 1997), and a heuristic device to organise and structure research of this form of international cooperation (Levy et al., 1995: 271). In rationalist terms, it is a social institution with stable rules, roles and relationships that enables alleviating problems of collective action and achieving collective outcomes closer to the Pareto frontier, by means of greater transparency and reduced incentives to defect, or transaction costs that make it possible to avoid collective losses and stabilise cooperation (Levy et al., 1995: 305; cf. Keohane, 1984).

Whereas for some scholars the change in participants' behaviour results from a modified calculus of costs and benefits, for others a constitutive relationship can be postulated between the structure of the regime and relevant actors' practice, e.g. in terms of conferring certain roles and even shaping their identities and subjectivities. Somewhere in between, one can locate perspectives that emphasise mechanisms of social learning that are operational in international regimes, producing new ideas about problems and measures to solve them – ideas that also can travel between regimes – and change not just perceptions of participants among themselves (e.g. generating more trust, based on the history of cooperative behaviour that the regime facilitates) but also value hierarchies that impact on how the participants' interests, rather than just strategies to realise them, are formed.

International regimes are forms of cooperation situated on the plane of international society. Therefore, regime membership is customarily reserved for *states*. The role of nonstate actors is indeed recognised (cf., Arts, 2000). Advocacy groups and epistemic communities (cf., Haas, 1992) of scientists and experts may play an instrumental role in framing the issue around which a regime can be formed, proposing measures to adopt and observe their implementation (sometimes benefiting from a recognised and formalised observer status). (This indeed is the case in space mining, where nation states engage in sometimes controversial law-making, from international law perspectives, while nonstate actors cluster in cooperative enterprises to produce more inclusive ideas to avoid future conflict.) Nonstate actors, such as private companies incorporated or operating in states' jurisdictions, are often targets of a regime's regulation, which as a consequence needs to be transposed to municipal (state) law. This, however, is the responsibility of participating states – which brings to the fore issues such as those states' capacity and will (in the case, e.g. of captured or corrupt states) to ensure compliance to prevent regime leakages.

In theory, a regime can be formed between just two participating states; or it can encompass *all* states. The category of regimes that have a totalising ambition to achieve universal membership is theorised by Nadelman (1990) as 'global prohibition regimes'. These regimes are defined as institutionalisations of explicit and implicit norms prohibiting certain activities of both state and nonstate actors through systemic diffusion in the international space and in international public law, as well as domestic criminal law, and processes by which these norms are enforced. The universal(−ising) nature of these regimes that tend to entail a strong moral condemnation of the proscribed activity, such as slavery or drug trafficking, is intended to prevent regime leakage and exploitation of loopholes. Recently, the concept of a global prohibition regime has generated a new research programme with a focus on the domain of security separated into three clusters: nonconventional (CBRN), humanitarian (antipersonnel landmines, cluster munitions and SALWs) and heterogeneous (drugs, endangered species and cybersecurity). The overall intention of this research programme is to examine how distinct forms of power – with their types corresponding to those identified by Barnett and Duvall (2005), as compulsory, institutional, structural and productive – combine, compete and resist each other, with a particular focus (in contrast to the previous power analysis of international regimes associated with realism, which sees power as the central feature of regime formation and survival; cf. Grieco, 1988) on the power to produce situated social capacities of actors (Ditrych et al., 2018; for a legal perspective on these regimes, see also Bilkova, 2017).

Nadelman recognised the difference between regulation and (universal) prohibition of a certain activity targeted by the regime; however, from his fundamentally progressivist standpoint, he associated regulation and prohibition with successive stages of regime evolution (Nadelman, 1990: 518). Hynek et al. (2018), on the other hand, devise several types along a conceptual continuum, facilitating a synchronic comparison in the domain of global security that encompasses strong global prohibition regimes meeting Nadelman's definitional criteria, weak global prohibition regimes (where adherence to the core prohibitionist norm is constrained), strong global regulatory regimes, weak global prohibition regimes and global security non-regimes (defined by institutional void, despite discursively salient processes of problematisation of relevant issues).

3 International Regime Theory: Key Assumptions

The most fundamental ontological (*what is*) assumption behind international regime theory is that while international politics may be anarchic, in the sense of absence of a common rule, it is not anomic. Instead of the caricature version of Thomas Hobbes' state of nature, it consists of a dense fabric of practices and rules governing action, even in the absence of a central lawmaker. This fabric comprises relations of conflict but also of patterned or regularised cooperation. The concept of regime is a heuristic device to structure the research of such international cooperation, as it is

reproduced in established domains and extended to new ones. With the density of human presence and interaction dynamically growing in space of late, and rudimentary if currently less than satisfactory regulation of humankind's activities there in place, there is no reason to assume a priori that it should be any exception.

In abstract, diagrammatic terms, the international is therefore politically imagined in international regime theory neither as a *void* – or 'anarchy', the *outside* contrasted to the hierarchically ordered inside of the states (Waltz, 1979; Ashley, 1988; Walker, 1993; Schmidt, 1998) – *pyramid* of hierarchical rule nor even *market*, productive of merely momentary, instantly appearing and disappearing connections and shifting states of equilibrium without socially integrative function (even as bargaining is considered as essential regime practice in mainstream international regime theory). The traditionally conceived void of the international is filled with institutions that feature little formal hierarchy yet nevertheless manage to mitigate the structural, adversarial effects of anarchy, due to convergence of participants' expectations, socialisation and even the conditioning of their identities.

Second, and perhaps even more important, is the assumption that regimes are not just derivations or reflections of power constellations (e.g. interests of powerful states), but *matter* in the sense of fostering meaningful cooperation among states, even when their immediate interests would dictate otherwise (Levy et al., 1995: 271) and there is no coercive power to elicit cooperative behaviour from them. Many (neo-)realist scholars in international relations theory would not dispute the empirical observation that international cooperation occurs (see next chapter) and can even be of a durable nature, yet would not attribute to international regimes any independent causal effects. A proposition such as one made in the previous chapter regarding the normative emptiness at the heart of state selfishness is immaterial to their rationalist calculations.

Epistemologically, the majority of international regime theory, with the exception of the thick constructivist stream (see below), adheres to positivist modes of inquiry (cf., Kratochwil & Ruggie, 1986). Notionally, it means maintaining a strong distinction between facts and values and the rejection of the possibility of verification of value judgements (cf., Frost, 1996: 19). Nonetheless, there are some clear, albeit often implicit, normative commitments shared across most of the field. Strange (1982, 488) was the first to engage in scathing normative criticism of international regime theory, charging against its (alleged) dissemination of a false sense of agreement on the general objective of more order and interdependence, and instead drawing attention to how the theory, conservative and biased toward the *status quo*, unintentionally blinds one to the normative contestation present in international relations, notably between the Global North and South. Strange's argument finds an unmistaken inspiration in the case against utopianism – at least as dialectically unrelated to 'reality' – made in the interwar period by E.H. Carr, who, while critically interrogating the period's liberal international thought, manifest in the founding of the League of Nations as the international organisation to preserve peace, dramatically pointed to its (alleged) ideological function of preserving the post-WWI political order, by obscuring the fundamental divergence of interest among nations seeking to maintain the *status quo* and those seeking to change it, as

well as to the complicity of liberal scholarship in the ideological cementing of this order by means of appeal to false universals (Carr, 2001 [1939]).

Richardson (2008) provides a careful analysis of these normative commitments, which he finds less overt than in the earlier institutionalist scholarship – that Carr criticised – its functionalist reinterpretation normatively advocating gradual and sectoral approaches to integration (Haas, 1961) or the more empirically oriented inquiries into complex interdependence (Keohane & Nye, 1977; Young, 1980) which ultimately, following the embrace of rationalist theory, evolved into international regime theory. Among these commitments is a positive value of cooperation that promotes general welfare (outcomes at or close to the Pareto frontier) – and is not asymmetrical and exploitive. Instead, the focus on reciprocity in bargaining indicates a commitment to fundamental symmetry in participants' relationship. However, while these values need not be prima facie contested, the commitment to them serves the ideological function of obfuscating and reifying the political *status quo,* by eschewing certain issues, above all redistribution – and, by extension, inequality – or the related empowerment of certain domestic actors enrolled in the networks of transnational embedded liberalism. Rather, reflecting a general managerial perspective influencing also the particular focus on reducing transaction costs and improved information, the overwhelming emphasis in the mainstream theory of international regimes is on the value of *efficiency*. Infusing the mainstream with game theory that occurred in the 1980s could overturn this ideological bias, since the theory fundamentally treats participants in an abstract manner as relative equals. Yet, Richardson concludes, it rather reinforced the mechanisms of making power in the international regimes invisible (ibid.).

Some moderation of this argument seems in order. First, in the realist branch of the mainstream theory, power is a key independent variable, and the unequal distribution of benefits from cooperation is identified as a major obstacle to regime building in anarchical society (Grieco, 1990), in the absence of a hegemon (dominant power) whose presence may produce collectively desired outcomes for all states (Snidal, 1985: 579). In liberal scholarship, it is empirically inferred, e.g. that the regimes that assign property rights to international authorities may allow for more equal distribution of resources, both between and inside states – albeit at the cost of likely producing more inefficiencies than alternatives. As the Cold War drew to a close, the possibility of gradual progress in international politics in terms of structural change was contemplated (Keohane, 1990), and the 'civilising' function of regimes in terms of regulating and institutionalising international conflict was postulated (Rittberger & Zürn, 1990). Finally, Keohane, as the classic mainstream scholar, comes rather close to the more radical critics of the effects of international regimes, as, at the turn of the millennium and in a stark contrast to the period's academic proponents of the period's US-designed liberal order, like Ikenberry (2001, 2011), he writes that the present institutions are of the privileged, by the privileged and for the privileged (2002: 256).

Yet, while mainstream international regime theory is embedded in the structure of international society and is oriented toward exploring modalities of international cooperation (rather than conflict) and their conditions, it presents a rather

conservative, *status quo* form of liberalism that does not subscribe to exploring the possibility of more radical transformation of this society. The more critical perspectives in the study of international regimes identify their power effects (Keeley, 1990; Gale, 1998) yet fail to formulate global political alternatives, contrary to cosmopolitan theory (see previous chapter). In that sense, international regime theory can be contrasted not only to the global governance paradigm – with its own ideological bias in terms of concealing power through the concepts of *steering* or *network* as the privileged diagram of social association, yet, at least, in the *power/knowledge* nexus, seeking to relocate (for better or worse) the main sites of power in international politics – but also to more radical political theories, such as the various streams of cosmopolitanism, including those that attempt to find a realistic ground in the concept of responsible cosmopolitan state discussed in this volume.

4 International Regime Theory: Emergence and Evolution

This section provides a brief survey of the emergence and evolution of international regime theory as *knowledge formation* whose genesis and structure are assumed to have particular conditions of possibility. It is genealogical, in that it takes inspiration from Michel Foucault's understanding of 'genealogy' as an effective history of interpretation (Foucault, 1977), which however is not attempted as consummate and the 'subject effects' of regime theory are explored only in passing. The inspiration consists, therefore, in the critical interrogation of the *power/knowledge* nexus, where not only power is postulated to constantly produce knowledge, but the knowledge – here international regime theory – constantly induces effects on power (Foucault, 1979).

The interest in the study of international regimes in the 1970s – a term not invented, but rather endowed with a new meaning in this period, as it previously had stood for formal agreements (Meiches & Hopkins, 2013) – was primarily not inspired by a theoretical curiosity concerning ever more complex interdependence and burgeoning institutionalised forms of international cooperation. Even in the mainstream scholarship, it is recognised that the emergence of the field was motivated by the concern about the ability of the United States to sustain the liberal order as a composite of various regimes formed after the WWII (cf., Little, 2014). The Vietnam *fiasco* compounded with the diminishing share in world production (from some 1/2 after the WWII to ca. 1/4 in the 1970s) and the economic rise of Germany and Japan – the vanquished of the war, yet now the 'rising powers' of the day – provided fertile ground for scenarios of hegemonic decline. The study of how regimes, together forming an assemblage of the liberal world order, can be most efficient in performing their function and even how they can *survive* after hegemony (Keohane, 1984) can thus be seen as a science in the service of the liberal yet preponderant power, explaining the commitment to an essentially conservative, *status quo* liberalism (cf., Richardson, 2008) short of exploring alternatives productive of more global social justice. In terms not of a general direction but *grammatical rules* of this

science, making it possible to endow the statements produced here with as much authority as possible, following the more empirical perspective of some of the leading authors on the study of international politics (Keohane & Nye, 1977; Young, 1980), the language of rational theory was adopted. Fundamentally *problem-solving*, i.e. searching for more optimal solutions within the framework of the present rules, rather than critically interrogating and challenging the normative order these rules form, rational choice theory also likely facilitated a certain desensitisation and a lack of reflectivity on one's political anchoring in the field of power, where the norms taken (and promoted as being taken) for granted and naturalised are in fact subject to contestation; perhaps a related interplay of power and (privileged) knowledge in the 1980s contributed to the complex process of forming what became the Washington 'consensus'.

The adoption of the same scientific language and corresponding norms for making valid, authoritative inferences about the world did not however result in a *theoretical* consensus on international regimes. Indeed, in international relations theory, the 1980s is sometimes referred to as the period of synthesis between (neo-)realist and (neo-)liberal perspectives. In international regime theory, these perspectives translated into distinct realist and liberal streams also termed as power- and interest-based theories (Hasenclever et al., 1997). The two indeed concur on the elementary observation that anarchy – in the sense of a lack of common power above states – obtains in international politics, and as a structural condition it betrays effects on patterns of conflict and cooperation, making the latter more difficult to achieve (Waltz, 1979). They disagree on much else.

The liberal, interest-based theories form the true mainstream of international regime theory, emphasising the regimes' role in realising the common interests of states by means of institutionalised cooperation (Hasenclever et al., 1997: 4). Regimes achieve this because they delimit the norms of tolerable behaviour, reduce uncertainty and lead to a decline in uncertainty due to more information, including through mechanisms for monitoring actors' behaviour, with the possibility of modification of their cost and benefit calculation through the sanctioning of norm violators (Keohane, 1984: 98; cf., Krasner, 1983; Oye, 1985). While liberal regime theories recognise an important role of the preponderant power in the system (the *hegemon*) in establishing international regimes, they put forward the argument, most forcefully in Keohane's *After Hegemony* (1984), that regimes may survive the preponderant power's decline (see below).

Such an assumption is in a stark contrast to the realist, power-based perspectives that, drawing on the theory of hegemonic stability (Kindleberger, 1973; Snidal, 1985), explain not only conflict but also cooperation in terms of the distribution of capabilities among states. The role of hegemon, either coercive (forcing others to cooperate) or benevolent, is therefore seen as essential in regime formation and survival. Without *at least* being tolerated by the powerful, international regimes are impossible (Strange, 1982), and their formation is limited to economic or environmental domains, but not to war and peace. A case of powerful countries preventing the emergence of a regime could be the domain of satellite surveillance, where it was vetoed by technologically more advanced states in the 1970s (Brown, 1977).

While smaller states may seek to exercise binding strategies through regimes to restrain the powers from certain unpredictable behaviour, as the argument goes in the previous chapter, for the realist theory such endeavour is ultimately futile. At this time, however, it would not yet hypothesise a situation in which a group of smaller states produced a new critical technology with inherent security sensitivity, and the path toward an international regime could be a preferred option for great powers to tame this technology and reduce their vulnerabilities (Schmidt & Ditrych, 2019).

Indeed, security regimes can be found in the realm of international politics, yet what characterises them is persistent rivalry, rather than the spirit of cooperation. They do not meet the definition of international regime, *because* the cooperation is the product, as Jervis argues concerning the Cold War regimes, e.g. in arms control, not of distinct interest but rather the distribution of power: '[t]o comply with a robber's demand to surrender money is not to participate in a regime' (Jervis, 1982: 357).[1] Moreover, for realists, international regimes do not have independent but rather dependent effects. While they may be instrumental in resolving issues of *coordination* (rather than *collaboration*, as liberal institutionalists believe; cf. Stein, 1982), they tend to produce differential benefits (relative rather than absolute gains) and thus reinforce the unequal distribution of power which begets them in the first place.

The scepticism regarding the independent effect of regime characteristic of realist theories makes some scholars (Levy et al., 1995) argue that, while these theories predict the emergence of regimes that facilitate free access and exchange – in other words, that maintain global 'commons' – when power is concentrated, and lead to privileging these forms of allocation of goods over nationalisation and internationalisation (i.e. transferring rights to an international authority), they are not regime formation theories at all. Such exclusion is understandable, insofar as realist theories challenge mainstream knowledge on international regime formation and effects, while reinforcing the general pessimist *Weltanschauung* associated with realism in international relations, and in some instances make this scepticism a point of departure for the criticism of false universals embedded in the contemporary liberal order and, performing an ideological (re-)stabilising function, thus concealing the various surrounding patterns of contestation.

The liberal conception of international regimes as benevolent, voluntary, cooperative and thus legitimate forms of association is challenged as obfuscating their true nature as sites for the exercise of power, conceived not as limited to coercion

[1] It is worth noting that despite Jervis' scepticism about the possibility of international regimes in the realm of security, in the field of international regime theory, the domain was opened to them over time to complement environmental or economic regimes (cf., Hynek et al., 2018). It is therefore now recognised both in the field and the political discourse that international regimes can be identified in the areas of WMDs (NPT, now in a severe crisis, CTBT, Chemical Weapons Convention or the much less institutionalised Biological Weapons Convention); their carriers and ballistic defences (ABM, INF, START); conventional arms (APLs, CMs or the nonprohibitive ATT); and a wealth of others from drugs and endangered species to the emerging regime for cyberspace regulation.

but extending, e.g. to the imposition and maintenance of discipline (Keeley, 1990) also from within the more radical margins of the third, and the most recent stream of international regime research, the knowledge-based theories. The constitution of this stream responded to the broader reflectivist, or linguistic, turn in the discipline of international relations in the late 1980s, which also coincided in the constitution of the discipline's new, continental centres. These theories stress the importance of nonmaterial variables, ideas and knowledge formations, impact on regime formation and effects, informing perceptions of international problems (Hasenclever et al., 1997: 137) but also identities of the participants who are conferred with and assume certain roles. While the weaker version of cognitivism or constructivism, associated with the Tübingen School, is predominantly concerned with social and behavioural dynamics that bear on the emergence of norms and epistemic consensus (Rittberger, 1995), the stronger versions point to this constitutive relationship of regimes and collective identities (Kratochwil & Ruggie, 1986) – e.g. brought together by a (negative) perception of a common threat or by seeking to act as a (positive) model for others – and the concomitant exercise of power (Keeley, 1990; Gale, 1998; for historical inquiries into norms and their subject effects, see in particular Price, 1997; Tannenwald, 2007). Both assume a critical stance regarding the mainstream liberal, rationalist theories, but neither displaces their epistemological or normative core. Whereas the weak cognitivist perspectives seek to *complement* and enrich the rationalist theories, the thicker and more radical perspectives fail to challenge the field's hegemonic core and remain marginal, perhaps in part due to the shift in attention in liberal international science, from concept to regime, to others like global governance or norm diffusion with more political traction – and thus also the potential for effective criticism – in the 1990s.

The evolution of international regime theory is sometimes conceived in terms of successive generations or waves (Hynek, 2017). Indeed, a certain theoretical progression can be identified in the field, as related both to the gradual establishment of dogmas and the broader evolution of international relations theory as such contributing to, e.g. the emergence of cognitivist perspectives. This should not, however, obfuscate the durability of the field's (neo-)liberal core, challenged by realist or critical constructivist dissent, but continually reinforced by the *power-knowledge* nexus. While the George W. Bush administration was notoriously sceptical toward participation in regimes that do not yield benefits in terms of direct US interest, the Obama presidency resurrected the nation's identity as the architect of the liberal order and in so doing could benefit from forceful academic articulations of such identity like Ikenberry (2001). Indeed, the Trump administration then visibly resigned the role of the liberal hegemon – the United States standing outside the Paris Agreement on climate change together with only one other state, Syria, spoke volumes to this end. Yet the Biden administration again returns to liberal multilateralism, even if somewhat selectively.

5 International Regime Theory: Key Insights

International regime theory does not feature a single paradigm. Instead, reflecting broader controversies in international relations theory, it comprises several research programmes linked to perspectives on international politics with a variable degree of following and prominence. The key insights generated in these programmes are recounted in this section, with a view to prospective relevance to the four cases this volume discusses and a particular focus on two broad areas: international regime *emergence* (and existence) and regime *effects*.

International regime emergence, or 'formation' (Haggard & Simmons, 1987; Efinger et al., 1993), was the first complex puzzle for the liberal theories. Like structural realists, liberals assume that the anarchic structure of international politics makes cooperation difficult due to the persistence of the Prisoner's Dilemma. The lack of trust demonstrated in this model situation means that irrational (suboptimal) outcomes can be explained in rational terms, as market failure is produced when actors pursue competitive rather than collaborative strategies based on the mutual expectations that others would do the same; however, this predicament can be overcome. In a clear albeit curious convergence with realism, of crucial importance here is power – power of the hegemon that can provide the initial impetus for patterned cooperation. In realist theories, international regimes develop because hegemonic powers have an interest in them, i.e. benefit from their existence even at the risk that some other participants would freeride and cheat. Alternatively, regimes can indeed emerge in the absence of hegemony, but in that case only to impede a formation of a less attractive Pareto frontier. (Thus, realist theories too operate with the notion of *interest*, but one that is not collective, is based on the promotion of relative gains and often is a property of the preponderant power.) When a constellation of power change, so does the international order, including norms and regimes.

For liberals – concerned, as noted above, with the projected decline of the United States – the founding of the regime framework is only the beginning. History teaches that the hegemonic power is instrumental in the founding of regimes, whether it was the setting of the global prohibition regime on the slave trade in the nineteenth century, in which the United Kingdom was invested, or the building of the liberal international economic order after WWII on the part of the United States. The introduction of Artemis Accords defining the regime of cooperation (including mining) on the Moon by the United States serves as another example, close to home. Yet, in a forceful challenge to the hegemonic stability theory, which assumes that the presence of a hegemon is a *conditio* sine qua non of regime existence, liberal theorists propose that international regimes survive the hegemon's decline, in the sense of an absence of defections from the collaborative strategies learned in the regime's framework (Keohane, 1984; Snidal, 1985). Since international regimes promote participants' interest in securing gains which, unlike in realism, are defined as *absolute* rather than relative (Keohane, 1984; Powell, 1991) – i.e. it does not matter how the benefit compares to those of other participants insofar as it is recognised as real – they share a collective interest in maintaining the regime where reciprocal relations have been

established in order to provide access to a rich fabric of information, reduce transaction costs and avoid controversial outcomes. Since international regimes provide these desirables and thus correct inefficient allocation of resources in the conditions when there is an of absence of a common power, once the threshold for their formation has been reached with the assistance of the hegemon, they are sustained by this collective interest and, as cognitivist theories stress, a gradually developed common identity.

In the early stage of international regime theory development, the liberal mainstream tended to see regimes instrumentally as (successful) means to overcoming collective action problems extensively discussed in economics; however, as the theory developed, the regimes started to be endowed with a power to impact the structure of collaboration and coordination in international politics (Nye, 1987), and so the possibility not only of regime survival after hegemony but also of regime formation without hegemony became possible to contemplate. The causal mechanism here involves the evolution of intersubjective knowledge that enables casting the shadow of the future and thus collective action to realise absolute gains in the future or one regime's success breeding international cooperation in other domains, an assumption anchored in the understanding of international regimes as embedded practices in the conditions of complex interdependence, whose *nesting* can have reinforcing effects or increase their resilience (Aggarwal, 1983; Keohane, 1984; for a comprehensive survey of international regimes interactive practices cf. Young, 2012).

The issue of international regime survival was grounded in certain period concerns and, as noted above, constituted at the *power/knowledge* intersection in the conditions of perceptions of all but inevitable hegemonic decline. The end of the Cold War produced a paradigmatic shift in the debate, however, toward pondering the 'unilateral moment', the prospect of future *rebalancing* – to salvage the neorealist theory of balances of power, in view of political realities of the day – or America's 'empire'. Yet, while the fundaments of the liberal order, as the architectural form of multilateralism and embedded liberalism, where power is exercised by means of rules and institutions (Ruggie, 1983, 1992; Ikenberry, 2001), have remained unchallenged until recently, the varying preferences of successive US administrations in maintaining the liberal order culminating in the recent challenge to this architecture by the Trump presidency return currency to the issue whether effective international regimes can be sustained and formed after hegemony, even as it is *resigned* rather than obliterated in a new balance of power. Second, currency may be returned also to the (realist) considerations of the emergence of alternative regimes based on other norms and principles, as the constellation of power is modified, even if less for material than subjective causes and there is ever more contestation and resistance in the current normative order related to the 'rise of the rest' harbouring a political vision of multipolar, rather than multilateral, world, with the United States as the primus inter pares.

No universal template on establishing a regime has emerged in international regime theory. Young (1983) identifies three distinct modes of regime formation – self-generation, negotiation and imposition (associating the latter two with liberal

and realist perspectives, respectively) – yet it seems that in practice, these modes often combine to form various complex patterns from which general rules are difficult to derive nomothetically. It is recognised that conventionally, the first stage in the process of regime emergence is agenda formation or the framing of the issue (Stein, 1982; cf. Levy et al., 1995). In particular, cognitivist theories stress the central importance here of scientific consensus and knowledge transfer or the advocacy effects of dedicated epistemic communities (Haas, 1992; Susskind, 1994) such as the space community. The following stage entails institutional choice and operationalisation. This often involves an agreement on the mechanism of the application of rules comprised in the regime on various actors that can be the ultimate targets of the regime's legislation (including, e.g. asteroid mining companies). Another step is the foundation of the bodies (agencies) for administration, running decisions and implementation review procedures.

The various streams of international regime theory tend to stress different key drivers of regime formation (power, interests, knowledge). Yet, as noted above, in their theories these drivers too combine and permeate to form complex causal mechanisms (e.g. power is recognised in liberal theories as an important means to initiate regime formation, which then entails complex bargaining based on interests). At the meso- and microlevel, important conditions indicated in the literature that facilitate regime emergence include the nature of the contested issue (the distribution of values is more difficult to negotiate than material goods, and coordination is easier to enact than collaboration, as the latter comes with incentives to cheat), intensity of the conflict of interests and the role of leaders (*political* professionals representing states, but also *intellectual* leaders developing ideas and motivating social learning, and *entrepreneurial* leaders). These observations notwithstanding, Levy et al. (1995) conclude that equifinality should be recognised in the study of international regime formation and multivariate models of possible trajectories that lead to emergence of stable and effective regimes should be devised.

In terms of effects, international regime theories concur that regimes are sites where cooperation between participants takes place, but disagree on the nature, extent and durability of such cooperation. Realist theories see the cooperation as either reinforcing an existing balance of power and serving a hegemon's interest or as limited to resolving minor coordination issues, where the bargaining process can point participants toward multiple Pareto optimal outcomes. Stressing the convergence of expectations and interests, liberal and cognitivist theories endow regimes with the capacity to enact cooperation in the form of collaboration, which moreover can be more extensive and durable. For realist theories, power is an obstacle to more serious international cooperation. For critical cognitivist perspectives, it is power that reinforces regimes that are however sites not of reciprocal action among equals but rather sites through which this power is enacted and *exercised*. For both the realist and these perspectives, international regimes produce effects in terms of power, albeit power of different kinds. In realist theories, the effects are independent, but rather dependent in terms of reflecting power arrangements. It is the hegemonic power that makes the regime capable of making an impact. (It has been empirically demonstrated, on the other hand, that international regimes can have a constraining

ability on powerful actors, even in the hard security area such as arms control; cf. Müller, 1999). For the mainstream perspectives, the regime effects are conceived above all in terms of *effectiveness*.

This effectiveness is often conceived in terms of *amelioration* of the issue (Levy et al., 1995: 291; cf. Young, 1991; Underdal, 1992). It is recognised in the literature, however, that to measure effectiveness in those terms is a rather mean task. Natural experiments (historic observations and synchronic comparisons) and thought experiments, e.g. using counterfactuals, have been proposed for that purpose (Levy & Young, 1993). The same is the case when the effectiveness is evaluated in terms of a series of changes in behavioural patterns (Kratochwil & Ruggie, 1986; Young, 1983) conceived in terms of utility modification (i.e. the regime alters participants' calculation of costs and benefits, which produces change in their behaviour). Underdal and Young (2004)'s suggestion, that since international regimes are nested and interact in a wider setting (e.g. trade regimes may bear on environment) their effects should be conceived in broader terms, seems theoretically sound; yet it does not make the task of measurement easier, since the causal mechanisms become even more difficult to establish. A less ambitious proposed method is to observe the success or failure of the international regime in regulating conflict through the participants' (and perhaps also nonparticipants') observance of contractual obligations.

For liberal theories, what makes international regimes structurally more effective is the patterned convergence of interests, while for realist theories it is the favourable distribution of influence, i.e. concentration of coercive power that is seen as the *conditio* sine qua non of institutional success (Gilpin, 1987). The weak cognitivist perspectives in turn emphasise the importance of knowledge disseminated by means of an epistemic community of scientists enjoying respect by political decision-makers and establishing functional channels of communication to them (Haas, 1992, 2015), as traced in the cases covered in this volume, or the institutionalisation of scientific and technical advice, e.g. in nongovernmental entities or bodies integrated in international regimes (Lidskog and Sundquist 2002) that may be endowed with a power to set agendas and thus to make the regime more amenable to external change in the issue area to which it should respond.

A separate stream of theorising as to what makes international regimes more effective concerns their institutional design. Similar to the perspectives mentioned above, in the absence of a solid yardstick for measuring regime effectiveness, the conclusions concerning institutional design are somewhat conjectural, derived in part from the observation of domestic institutions. McGinnis and Ostrom (1992) mention, as the criteria of regime effectiveness, the following: the right to use the resource is clearly defined, rules match local circumstances, individuals affected by operational rules have an opportunity to participate in their modification (which also makes the regime more adaptive), monitoring is conducted and violators are subject to graduated sanctions (a strong compliance mechanism is more likely to alter participants' behaviour; however, from the cognitivist viewpoint in particular, compliance is not just about punishment but also social pressure and identity transformation), participants have access to low-cost conflict resolution, rights of participants to devise their own institutions are not challenged by other authorities and the

institutional activity in the regime is organised in multiple, nested layers. The nature of rules, i.e. whether they forbid, require or permit some action or outcome (Ostrom, 1990: 139), is also of importance, with permitting rules (including, e.g. on commercial space exploitation forestalling future conflict and fostering expectations) expected to be the easiest to implement. According to Franck (1990), the international regime's legitimacy is enhanced, with a positive effect on compliance and therefore effectiveness, when the rules are determinate and clear, symbolically validated within the community and internally coherent and primary and secondary rules are vertically linked.

6 Conclusion

There is no a priori reason why patterned cooperation that rests on principles, norms, rules and procedures around which actors' expectations converged – what is normally considered a developed international regime – should not be extended, updated and upgraded to the area now rapidly populated by humankind, space. From the rationalist perspective, it would provide material benefit in terms of reducing collective action problems; providing a modicum of predictability in otherwise unpredicted situations – such as discovery of an asteroid on a collision course; or resolving distribution and coordination problems related to space mining. From the cognitivist perspective, it would furthermore create opportunities for social learning, advancing the extent of cooperation and even having constitutive effects on actors' identities. In the spirit of this volume, it could make these actors more cosmopolitan and responsible, shaping their interest so that common ('absolute') *otherworldly* gains are emphasised over the ('relative') *worldly* ones that dominate in the increasingly multipolar and normatively fragmented international order.

The notion of the responsible cosmopolitan state introduced in the previous chapter comes to terms with the importance of territorial states, whom it makes an agent of cosmopolitan goals. This position is consistent with international regime theory, which does recognise an important role for nonstate actors enrolled, e.g. in epistemic communities, but otherwise remains locked in the trap of the territorial state. This theory can therefore provide useful insight into the processes of formation and evolution of international regimes in space related to planetary defence, space mining or lasers, both in general terms and when these are driven by a cluster of responsible cosmopolitan states in the absence of hegemony – but also, it should be stressed, in the absence of overt resistance by great powers. For realists, this formation can be inspired by seeking to avoid a less attractive Pareto frontier in distribution (e.g. in relation to space mining activities). For liberals and cognitivists among regime theorists, the key in the causal mechanism of regime formation is intersubjective knowledge – stressing the role of institutionalised advice and communities of practice (of which the space community undoubtedly serves as a case) – or the idea that a limited regime's success in one area is conducive to patterned cooperation in other, similar ones (*nesting*).

The proposition that, in the condition of a normative void in outer space, even a cluster of similarly minded small states, the residual yet most populated category of state actors around, can trigger regime formation in an area such as space mining or laser technology is therefore not inconsistent with the insight generated in international regime theory. In the process of the regime's evolution, this incipient cooperation may moreover indeed force great powers to engage, in pursuit of their rational (self-)interest to avoid possible conflicts in those areas, while planetary defence creates incentives, by the very nature of the domain, for them to participate in order to strengthen their position, secure critical technologies and avoid relative losses of political legitimacy in the ongoing ('worldly') geopolitical competition. Moreover, not only does regime theory supply empirical evidence that regimes can constrain powerful states even in hard security domains; its cognitivist stream posits that it can shape or even constitute actors' interests and identities, paving the path for cooperation unfathomable in the political constellation unfavourable to such evolution at first. (It is worth noting that the now dilapidated arms control architecture was born from the dark clouds of the Cold War.) Regime theory finally provides ample insight and yardsticks for designing successful regimes.

That said, it provides also caveats. First, with the limited participation or absence of great powers at the outset, one obvious issue would be regime leakage and limited incentives for enrolment. A possible solution is advocacy by the cluster of responsible cosmopolitan states, supported by the epistemic community, for a global regime from the beginning, instead of a limited regime formation seeking expanding membership. As pointed out later in the volume, in the domain of space mining, such a regime may benefit from the support of powerful, globally operating corporations for whom the absence of predictable international legal environment continues to serve as a powerful obstacle to space exploration, even if some great powers such as the United States proceed to legislate unilaterally.

Second, any normative entrepreneurship in space should not ignore the issue of differential benefits the regimes afford, as pointed out by the realists, or their function as ways through which power is exercised (rather than *erased*), and asymmetries and inequalities produced and reproduced. Even regimes advocated or initiated by responsible cosmopolitan states would not by default be a universally favoured alternative to a normative limbo exploited by resourceful nonstate actors – wealthy individuals or corporations. Small powers are still powers. Noble intentions should serve as cloaks for individual states' interests no more than the values of reciprocity and efficiency propagated in the power/knowledge nexus of international regimes (theory). This fundamentally realist assumption must be recognised and worked around with care and inspired leadership, to prevent outer space succumbing to geopolitical competition as the following chapter predicts – in other words, to save space from realism itself.

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References

Aggarwal, V. K. (1983). The unravelling of the multi-fiber arrangement (1981): An examination of international regime change. *International Organization, 37*(4), 617–645.

Agnew, J. (2005). Sovereignty regimes: Territoriality and state authority in contemporary world politics. *Annals of the Association of American Geographers, 95*(2), 437–461.

Arts, B. (2000). Regimes, nonstate actors and the state system: A 'structurational' regime model. *European Journal of International Relations, 6*(4), 513–542.

Ashley, R. (1988). Untying the sovereign state: A double reading of the anarchy Problematique. *Millenium, 17*(2), 227–262.

Barnett, M., & Raymond, D. (2005). Power in international politics. *International Organization, 59*(1), 39–75.

Bilkova, V. (2017). *Global prohibition regimes and international law*. RWW.

Brown, S. (1977). *Regimes for the ocean, outer space and the weather*. Brookings Institution.

Carr, E. H. (2001). *The twenty years' crisis (1919–1939)*. Perennial.

Ditrych, O., Hynek, N., Ruzicka, J., & Stritecky, V. E. (2018). Global prohibition security regimes: Operations of power (special issue). *International Politics.*

Efinger, M., Mayer, O., & Schwarzer, G. (1993). Integrating and contextualising hypotheses: Alternative paths to better explanations of regime formation. In V. Rittberger (Ed.), *Regime theory and international relations*. Oxford University Press.

Foucault, M. (1977). Nietzsche, genealogy, history. In D. F. Bouchard (Ed.), *Language, countermemory, practice: Selected essays and interviews*. Cornell University Press.

Foucault, M. (1979). *Discipline and punish: The birth of the prison*. Random House.

Franck, T. (1990). *The power of legitimacy among nations*. Oxford University Press.

Frost, M. (1996). *Ethics in international relations: A constitutive theory*. Cambridge University Press.

Gale, F. (1998). Cave 'Cave! Hic dragones': A neo-Gramscian deconstruction and reconstruction of international regime theory. *Review of International Political Economy, 5*(2), 252–283.

Gilpin, R. (1987). *The political economy of international relations*. Princeton University Press.

Grieco, J. (1988). Realist theory and the problem of international cooperation. *Journal of Politics, 50*(3), 600–625.

Grieco, J. (1990). *The cooperation among nations*. Cornell University Press.

Haggard, S., & Simmons, B. (1987). Theories of international regimes. *International Organization, 41*(3), 491–517.

Hasenclever, A., Mayer, P., & Rittberger, V. (1997). *Theories of international regimes*. Cambridge University Press.

Haas, E. (1961). International integration: The European and the universal process. *International Organization, 15*(3), 366–392.

Haas, P. (1992). Epistemic communities and international policy coordination. *International Organization, 46*(1), 1–35.

Haas, P. (2015). *Epistemic communities, constructivism, and international environmental politics*. Routledge.

Hynek, N. (2017). Regime theory as IR theory: Reflection on three waves of 'isms'. *CEJISS, 11*(1), 11–30.

Hynek, N., Ditrych, O., & Stritecky, V. (2018). *Regulating global security: Insights from conventional and unconventional regimes*. Palgrave Macmillan.

Ikenberry, J. (2001). *After victory: Institutions, strategic restraint, and the rebuilding of order after major wars*. Princeton University Press.

Ikenberry, J. (2011). *Liberal leviathan*. Princeton University Press.

Jervis, R. (1982). Security regimes. *International Organization, 36*(2), 357–378.

Keeley, J. (1990). Toward a foucauldian analysis of international regimes. *International Organization, 44*(1), 83–105.

Keohane, R. (1984). *After hegemony*. Princeton University Press.

Keohane, R. (1990). International liberalism reconsidered. In J. Dunn (Ed.), *The economic limits to modern politics*. Cambridge University Press.
Keohane, R. (2002). *Power and governance in a partially globalized world*. Routledge.
Keohane, R., & Nye, J. (1977). *Power and interdependence*. Little and Brown.
Kindleberger, C. (1973). *The world in depression (1929–1939)*. University of California Press.
Krasner, S. (Ed.). (1983). *International regimes*. Cornell University Press.
Kratochwil, F., & Ruggie, J. (1986). International organization: A state of the art or an art of the state. *International Organization, 40*(4), 753–775.
Levy, M., & Young, O. (1993). Workshop results. A memorandum to members of research project on *Effectiveness of International Environmental Regimes* (14 January).
Levy, M., Young, O., & Zürn, M. (1995). The study of international regimes. *European Journal of International Relations, 1*(3), 267–330.
Lidskog, R., & Sundquist, G. (2002). The role of science in environmental regimes: The case of LRTAP. *European Journal of International Relations, 8*(1), 77–101.
Little, R. (2014). International regimes. In J. Baylis, S. Smith, & P. Owens (Eds.), *Globalisation in world politics* (6th ed.). Oxford University Press.
McGinnis, M., & Ostrom, E. (1992). Design principles for local and global commons. A paper delivered at conference *linking local and global commons*, Cambridge, MA (23–25 April 1992).
Meiches, B., & Hopkins, R. (2013). *The international studies encyclopedia*. Malden: Wiley-Blackwell.
Müller, H. (1999). The internationalization of principles, norms and rules by governments: The case of security regimes. In V. Rittberger (Ed.), *Regime theory and international relations*. Oxford University Press.
Nadelman, E. (1990). Global prohibition regimes: The evolution of norms in international society. *International Organization, 44*(4), 479–526.
Milner, H. (1993). International regimes and world politics. *International Social Science Journal, 45*(4), 491–497.
Nye, J. (1987). Nuclear learning and U.S. Soviet security regimes. *International Organization, 41*(3), 371–402.
Ostrom, E. (1990). *Governing the commons*. Cambridge University Press.
Oye, K. (1985). Explaining cooperation under anarchy: Hypotheses and strategies. *World Politics, 38*(1), 1–24.
Powell, R. (1991). Absolute and relative gains in international relations theory. *The American Political Science Review, 85*(4), 1303–1320.
Price, R. (1997). *The chemical weapons taboo*. Cornell University Press.
Richardson, J. (2008). The ethics of neoliberal institutionalism. In C. Reus-Smit & D. Snidal (Eds.), *The Oxford handbook of international relations*. Oxford University Press.
Rittberger, V. (Ed.). (1995). *Regime theory and international relations*. Oxford University Press.
Rittberger, V., & Zürn, M. (1990). Towards regulated anarchy in east-west relations: Causes and consequences of east-west regimes. In V. Rittberger (Ed.), *International regimes in east-west politics*. Pinter.
Ruggie, J. (1983). International regimes, transactions, and change: Embedded liberalism in the postwar economic order. In S. Krasner (Ed.), *International regimes*. Cornell University Press.
Ruggie, J. (1992). Multilateralism: The anatomy of an international institution. *International Organization, 46*(3), 561–598.
Schmidt, B. (1998). *The political discourse of anarchy*. State University of New York.
Snidal, D. (1985). Limits of hegemonic stability theory. *International Organization, 39*(4), 579–614.
Stein, A. (1982). Coordination and collaboration: Regimes in an anarchic world. *International Organization, 36*(2), 299–324.
Strange, S. (1982). Cave! Hic dragones: A critique of regime analysis. *International Organization, 36*(2), 479–496.
Susskind, L. (1994). *Making environmental diplomacy*. Oxford University Press.

Tannenwald, N. (2007). *The nuclear taboo: The United States and the non-use of nuclear weapons since 1945*. Cambridge University Press.
Underdal, A. (1992). The concept of regime 'effectiveness'. *Cooperation and Conflict, 27*(3), 227–240.
Underdal, A., & Young, O. (2004). *Regime consequences: Methodological challenges and research strategies*. Springer.
Walker, R. B. J. (1993). *Inside-outside*. Cambridge University Press.
Waltz, K. (1979). *Theory of international politics*. McGraw Hill.
Young, M. A. (Ed.). (2012). *Regime interaction in international law: Facing fragmentation*. Cambridge University Press.
Young, O. (1980). International regimes: Problems of concept formation. *World Politics, 32*(3), 331–356.
Young, O. (1983). Regime dynamics: The rise and fall of international regimes. In S. Krasner (Ed.), *International regimes*. Cornell University Press.
Young, O. (1991). *On the effectiveness of international regimes: Defining concepts and identifying variables*. An unpublished working paper.

Cosmopolitan Visions Under the Critical Lens of Realist(ic) Geopolitics

Bohumil Doboš

1 Introduction

The cosmopolitan vision of space security and understanding of the seemingly unique role the domain is about to play in changing terrestrial political dynamics predates humanity's ability to orbit the Earth. A notion of outer space as a domain that will help overcome the divisions on Earth, famously captured as one interdependent entity by the pictures of planet Earth taken by probes and astronauts, has, nonetheless, not been fulfilled. Similar to other domains, outer space is filled with terrestrial power dynamics; however, that is to a degree so far limited by the lack of technological sophistication and environmental limitations. It seems as if outer space will succumb to the logic of geopolitical competition, despite the attempts of part of the scientific and policy-making community to the contrary. This chapter aims to provide a critical reflection on the cosmopolitan ideas regarding the role of a mid-sized European state like the Czech Republic in the space domain and provide a set of contrasting recommendations that stem from a realist(ic) reading of international space affairs, based on empirically rooted geopolitical analysis. Even though it agrees with the notion that a mid-sized European country benefits from a predictable, rule-based framework free of armed conflict, it refuses the notion of a responsible cosmopolitan state as a path to reach the goal and instead promotes territorial responsibility.

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2 Geopolitical Reading of Politics

The origins of geopolitical thinking have their roots in the nineteenth century and the so-called organic theory of state developed by authors such as Kjellén or Ratzel. Originally, geopolitics was to study political processes from the perspective of natural sciences – notably geography – and find causal links between the behaviour of states, their strength, geography, and population. Since then, it has undergone many changes, mutations, and reformulations, was almost forgotten following the Second World War, and currently is developed by many competing streams of academic thought, stretching from classical to anti-approaches. To provide a critique of the foreign politics rooted in the cosmopolitan approach, it is first necessary to develop what is understood by geopolitics in this work and how is it connected to outer space.

This chapter follows the (neo)classical approach to geopolitics. It thus understands geopolitics as a discipline that analyses the power distribution in space[1] and presents the geographical component of international relations. It, therefore, ties an empirically based analysis of the environmental, geographic, demographic, historical, or political environment to the actions of political actors. The first crucial author that developed (neo)classical geopolitical thinking for the outer space environment was Everett Dolman (2002). While provocative and sometimes reductionist in its conclusions, his work provided important insights that demystified outer space politics. Dolman importantly pointed out that, similar to other domains, outer space will face conflict among space powers, once technology allows for it. He thus thought of outer space not as an extraordinary domain, but merely as one that is more demanding in its utilisation. Dolman considers international conflict as a constant of global politics and power competition that we must accept as a given and understand the shape it will take in the space age. If we accept this paradigm, we can utilise theoretical and methodological tools applied to the study of terrestrial international politics and rework them to fit the environmental and physical realities of outer space. Dolman thus presents the basics of astrography – the geography of outer space rooted in gravitational effects of celestial bodies – and their relation to future conflict in the domain. While we will not be dwelling on the specifics of Dolman's approach to outer space, this basic logic is crucial to a theoretically founded critique of the approaches portraying outer space as a unique domain that would change the behaviour of political actors.

The applicability of this basic logic was further tested by Sheng-Chih Wang (2013), who based his work on the history of transatlantic relations in outer space. Wang presented an analysis of the transatlantic relations, in order to test which theoretical approach explains the dynamics most accurately. He claims that outer space is not changing the dynamics of international politics in any significant way, but is following the relationships established in terrestrial politics, and he concludes that the most precise theoretical framework remains neoclassical realism. While it is true that, compared to terrestrial issues, the relations among space powers are more

[1] Do not confuse with outer space.

cooperative in dealings regarding space policy, this is true only because there exist enormous economic and technological challenges to space travel and overall backwardness in the development of space technologies, including access to the domain. States are less hostile due to the costs of such behaviour being so far very high and the level of technological development too low to allow for a more sustained conflict. Wang points out that even the closest allies among the established space powers – Europe and the USA – have been throughout history in competition over space activities (e.g. provision of launches and development of Ariane launchers in the 1970s and 1980s or construction of Galileo navigational system (Němečková, 2020)) and we cannot expect the domain to dramatically change the dynamics of mutual relations among states as it appears on Earth. Each of the space powers will protect its interests, and outer space will not become a sphere of pure collaboration. On the contrary, with the increased technological sophistication, the barriers to more open approaches to waging a conflict will fall.

Based on these theoretical assumptions, it is possible to analyse the capabilities and aims of any nation with space ambitions via the same prism as we can do on Earth. A useful approach was presented by Saul Cohen (2015), who developed a model of geopolitical analysis based on the hierarchical order of states, which presents the power potential of different countries. His model is divided into five orders, among which states move according to the changing conditions. First-tier powers are global powers, second-tier powers are regional powers, third-tier powers are not regional powers but are having influence due to some unique specific characteristic (mostly cultural or political), fourth-tier states are not projecting their power abroad but are stable, and fifth-tier states are the failed states (see Fig. 1). The higher the country is in the hierarchy, the more significant influence it has on the state of world affairs. What is also crucial in relation to the applicability of Cohen's work to outer

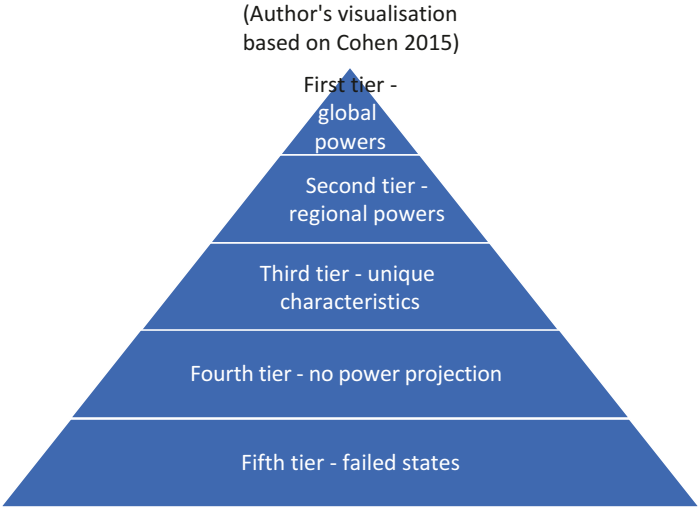

Fig. 1 Hierarchical order of international politics. (Author's visualisation based on Cohen, 2015)

space is that he treats the European Union as an entity potentially on par with the USA. In order to affect the outer space framework sufficient to meet its interests, a mid-sized European state must obtain some specific leverage on the course of events. While a truly honest global diplomatic breakthrough is unlikely, as it would be reconditioned by a similarity of goals among the space powers, it is important to look at other options.

This limited introduction into the theory tells us not only that states and their self-interest remain the primary driving force of international politics on the ground but also that their application to outer space is limited not by normative constraints but technological backwardness and economic restrictions. To develop a stable environment that will serve the interest of a mid-sized European country, such a country must act from some position of power inside the hierarchy of world powers, because, otherwise, the visions of such an order of competing political systems will prevail. The development of any global regulation will necessarily be more affected by more powerful actors in the hierarchy. Global initiatives remain a field of competition, and international legal systems are not neutral but politically biased – there is no universal, neutral, normative framework available. Any regulative measures will always be shaped by the interests of the relevant actors who develop them. A case in point is the very specific and vague definition of space weapon in the draft of the Treaty on Prevention of the Placement of Weapons in Outer Space and of the Threat or Use of Force against Outer Space Objects (Conference on Disarmament, 2008)[2] that was presented by Russia and China and that left ground-based anti-satellite weapons utilised by these two powers out of the scope of the treaty. As such, it was opposed by the USA. Understanding the underlying interests of the states helps us more in developing valid policy recommendations than covering the normative language.

It is indeed in the interest of a mid-sized European state to keep outer space free of destructive conflict and open to cooperation, as it by itself cannot manage a fully developed military space programme and protect its interests in unregulated competition. It needs to develop such a framework from a realist(ic) perspective rooted in the understanding of the self-interested reality of international politics, based on the principle of national or personal interest, rather than often verbal responsibility for collective goods.

It is also important to point out that the outlook of the current international political system is an outcome of centuries of evolution and not of a design that would lead to an establishment of a set of unitary entities – states – with the same internal organisation. It is not the case that the Treaty of Westphalia would draft a completely new structure of international relations, and the rest of the world would apply it, and that can be easily dismantled. Any reductionist attempt made by any

[2] The term ‘weapon in outer space’ means any device placed in outer space, based on any physical principle, which has been specially produced or converted to destroy, damage, or disrupt the normal functioning of objects in outer space, on Earth, or in the Earth’s atmosphere or to eliminate or inflict damage on a population or components of the biosphere which are important to human existence.

stream of political thought that omits the unevenness of types of political organisations of space around the globe overlooks a crucial empirical limit to the applicability of universalistic theories. Unlike an honest geopolitical analysis that takes these conditions into account, many approaches forget about the limitations of their models. The current state system has its origins in medieval Europe, and this specific type of institution uniting population and territory is an outcome of centuries of warfare in a relatively densely populated continent in the context of the emerging capitalist economy (Strayer, 1970, Tilly, 1975, 1990, Spruyt, 1996). Application of this type of organisation of political space outside Europe, nonetheless, did not yield a universal system of states. Following the end of the Cold War competition, we can identify the transformation of the political organisation of space that goes very basically in three directions – lower stability with an increased number of actors and weak states; autocratic centralisation; and supranational cooperation (Doboš, 2020). Any ideas on the transformation of the global system or development of universal authority must take this fact into account.

3 Cosmopolitanism in the Vacuum of Outer Space

The cosmopolitan argument on planetary defence and related issues constructs a normative vision of a universalist response to a potential collision with an asteroid or a comet. The cosmopolitan approach is inherently rooted in the applicability of the main legal provisions developed by the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space (Outer Space Treaty). These mainly include the utilisation of outer space for the benefit, and in the interest, of all countries as the province of all mankind or the principle of territorial non-appropriation that is directly applicable to the related fields of planetary defence and asteroid mining (Schmidt et al., 2019). Cosmopolitanism thus establishes an idealist approach to international politics (Schmidt, 2019a) that attempts to solve the issue of the necessity of establishment of a stable legal framework that would allow a cooperative approach to solving global issues (Švec et al., 2020). Such an approach would additionally bring a workable framework not only for other space projects such as the Breakthrough Initiatives and peaceful use of powerful lasers (Johnson-Freese & Schmidt, 2020) but also for space exploration and other non-space related issues in general.

The idea of cosmopolitanism related to space affairs focuses on the ability of states to genuinely cooperate and thus negate the conflicting nature of terrestrial politics – an example is the common European space programme that overcomes the inability of a smaller European state to establish a full-fledged national space agency (Johnson-Freese & Schmidt, 2020). It also operates with a precondition that, despite the fact that individual nations are capable of operating in the interest of humankind and tackling global universal challenges, the outcomes of such an activity might be problematic and, depending on the perspective of individual communities, even undesirable (Schmidt, 2019b). This is especially the case with planetary

defence, when a failed deflection mission might affect the territory of states that were not included in the original mission design. It is the cosmopolitan argument that all stakeholders must be around the table when a decision on the specific form of deflection is being made (Schmidt et al., 2019).

While there are different types of cosmopolitanism with varying approaches to specific issues, they generally focus on policy theory from the post-international perspective (Schmidt, 2019c). A fault line might be found between the supporters of a solution that does not involve establishing a global government but attempts to find other workable solutions, such as an inclusive international organisation (Schmidt & Boháček, 2019), and those that perceive non-government solutions as unworkable (Dufek, 2019). There are also streams highlighting the need to unite cosmopolitan theory with empirical practice and rework the institution of state that cannot be wished away (Brown, 2011). Despite these disputes, the authors agree that planetary defence is cosmopolitan in nature. It protects the whole of humanity, and cosmopolitanism establishes an important guiding principle for the technological solutions of asteroid or comet deflection foreign policies of responsible states. Such a principle is rooted in the vision of states taking responsibility beyond their borders (Schmidt, 2019c). To establish such a system, the cosmopolitan feeling that is a necessary prerequisite of supranational governance must be shared by a large enough segment of the world's population that might be aided by the so-called overview effect – witnessing the unity of the population on the pale blue dot (White, 2019).

The idea of cosmopolitanism thus works with an assumption that it is possible to bring all stakeholders to the table and make them reach a consensual solution in the face of a grave crisis – that it is possible to overcome the anarchy of the international system because, in the end, it is merely what states make of it. It is rooted in the fact that the population aware of global consequences, partially thanks to the new perspective brought by space exploration, will push their governments to act as a globally responsible actor. As a consequence, we will find all the stakeholders presenting responsible solutions to a possible global crisis and thus begin a process of cosmopolitan solutions to global issues beyond planetary defence or asteroid mining.

What this approach presents is basically the United Nations (UN) on steroids. A body that would allow everyone to speak, but the result would be, instead of an inconclusive resolution, a compromise on the specific issue. While it seems normatively correct to attempt to include everyone into the decision-making regarding a potentially global crisis, many of the assumptions are naïve, and the outcome might be even threatening to political communities around the world.

4 The Fallacy of a Responsible Cosmopolitan State

An attempt to root theoretical assumptions of cosmopolitanism in empirical reality has been developed inside the concept of a responsible cosmopolitan state. Such a state holds responsibility beyond its borders and becomes an agent of the shift towards cosmopolitanism. Geographically localised states will become responsible

for promoting and applying the cosmopolitan visions of universal cooperation and responsibility for affairs beyond their borders. As such, unlike theoretical cosmopolitanism, the idea of cosmopolitan state overcomes the empirical reality of the existence of states while simultaneously criticising the similarly naïve, national-populist call for the return of sovereignty, understood as almost complete autarky (Beardsworth et al., 2019). Such a vision is clearly tied to an idea of extraterritoriality that is developed as a way to reduce harm rooted in the cosmopolitan harm principle (Shapcott, 2019). The states thus hold moral obligations to all actors/people without attempts to dominate others. A cosmopolitan state is globally responsible for its actions; however, how these moral obligations are to be played out in detail remains a tricky question (Ronzoni, 2019, Burke, 2013). Burke (2013, 23), in this sense, presents a global normative imperative – 'act as if both the principles and consequences of your action will become global, across space and through time, and act only *in ways that will bring a more secure life for all human beings closer*'. As such, a responsible cosmopolitan state is contrasted to nationalist-populist foreign policy choices (Linklater, 2019). This responsibly cosmopolitan or nationalist chauvinist dichotomy is, however, illusory, and the details of its applicability are, indeed, the devil.

In theory, the state is currently responsible for its own population and territory, not globally. The connection of governing institutions to people living inside agreed borders is quite clear, and the role of foreign policy is to promote the external interests of the population. These interests, however, are not necessarily conflicting or geographically constrained – the interest of the geographically defined population abroad might be to find a solution to climate change. As such, states have, unlike the cosmopolitan state, a clear mandate and limited responsibility. In the idealised realist model, states have clear interests that bring them into conflict or cooperation based on the perceived value of any such action.

Not everyone, however, is represented by a state. We can, for example, identify significant parts of the population that would not be represented by their governments, as they are not represented by their state. These would include those living in unrecognised states like Somaliland, South Ossetia, or the Republic of China (Taiwan); those living in areas out of governmental control that are located in places such as the slums of Latin America, rebel-held areas of sub-Saharan Africa and the Middle East, or breakaway regions of Southeast Asia; or simply those inhabiting the states with non-responsive authoritarian governments. In the current era of increased governmental control over information streams in many parts of the world, tampered information on any crisis might lead to alternative reactions by parts of the population that are completely unrealistic. Developing a cosmopolitan responsibility for such a diverse set of the population is very hard, if it was ever possible to establish some way to take into account interests accented by a wide variety of governments. A state that wishes to be responsibly cosmopolitan can never find a clear, extraterritorial direction to take in cases when it wishes to make decisions that would be globally perceived as helpful.

Let us assume, nonetheless, that the cosmopolitan body would manage to include representation of the global population, giving each and every state one vote and

holding sovereignty over the whole of the population inside their borders, as this model constitutes the furthest that empirical reality can be stretched to meet the cosmopolitan argument. Many governments will be irresponsible in their demands, and often there will be a divergence between their representation of the interests of their own population and extraterritorial global responsibility developed by the majority of the global population. Furthermore, there is an issue of potential spoilers and corruptors. In current international affairs, we can identify regimes that utilise spoiling as a strategy of having their voice heard. What if North Korea, which calculates that the potential impact will not affect its territory, will refuse to agree on the utilisation of a planetary defence system? There will be a very difficult moral choice of states and might lead as far as harmful conduct to one country that is perceived as a threat to the perceived common cosmopolitan good.

The cosmopolitan counterargument might be that all states must be globally responsible in order for their model to work or that there are inherent limits to the cosmopolitan responsibilities of states (Ronzoni, 2019). There is also a second issue – corruption. In contemporary international politics, we can identify several types of decisions that are affected by cash injections or other types of foreign investments. A case in point is the recognition of Taiwan or Caucasian unrecognised states[3] based on financial motivation from one or other side of the dispute. Suppose the support of a small, poor country regarding the utilisation of a deflection method is motivated by a cash injection provided by an interested party and not by the attempt to take into consideration the possible impacts of one or the other for a global community. Is such a voice to be heard in cosmopolitan decision-making? A practical response to these questions leads us back to the utility of territorially bound responsibilities.

So far, the critique has focused on some aspects of the practicality of the development of cosmopolitan decision-making; however, it is also possible to criticise its morality. First of all, the propositions are often liberal, Western-centric, and inherently technocratic. They all accept the rationality of the utilisation of, for example, deflection technology and decision-making based on the globalist institutional design. It would be a very demanding normative argument to save a community of strong believers who see the incoming collision as an act of God. Furthermore, a responsible cosmopolitan action must decide whether there is a difference between an unwillingness to act for religious or radical environmental and political interests. There might be a solution in the establishment of global authority that would overcome these issues and simply decide in the utilitarian interest of the majority; but, otherwise, the cosmopolitan extraterritorial activities will always be held from a specific geographical and cultural perspective, thus imposing specific liberal normative argument on societies that might not accept such an approach. Additionally, the cosmopolitan language of some states' foreign policies obscures their restrictive internal policies that directly contradict any form of responsibility, let alone a global one.

[3] See, for example, Riegl and Doboš (2018).

The territorial dimension of states was set up as the primary demarcation line following the Treaty of Westphalia, to prevent catastrophic collisions of extraterritoriality. Even though there are attempts to overcome its limitations peacefully, such as in Europe following the horrors of the Second World War, these attempts are moving forward very slowly, as they tamper with the very fundaments of international politics, rooted in centuries of continuous development. In cases when such an extraterritorial responsibility was taken unilaterally, it usually ended in very negative outcomes. Additionally, as seen above in the case of the Sino-Russian proposal, cosmopolitan language is often used to promote hidden agendas and improve the soft power of certain nations – interestingly often of those who do not apply cosmopolitan principles towards their internal populations. Either way, the final outcome does not bode well for a concept of a responsible cosmopolitan state.

The advantage of making the decision based on responsibilities rooted in territorially demarcated units with clear responsibilities to the population is that we might avoid the worst-case scenario of cosmopolitan decision-making – blocking any decision or conflict of clashing universalistic ideas. A territorially responsible state will not await the final global decision, when its territory or other vital (even global) interests are threatened. This does not mean that the realist(ic) argument would omit the normative and cooperative dimension. The leading powers will not want to be responsible for allowing a regional or global catastrophe to materialise, and global cooperation in such an effort is always preferred to competition. But this should not make us forget that there are many parts of the world that will not be represented in cosmopolitan decision-making. That there is a limited number of actors able to tackle space-based threats and that all political communities make their decisions in a larger context than, for example, a simple technicist approach to the actual method of deflection. While it is in the interest of mid-sized European liberal democratic states to operate in a predictable, rules-based, and cooperative space environment, the claims of global responsibility and not territorially bound interests are not the way forward, as it is not possible to extraterritorially promote or even universally define the ‘common good’.

This is not to say that a cooperative community developed in terms of common interest will not appear and that an empirically driven approach to geopolitics does operate with the inevitability of conflict among all the units in the international domain. A rule-based system is definitely in the interest of Western countries (Blackwill & Harris, 2016, 186), and we can see an evolution in transatlantic, and parts of transpacific, space towards such an end. Nonetheless, development in countries like China and Russia clearly presents a picture of political communities unwilling to restrain their territorially bound sovereignty. Additionally, places such as Somalia or Afghanistan present another set of non-state alternatives that are unlikely to be responsive to Western-centric cosmopolitan globalist tendencies. In any case, the evolution of the international system will take time, and its outcome is hard to predict. A top-down approach towards the synchronisation of policies based on the willingness of an uneven group of political actors to reach a common agreement is unlikely to succeed, as is the promotion of liberal cosmopolitan ideas, no matter how relevant they might be from our Western perspective. While

cosmopolitan thinkers might perceive the cosmopolitan state as promoting the common good, they, in fact, promote the propagation of a specific outlook on international politics or soft power projection on others.

5 A Realistic Alternative

The three topics covered in this book – planetary defence, asteroid mining, and development of a large laser – can be more suitably conducted in the empirically driven framework of neorealist geopolitics rather than from the point of view of a responsible cosmopolitan state. As neorealist empirically driven geopolitics analyses the world based on its empirical richness and not theoretical simplifications, it presents us with various foreign policy tools that combine cooperation and conflict. These tools are rooted in the territorial responsibilities of actors of international politics and depend on their interest themselves, based on several factors, including the population's interests, and tools of power projection available. In mid-sized liberal democratic states in Europe, the role of the population will be larger than in the case of authoritarian states.

An approach of mid-sized European states to asteroid politics, including their deflection and mining, must be in conformity with the empirical reality of international politics and its wider strategic decisions. Unlike states with similar power potential in other regions, however, they can make use of the common European framework that establishes an aspiring first-tier power to promote its interests on the global scene. It is the advantage of the smaller European countries that, if potent enough, they might enhance their global voice through the common European project. In this sense, smaller countries with some unique advantage that would, under normal circumstances, fit (at best) into the third-tier category and maximally affect regional politics can suddenly take advantage of the shared resources and act, in the given issue, as an aspiring global power, representing the common European project. This is exactly what a mid-sized European power invested in certain space projects should realistically aim to do.

It is in the interest of smaller European countries and their populations to operate in a predictable, rules-based, and non-confrontational international environment. This constitutes the main security predicament for their existence and development. It is in the interest of the Western countries, in general, to operate in the liberal rules-based order, as it constitutes a framework that allows them to promote their political and economic interests most effectively. These countries are open to international flows and liberalisation of policies and thus make the best use of the open, predictable, liberal framework. As such, the essential interests of the two are not in opposition. Thus, it is possible to take the initiative and attempt to promote a mid-sized European country's interest in a predictable approach to planetary defence that would bring some interesting offer to the table. In the case of the Czech Republic,

such a unique capacity would be the production of high-powered lasers that might be used in asteroid deflection missions. While the predictable approach to deflection, liberal rules-based framework concerning asteroid mining, including possible redistribution of part of generated wealth through humanitarian assistance, or development of high-powered lasers built on the Czech soil, is in the interest of the Czech Republic, it is crucial to understand that such a framework is by no means universally accepted or cosmopolitan.

As pointed out by Klein (2019, 159–161), small states with space ambitions may use several non-military means of increasing power, including diplomatic initiatives, instilling national pride, or utilising a technically educated workforce. It is this technological advantage that can be used by mid-sized European countries such as the Czech Republic to promote diplomatic initiatives in the domain of planetary defence or, potentially, even asteroid mining and shape the international environment towards its policy interests. The Czech Republic is a long-term supporter of de-nuclearisation, meaning that it can present laser technologies as workable alternatives to the nuclear deflection methods and make use of European global standing, to promote such a goal on the international scene. As such, it might inspire greater investment into the technology that is being developed on its territory and thus become an important space actor through research and development efforts. As such, it might become the representative of the common European approach on the international fora and thus help shape the regulations to meet the interests of the Czech foreign policy. These would include the development of crisis mechanisms, investment into non-nuclear deflection capabilities, promotion of a rules-based framework, and increase of confidence among the space powers along the lines of the proposed European International Code of Conduct for Outer Space Activities.[4] Becoming a third-tier power in the field of space security in a region that allows for the magnifying of the voices of its members in the global arena establishes a realistic avenue for the promotion of the goals dedicated to planetary defence, unlike those proposed by cosmopolitan thinking.

It is a myth that honest, realistic, geopolitical thinking rooted in in-depth empirical analysis calls for conflict among idealised self-interested sovereign states. While such a simplification has been brought into the discussion by the ‘neo’ approaches in international relations theory, it is not relevant for proper geopolitical analysis that takes into account a wide variety of factors relevant for the political decision-making, as well as the unevenness of international politics. While many states are the main representatives of the communities on their territories, this is not universally the case. Also, not all the states are interested in sustaining the conflicting nature of international politics and opt for interdependence and cooperation. While it remains important that the territorial responsibility of states is preserved, this does

[4] https://eeas.europa.eu/archives/docs/non-proliferation-and-disarmament/pdf/space_code_conduct_draft_vers_31-march-2014_en.pdf

not amount to universal conflict over each and every issue or idealised total sovereignty promoted by right-wing populists.

Additionally, the evolution of the international system has developed units in several political sub-systems that project differing basic logics of conducting politics, thus making the universalistic prescriptions of cosmopolitanism even remote from the empirical reality. Suppose a mid-sized European country like the Czech Republic wants to promote a more stable non-nuclear framework for planetary deflection or asteroid mining. In that case, it must take the initiative, develop its interests and capacities, and utilise the European framework to steer the global community towards its point of view. A responsible cosmopolitan state is either a fallacy misreading one's universalistic values for universally accepted ones or a soft power projection tool of mainly authoritarian regimes with very limited territorial responsibility. A responsibility to everyone means a responsibility to no one. A truly territorially responsible foreign policy based on the ideas of populations will facilitate the finding of consensus much better than the fallacy of cosmopolitanism, often misused by regimes that are not responsible even to their own populations. If a value or threat is globally accepted, it will be more effectively tackled by territorially responsible states rather than cosmopolitan ones.

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References

Beardsworth, R., Brown, G. W., & Shapcott, R. (2019). Introduction. In *The state and cosmopolitan responsibilities* (pp. 1–12). Oxford University Press.

Blackwill, R. D., & Harris, J. M. (2016). *War by other means: Geoeconomics and statecraft*. The Belknap Press of Harvard University Press.

Brown, G. W. (2011). Bringing the state back into cosmopolitanism: The idea of responsible cosmopolitan states. *Political Studies Review, 9*(1), 53–66.

Burke, A. (2013). Security cosmopolitanism. *Critical Studies on Security, 1*(1), 13–28. https://doi.org/10.1080/21624887.2013.790194

Cohen, S. B. (2015). *Geopolitics: The geography of international relations*. Rowman and Littlefield.

Conference on Disarmament. (2008). *Letter Dated 12 February 2008 from the Permanent Representative of the Russian Federation and the Permanent Representative of China to the Conference on Disarmament Addressed to the Secretary-General of the Conference.* 28 February. https://digitallibrary.un.org/record/633470. Accessed 18 Feb 2021.

Doboš, B. (2020). *New middle ages: Geopolitics of post-westphalian world*. Springer.

Dolman, E. (2002). *Astropolitik: Classical geopolitics in the space age*. Frank Cass.

Dufek, P. (2019). Why a world state is unavoidable in planetary defense: On loopholes in the vision of a cosmopolitan governance. In N. Schmidt (Ed.), *Planetary defense: Global collaboration for defending earth from asteroids and comets* (pp. 375–399). Springer International Publishing.

Johnson-Freese, J., & Schmidt, N. (2020). Reaching for the stars: The case for cooperative governance of directed energy technologies. *Bulletin of the Atomic Scientists, 76*(00), 1–6. https://doi.org/10.1080/00963402.2020.1751972

Klein, J. J. (2019). *Understanding space strategy: The art of war in space*. Routledge.

Linklater, A. (2019). Political community and cosmopolitan responsibility. In *The state and cosmopolitan responsibilities* (pp. 170–180). Oxford University Press. https://doi.org/10.1093/oso/9780198800613.003.0009

Němečková, M. (2020). *The concept of security dilemma in the environment of outer space: The case of the Galileo system*. Univerzita Karlova, Fakulta sociálních věd, Institut politologických studií.

Riegl, M., & Doboš, B. (2018). Geopolitics of Secession: Post-Soviet De Facto States and Russian Geopolotical Strategy. *Central European Journal of International and Security Studies, 12*(1), 59–89.

Ronzoni, M. (2019). The cosmopolitan responsibilities of republican states. In *The state and cosmopolitan responsibilities* (pp. 319–330). Oxford University Press. https://doi.org/10.1093/oso/9780198800613.003.0017

Schmidt, N. (2019a). Introduction: Planetary defense as the unique historical opportunity to shape our shared destiny. In N. Schmidt (Ed.), *Planetary defense: Global collaboration for defending earth from asteroids and comets* (pp. 1–12). Springer.

Schmidt, N. (2019b). Conceptualizing the asteroid threat and searching for a balanced answer between effectiveness and desirability. In N. Schmidt (Ed.), *Planetary defense: Global collaboration for defending earth from asteroids and comets* (pp. 217–230). Springer.

Schmidt, N. (2019c). Cosmopolitan rationale for planetary defense. In N. Schmidt (Ed.), *Planetary defense: Global collaboration for defending earth from asteroids and comets* (pp. 299–313). Springer.

Schmidt, N., & Boháček, P. (2019). Dawn of cosmopolitan order? The new norm of responsibility to defend earth and the planetary council. In N. Schmidt (Ed.), *Planetary defense: Global collaboration for defending earth from asteroids and comets* (pp. 315–338). Springer.

Schmidt, N., Boháček, P., Švec, M., Borovička, J., Pravec, P., & Spurný, P. (2019). Výzvy pro národní politiku obrany planety a těžby asteroidů. *Politologická revue, 25*(2), 65–99.

Shapcott, R. (2019). Cosmopolitan extraterritoriality. In *The state and cosmopolitan responsibilities* (pp. 99–118). Oxford University Press. https://doi.org/10.1093/oso/9780198800613.003.0006

Spruyt, H. (1996). *The sovereign state and its competitors: An analysis of systems change*. Princeton University Press.

Strayer, J. S. (1970). *On the medieval origins of the modern state*. Princeton University Press.

Švec, M., Bohacek, P., & Schmidt, N. (2020). Utilization of natural resources in outer space: Social license to operate as an alternative source of both legality and legitimacy. *Oil, Gas & Energy Law Journal (OGEL), 18*(1), 19.

Tilly, C. (1975). Reflections on the history of European state-making. In *The formation of national states in Western Europe* (pp. 3–83). Princeton.

Tilly, C. (1990). *Coercion, capital, and European states, AD 990–1990*. Basil Blackwell, Inc.

Wang, S.-C. (2013). *Transatlantic space politics: Competition and cooperation above the clouds*. Routledge.

White, F. (2019). The overview effect and planetary defense. In *Planetary defense: Global collaboration for defending earth from asteroids and comets* (pp. 289–298). Springer.

Part II
Cosmopolitan Responsibility in Space

International Space Law as the Transiting Path to Cosmopolitan Order

Martin Švec and Nikola Schmidt

1 Introduction

Can international space law be considered cosmopolitan? This core question of the following chapter was laid out at the beginning of its drafting. A key presupposition would say that if international law is setting up a regime between states, it cannot be. However, as cosmopolitan theory generally says that cosmopolitan rights can be achieved when we deconstruct the main illegitimate political entities (states enclosed within their borders) and begin treating all humans as humankind, as a single community with equal rights, we have to say that space has no drawn borders and is res communis omnium – "a thing of the (entire) community." This very quick analysis finally inspired us to proceed into a debate that – to our knowledge – is significantly understudied.

Cosmopolitan theorists vary on a hugely broad spectrum of interests across various disciplines. Having this fact on mind, we decided to focus on that part of cosmopolitan thought exposition that helps us to discuss its influence on space law development and its current status while introducing an interesting concept that this volume discusses in all its chapters – the concept of the responsible cosmopolitan state. This turn by the cosmopolitan scholars was motivated mainly by the criticism that the cosmopolitan ideas are failing to materialize on the global level; therefore, they decided to take back the state and discuss to what extent states can play the role

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of agents in the putting of cosmopolitan thought into practice. Colloquially said, from the long-term perspective, it is a suicide mission as states are certainly not legitimate political actors from the cosmopolitan perspective; however, at the same time they are currently the most politically legitimate actors to deliver the change. If the transition period from the global system of nation states cannot happen at 1 conference where 200 states would annul their sovereignty and step under the umbrella of a world state with its own government and parliament, one would ask, "What are the longer possible shapes of this transition to a globalized world based on cosmopolitan principles, and reflecting cosmopolitan values?" We are far away from that utopian vision; however, every cosmopolitan usually argues by pointing to the last 200 years of political development since Kant wrote his masterpiece *Perpetual Peace*.

Responsible cosmopolitan states definitely can have a weak moral cosmopolitan position by spreading cosmopolitan moral ideas and helping them to become incorporated in a legal regime that is binding for other states – international law. At the same time, states can establish entities to which they transfer some portion of their power – where the problem of collective action hampers making effective decisions or where it is simply right. States can also introduce a language that is inherently cosmopolitan (e.g., "envoys of mankind"), effectively influencing the following decades of discussions having a legal impact on states through binding international treaties. In this regard, we are approaching the analysis of "whether international space law is cosmopolitan" from this transition perspective and examine whether it can play a role in the cosmopolitanization of the world by binding activities in space that are going to be bounded by an international space law written decades ago.

2 Cosmopolitanism

Cosmopolitanism is a word derived from the Ancient Greek word *kosmopolitês*, which was formed from the words *kosmo* (world, universe) *and politês* (citizens); as such it is used nowadays to define the term "citizens of the world." Oxford Reference defines cosmopolitanism as a philosophical idea that human beings have equal moral and political obligations to each other without reference to state citizenship, national identity, religious affiliation, ethnicity, or place of birth. All human beings share a capacity for reason and are therefore, by nature, members of a universal community. Thus, cosmopolitanism makes the normative claim that political boundaries and national identities are morally arbitrary and that all human beings should be held as the primary units of moral worth, as if they were equal citizens of a universal political community. Cosmopolitanism currently has various modalities (Beardsworth (2011) distinguishes the cultural, moral, normative, institutional, legal, and political modalities) that are intertwined but at the same time have different objects of study.

2.1 *Modalities of Cosmopolitanism, Between Ideas and Practice*

At the end of the eighteenth century when cosmopolitanism was revived mainly by Immanuel Kant, scholars distinguished six slightly different modalities: moral cosmopolitanism as the philosophical core; political and legal cosmopolitanisms, which propose political and legal reforms; cultural cosmopolitanism, which emphasizes the value of global cultural pluralism; economic cosmopolitanism, which focuses on the global free market that we currently know only at the European level; and romantic cosmopolitanism, which talks about the ideal of all of humanity being united in faith and love (Kleingeld, 1999). In the following text, legal and political modalities are discussed together.

First, moral cosmopolitanism as the philosophical core for any further cosmopolitan theorization is the underlying inspiration for any more focused cosmopolitan ideas. Moral cosmopolitanism introduces several key ideas such as the morally arbitrary nature of borders, that each human being must be treated equally or that all human beings are citizens of the world and, as such, members of a single community. In this perspective, the national sovereignty demarcating line between citizens of the nation states and the "others" along with their rights and obligations is, from the moral cosmopolitan perspective, understood as unacceptable and immoral. Therefore, the whole concept of a responsible cosmopolitan state might be attacked from the moral cosmopolitan viewpoint as also unacceptable, as it is still a state with borders. Types of moral cosmopolitanism can differ mainly on the line between weak and strong cosmopolitanism. Weak cosmopolitans require equal *moral concern* for human beings, while strong cosmopolitans require equal treatment for all human beings (Miller, 2007, pp. 43–44). Let's consider these terms as being on a continuum rather than as being two distinct camps. In that sense, from the weak perspective, a responsible cosmopolitan state views all human beings as equals but does not have the political instruments to treat them equally; from the strong moral perspective, Dufek argues that the realization of strong moral requirements of justice "should be entrusted to global political institutions with legitimate coercive power, which in turn would rest on a global system of positive law to which jurisdiction of individual states would be subordinated – in other words, a version of a globalized modern state of which all people in the world would be citizens" (Dufek, 2013).

Second, legal and political cosmopolitanism then react to the moral cosmopolitan arguments and introduce various legal instruments and political institutions with an objective to fulfill the moral cosmopolitan ideas. It is important to say that these proposals of instruments vary a lot. From the strong to the weak perspective, we can begin with a world state similar to a nation state with its own world constitution. Then, below the world state, we can consider a world government that is linked to nation states in a system comparable to the multilevel governance of the European Union, which has a supranational government (the Commission) with the European Parliament but also with the power balancing European Council, above the

governments of member states. The following level could be a political authority to which nation states have to subordinate their sovereignty but only in dealing with certain political questions. The United Nations Security Council could be considered as such an authority. The next, fourth level, could be a multilevel governance linked to various policies related to problems that humanity has to deal with together. Another example of multilevel governance can be found in the searching for solutions to the climate crisis. Global environmental policies are built on scientific research and prepared by multilevel governance bodies; the Intergovernmental Panel on Climate Change (IPCC) prepares the groundwork for the COP (Conference of the Parties), which consists of states. A huge amount of critical knowledge is prepared and critically assessed elsewhere (in the IPCC) before it is handed over to the state for making a decision. In that sense, we can find a certain kind of multilevel governance everywhere that democratic deliberations take place. However, these four levels are just examples of how the continuum between weak and strong moral ideas can be transcribed into practical political instruments fulfilling cosmopolitan ideas.

Third, cultural cosmopolitanism nourishes *pluralism* against *homogeneity*, which was reiterated, for example, by Beck when he said that "cosmopolitanism without provincialism is empty, provincialism without cosmopolitanism is blind" (Beck, 2006, p. 7). Cosmopolitanism is about richness, and when scholars talk about universality, it is not about homogenization of our cultural or political differences but about pushing for or maintaining equality while nourishing heterogeneity. Therefore, arguing against realist critics, political and legal cosmopolitanisms do not (necessarily) strive for a nation state system deconstruction but for a political plurality reflecting moral cosmopolitan ideas. Here, cultural cosmopolitanism meets political cosmopolitanism. This is also a common difference from Kant's interpretation. Rawls understands Kant's discussions about a world state as a proposal for a new sovereign political entity (probably from the perspective of sovereignty as radical autonomy – see chapter 6) and immediately makes an argument that it would slide into global despotism (see below) (Rawls, 1999, p. 36). While Pogge (2012) sees Kant as a proponent of a world state that is neither created by conquest nor an imposed political entity, but a rational end of our moral efforts, Pogge also says that legal cosmopolitanism endorses a world state or *cosmopolis*. In his words, a world state "is a political society that includes all human beings or at least is open to all," which means a political entity far away from being sovereign over all its citizens but rather an entity that "includes all human beings or at least is open to all." It is not imposed on all but based on a cosmopolitan social justice that is still a philosophical idea rather than a global political practice (Pogge, 2012). Sometimes following these nuances in cosmopolitan thought is understandably tricky, especially when Pogge is widely considered to be a strong moral cosmopolitan. However, accepting that global governance can be cosmopolitan without an ultimately powerful world state is the way to understand the legitimacy of the responsible cosmopolitan state idea in the light of moral cosmopolitan requirements. It also opens doors for

understanding international law as possibly cosmopolitan despite the fact that it still regulates relations between states.

Fourth, the idea of a global free market is not just a liberal pragmatic idea isolated from idealistic cosmopolitan ideas but a cosmopolitan idea itself, which is an indicator of an ongoing cosmopolitanization of global political life (Held, 2010). However, we do not need to go too far to see harsh criticism against the global market stating that it is the core of ongoing global injustice. In the end, the last years following the election of Donald Trump, the core discussion over economic globalization in the sense of a global free market has been filled with arguments that the populists elected in those years were elected because most people were kept behind the economic evolution and advantages the global market provides (Acemoglu, 2020). That said, the current global market is not making people more equal despite the cosmopolitan idea that economic cosmopolitanism is supposed to make people equal traders and finally equal humans. In contrast, as the world is becoming more economically interdependent, it puts an increasing array of moral obligations on politicians so that they would follow the core idea of cosmopolitanism about human equality (Nagel, 2005, p. 138); in the case of the global market consequences for people's equality, the pressure is to reform it along with legal and political cosmopolitan ideals. That said, some are arguing against the general principles of the free market based on its flaws, portraying globalization as flawed as well and therefore understanding cosmopolitan ideas as following these flaws, but the problem is about practical means of its regulation to fulfill the cosmopolitan ideas. The idea behind the free market is not about free trade but fair trade. The current state of the global market is making the desire for fair trade a moral pressure; the same is happening in political and legal cosmopolitanisms.

Fifth, as we can see a dedicated romantic cosmopolitanism being focused faithfully on romantic ideas of an unprecedented global unity, the other modalities of cosmopolitanism, especially the legal and political modalities, are seeking for practical policies that will cosmopolitanize our world. As shown on the preceding example with the global market, there are no ideal solutions but idea(l)s to strive for, and we think that cosmopolitanism should be understood in this way – that it analyzes, proposes, criticizes, or refuses various practical means (instruments of legal and political cosmopolitanism) for achieving moral cosmopolitan ideals – and therefore, cosmopolitanism cannot be internally perfectly consistent as some cosmopolitan scholars simply disagree with each other. Legal and political cosmopolitanisms do not come with ideal solutions but with proposals bringing us closer to the ideals, and we should try them if we strive for a more equal and just world.

2.2 From Moral to Legal Cosmopolitanism

Cosmopolitanism refers to a very wide range of theories and practices built around a universal embracement of humanity (Delanty, 2012). Moral cosmopolitanism is built on the premise that every human being has a global stature as an ultimate unit

of moral concern and, *thus*, all persons stand in certain moral relations to one another (Pogge, 2012); it is meant to be the source of ideas for further implementation into social practice. Moral cosmopolitanism has been defined for the modern and recent debate by Pogge, who stipulates three key moral principles for moral cosmopolitanism: these are *individualism* (the referent object is not a state, tribe, or ethnic community but individual humans), *universalism* (all living human beings are equal), and *generality* (moral concerns apply to everyone, not just to our compatriots) (Pogge, 1992).

According to A. R. Bernstein, any actions (especially law-making and policy-making) that may significantly affect anyone's vital, fundamental, or otherwise important interests should be properly taken into account in practical deliberations (Chatterjee, 2011). Most importantly, we argue that some weak moral cosmopolitan ideas are not only compatible with the current system of international law, but they have also already significantly affected various fields of international law, such as international environmental law, international human rights law, the law of the seas, etc. (in contrast to legal cosmopolitanism following strong moral cosmopolitan ideas – see below) (Bernstein, 2011).

This slow process of developing international regimes that would harmonize the behavior of states can be considered as a cosmopolitanization of the world if it does reflect moral cosmopolitan ideas and transcribes them into legal instruments (or other instruments forming international regimes – see chapter 3); as such it has the potential to lead towards a random level of the cosmopolitan governance models sketched out above, including the world state. Pogge shows how some scholars tend to understand discussions over a world state in a common statist perspective and points to Rawls, who said: "I follow Kant's lead in Perpetual Peace (1795) in thinking that a world government ... would either be a global despotism or else would rule over a fragile empire torn by frequent civil strife as various regions and peoples [would try] to gain their political freedom and autonomy" (Rawls, 1999, p. 36). Others tend to understand world statism in a comparable way, perceiving despotic futures without democratic deliberation as the power is handed over to a single point that logically inclines to despotism (Zolo, 2000). Pogge's meaning is still on the level of the moral cosmopolitanism surrounding the strong moral cosmopolitan argument that freedom and equality cannot stay on the national level within constructed borders because one cannot draw a line between different levels of personality and justice – national and global – they should be the same (Caney, 2005, pp. 72, 124). As said above, weak cosmopolitans require equal *moral concern* for human beings, while strong cosmopolitans require equal *treatment* (Miller, 2007, pp. 43–44). Moral concern is a normative requirement, and reliable treatment would be a usually enforced legal requirement.

Legal cosmopolitanism, then, looks at instruments providing a legal status to cosmopolitan ideals and the moral foundation defined in moral cosmopolitan thought to international law (Buchanan, 2007). In this sense Pogge talks about a world state, but he does not foresee a world state as a new and definitive political entity taking over power from nation states on the global level, effectively deconstructing the nation state system; he talks about a *cosmopolis* as we explained it

above, a political society including, or open to, all; he follows Kant in preferring a world republic above a league of sovereign states (Pogge, 2012, p. 13).

2.3 *From Moral Guidance to the Responsible Cosmopolitan State*

The concept of a responsible cosmopolitan state does not bring in the argument of a global authority, whether it is a world state, a world government, a global authority, etc., but lays the burden of cosmopolitan responsibility on the state. In this sense, the concept of a cosmopolitan responsible state is motivated by weak cosmopolitan moral principles because it does not require a construction of a world state but lays moral obligations on nation states to behave in a morally responsible way towards all human beings. A responsible cosmopolitan state, therefore, reflects *some* moral ideals but does not strive to achieve any new utopian political entities; it focuses on certain moral behavior, and that can include foreign policy along with diplomatic efforts with an objective to adopt international laws regulating the international system that would respect *some* ideals of moral cosmopolitanism. However, no one says that such a foreign policy cannot lead to a diminishing of national sovereignties for the benefit of any global form of governance above nation states; it can and should, according to moral cosmopolitanism.

As said above, Pogge talks about a political entity that is open to all, in which all human beings would be fellow citizens and a cosmopolitan institutional order would ensure that all persons have equal rights and duties (Pogge, 2012). Rawls' reading of Kant, as shown above, is questionable to Pogge, and we would agree with Pogge because Kant was talking about a federation of republics, *civitas gentium*; he did not foresee a world state taking over power from nation states but rather a republican federation covering like-minded republican states (Kant, 1795). Beardsworth adds to this distinct interpretation and argues that Kant was talking about a process in which a liberally oriented republican state would lead by example in the dissemination of the republican ideals that would actually create global political environment in which global authority would emerge naturally (Beardsworth, 2011, pp. 37–38). Republican states would help with this process because they would be willing to secure their existence. The analogy with NATO and the motivation of states to become its members is a good example of fulfilling these ideas.

The process of the global authority's emergence will be long, but we still live in an era in which states are looking for a common ground for dealing with common problems. States are not keen on creating a global government with its own parliament; therefore, we cannot expect to see cosmopolitan rights being encoded in cosmopolitan laws anytime soon because such laws would require authority, power, and respected legitimacy to be enforced.

Kant discerns between international rights and cosmopolitan rights,[1] where the former involves rights of states in their legal relations (treaties), while the latter involves states and individuals in their legal relations on a global level (Kant, 1795, 2010). In Kant's meaning cosmopolitan laws must be backed by force so that they would be enforced as cosmopolitan rights, and because he was aware of the dilemma that cosmopolitan laws on the cosmopolitan level run into the risk of domination and conflict, he counted on his expectation that the international law rules of international rights among the republican states with a republican state leadership – the ones who would lead by example – would evolve into cosmopolitan law: "One powerful state will provide a focal point for federal association among other states. These will join up with the first one, thus securing the freedom of each state with the ideas of international right, and the whole will gradually spread further and further" (Cited as in Beardsworth, 2011; Kant, 1795).

Kant was fully aware of the dilemma that cosmopolitan laws enforced on the global level bring the risk of despotism and of the political reality that "natural rights allow us to say of men living in lawless condition that they ought to abandon it, [and] the right of nations does not allow us to say the same of states" (Kant, 1795). Therefore, Kant thought that the federation of nation states should be primarily based on the international law principles emanating from the constitutional practice of the like-minded republican states and the dissemination of the republican example before they constitute cosmopolitan law. Because we do not have a cosmopolitan authority but still govern the world through international law, the responsible cosmopolitan state concept provides us a middle-way solution that actually follows Kant's ideas of achieving a world state reflecting cosmopolitan rights in a randomly distant future by pursuing them right now. As Dufek argues in chapter 2, the concept of a responsible cosmopolitan state takes up the role for states in which they are foremost agents of cosmopolitan morality, and therefore it is the middle ground reconciliation between utopian cosmopolitan theorizing (dreaming about cosmopolitan law) and the status quo of the current global order (based on international law), while it provides a guidance towards the cosmopolitan ideals, so we can pursue them in the available politico-legal system.

Therefore, if we follow weak cosmopolitans, international laws have the potential to pave the road to establishing a cosmopolitan authority that would introduce cosmopolitan rights in the future. In connection with this, we should not consider

[1] Cosmopolitan literature refers to cosmopolitan law as "hard law" and international law as "soft law," which is significantly distinct from "hard law" and "soft law" in international law literature. In the cosmopolitan literature, hard law points to laws that are enforced (national practice by law enforcement agencies or cosmopolitan ideals that mostly do not exist, though there are exceptions such as, e.g., the International Criminal Court), while soft law is rather a normative plane (international law) harmonizing behavior between states. In the international law literature, soft law points to standardization or guidelines, while the hard law is international law stipulated in treaties. For the sake of clarity in this text, we use only cosmopolitan law as reflecting cosmopolitan rights and international law as reflecting international rights. Kant used the terms "hard law" and "soft law" with the meanings of cosmopolitan literature.

the success of legal cosmopolitan efforts to be only in the shape of a world state based on cosmopolitan law, but the success should rather be in the form of a (soft) regime limiting the behavior of states and individuals as well as granting them equal rights through international law. The regime should be motivating (not enforcing) for entities with influence on political life, whether they are states, powerful individuals, or global corporations, and it should motivate them to follow, fulfill, elevate, and promote cosmopolitan values, principles, and goals, mainly in a normative way. The resulting cloud of ideals should be transcribed into the way we all behave (in foreign policy, international cooperation, scientific efforts, etc.). However, this could be hard to swallow for the majority of legal scholars discussing international law, but as Hedley Bull puts it, international law is a system of principles suppressing anarchy, emanating from *positive international morality* (in the meaning of cosmopolitan morality), and one would argue that international law is not necessarily strong in its interpretation of and power to impose the rules and principles it contains, but it should rather be seen as a *normative plane* that guides our actions in world politics (Bull, 2002).

Analyzing to what extent international space law accommodates cosmopolitan ideas could, therefore, be based solely on weak moral cosmopolitan ideas that might have the potential to transform (later) into something more enforceable. There are multiple ways in which moral cosmopolitanism can be incorporated into the legal framework. The following part of the chapter focuses on the following aspects in a pure legal analysis approach:

(a) Does the legal framework treat all human beings equally?
(b) Does the legal framework properly take the interests of all human beings into account?
(c) Are the legal norms universally applicable?

3 Searching for Cosmopolitan Ideas in National Law

The conceptualization of cosmopolitanism has been a center of philosophical inquiry since ancient times. Cosmopolitan ideas formulated by Stoics influenced legal education and consequently ancient legal norms. While Cicero, a Roman lawyer, recognized and elaborated a theory of the international community, and his concept of *jus gentium* was based on the idea that the human race is naturally and harmonically united (Domingo, 2019, p. 221),[2] Ulpian acknowledged the legal

[2] According to Conklin, Cicero acknowledged that human beings are bound together socially by virtue of their capacity to communicate and reason through language. The bonding marks the sociability of human beings with each other, and, thus, the bonding is natural. The highest form of such sociability is res publica manifesting a bonding through "this celestial order" or "this whole cosmos." "Any particular human being is all the more "grand and glorious" because he is a member of the fellowship of the cosmic order. What begins as parental love extends into friendship with strangers and then into the whole human species" (Conklin, 2010, p. 486).

challenges arising from the extension of citizenship to all free individuals of the Roman Empire. According to Rafael Domingo, Ulpian aimed to convert Roman law into a more cosmopolitan legal system that would be suitable to the needs of a multicultural society (Domingo, 2019, p. 222). This system was to be based on cosmopolitan values such as liberty, dignity, universality, and equality (Honoré, 2002).

Medieval history revealed that a society based on inequality prevents cosmopolitan ideas from being incorporated into legal frameworks. Thus, the Middle Ages are by many viewed as mostly antithetical to cosmopolitan ideas (Ganim, 2010). In contrast, cosmopolitan ideas flourished during the Enlightenment, when the concepts of liberty and equality significantly affected both legal scholarship and legal norms.[3]

Today, most of the legal systems in democratic and liberal countries treat human beings equally, irrespective of their citizenship, national identity, religious affiliation, or ethnicity.[4] However, national laws only rarely address the interests of all human beings due to the practical and legal limitations. First, national laws primarily aim to pursue national objectives since national legislators derive their legitimacy from the people they represent. Second, national legislators usually do not have the tools to identify the interests of all human beings. Third, even if global objectives have been identified (see the 2030 Agenda for Sustainable Development), national legislators are likely to prioritize national interests over global interests if these two are not compatible. In other words, national law remains subordinated to national interests and as such cannot be considered truly cosmopolitan (see chapter 7). Fourth, the inherent jurisdictional limitations arising from the concept of state sovereignty make the implementation of cosmopolitan ideas via national law very challenging. The application of national law is territorially limited.[5] Extraterritorial enforcement of national law would be likely considered as an interference in the internal affairs of other sovereign states. In other words, regardless of the ambition of incorporating cosmopolitan ideas into national legal frameworks, national law appears to be, in its nature, deeply anti-cosmopolitan.

In addition, an effort to incorporate cosmopolitan ideas into the national legal framework of one state does not usually have any impact on human beings falling under the jurisdiction of other states. The impact of the cosmopolitan ideas enshrined

[3] Ibid., see Declaration of the Rights of Man, 1789.

[4] There are some exemptions such as tax law or pension/social security schemes; however, most of them are justified.

[5] National law applies extraterritorially only in exceptional cases. Some well-known examples of the extraterritorial application of national laws concern US antitrust laws, US unitary tax formulas, and US export controls which forbid foreign companies from re-exporting technology to the Eastern bloc. See (Naldi, 1990). Another example of an extraterritorial application of national would be the concept of universal jurisdiction. See International Committee of the Red Cross. "Rule 157. Jurisdiction over War Crimes." IHL Database: Customary IHL and International Justice Resource Center. "Universal Jurisdiction." https://ijrcenter.org/cases-before-national-courts/domestic-exercise-of-universal-jurisdiction/

in national legal frameworks is *thus* significantly limited by national border lines (read also as jurisdiction). Being based on political boundaries and national identities, the concept of state sovereignty contradicts the idea of a universal political community. National law and state sovereignty are deeply intertwined, and, therefore, national law can never aspire to be truly cosmopolitan.

Having said that, national legislators can play only a complementary role in the global effort to materialize cosmopolitan ideas. However, there are several noteworthy exceptions, such as environmental law, the concept of universal jurisdiction, or national legislation relating to asylum. While the application of environmental law is limited by the concept of state sovereignty and the state's jurisdiction, its impact is truly cosmopolitan since the environmental degradation is not limited by national borders. In certain situations, national and global objectives, such as biodiversity or sustainability, are identical. Hence, environmental law is, due to its subject-matter, inherently cosmopolitan. In contrast, both asylum law and the concept of universal jurisdiction have been intentionally developed to pursue cosmopolitan ideals beyond national jurisdiction. According to Niraj Nathwani, the purpose of the institution of asylum is to serve as a backup system for individuals whose human rights cannot be guaranteed in their country of origin. By doing so, asylum law allows states to effectively protect human rights beyond their jurisdiction (Hathaway, 1995; Nathwani, 2000, p. 364). The principle of universal jurisdiction allows a state to bring criminal proceedings in respect to certain crimes irrespective of the location of the crime and the nationality of the perpetrator or the victim (International Law Association Committee on International Human Rights Law and Practice, 2000, p. 2; Randall, 1988, pp. 785–788).

To conclude, national law is not an ideal tool for pursuing cosmopolitan ideas. However, the abovementioned examples reveal that a national policy driven by cosmopolitan ideals may be translated into national law, stimulating a materialization of cosmopolitan ideals even beyond national jurisdiction. National space mining law, which is addressed in chapter 7, may serve as another example of national law having the potential to reflect cosmopolitan ideals.

4 Searching for Cosmopolitan Ideas in International Law

4.1 Non-cosmopolitan International Law

There is no doubt that international law is much better positioned to bear cosmopolitan ideas than national legal frameworks. The transnational nature of international law effectively addresses barriers preventing national law from fully incorporating cosmopolitan ideas, including the very concept of state sovereignty and territorially limited jurisdiction. However, international law had long been unable to contribute to the development of cosmopolitanism. Until the twentieth

century, international law was understood as the "law of co-existence" (Fassbender, 2012, p. 139). Fassbender explains that, "(…) it was a typical aspect of the law of co-existence that [a] state's sovereign rights were not conceived of as powers to be used towards the public good but as subjective rights which a state can exercise just as it likes" (Fassbender, 2012, p. 138). Hence, international law was essentially bilateral (reciprocal) as its norms were viewed as tools that aim to regulate the pursuing of national interests beyond a state's territory (Simma, 1994, pp. 230–233). In other words, until the twentieth century, international law was not aimed to bear cosmopolitan ideas.

International law has long been considered a body of norms regulating exclusively relationships between states, and *thus*, only states could be subjects of international law (public international law is often referred to as the law of nations). Individuals have been excluded from the subject matter of norms of international law. As such, the state-centered system of international law in which individuals may benefit only indirectly was not able to materialize the cosmopolitan vision as one would expect.

Sovereign equality, a fundamental axiomatic premise of the international legal order, has been often viewed as a conceptual obstacle to the implementation of cosmopolitan ideas as well. Richard Beardsworth, Garrett Wallace Brown, and Richard Shapcott argue in this context that the concept of state sovereignty effectively prevents the international community from taking responsibility for materializing cosmopolitan ideas (Beardsworth et al., 2019).

4.2 Cosmopolitanization of International Law: Generality

Contemporary international law has moved well beyond bilateralism towards a legal system grounded not in an exchange of rights and duties but in an adherence to a normative system (comparable to Bull's concept of a *normative plane*). According to Bardo Fassbender, states came to realize that the international community must take into account the valid interests of the other members and acknowledged the need for cooperation for the promotion of community goals (Fassbender, 2012, p. 140), such as protection of human rights, protection of the ozone layer, environmental protection, the fight against terrorism, prosecution of international crimes and prohibition/non-proliferation of nuclear weapons, international climate law, or preserving the cultural heritage and common heritage of mankind (Baynes, 2009; Charney, 1993; Taylor, 2019, pp. 148–149). The most noteworthy attempts to address the binary antagonistic relationship between cosmopolitanism and state sovereignty include the Responsibility to Protect (R2P)[6] and the Rome Statute

[6] The Responsibility to Protect doctrine, in its form that was endorsed by the UN World Summit in 2005, stipulates three pillars of responsibility: "Every state has the Responsibility to Protect its population (Pillar One), the wider international community has the responsibility to encourage and assist individual states in meeting that responsibility (Pillar Two) and if a state is manifestly failing

framework.[7] Samuel James Wyatt discusses an increasing conflation between states' self-interest on the one hand and humanitarian concerns on the other. He argues that the R2P concept enshrines key cosmopolitan maxims and that it significantly enhanced the relevance of cosmopolitan justice, both its legal-criminal form and its socioeconomic understandings (Wyatt, 2019, pp. 97, 132–133). Stella Margariti analyzed the role of the International Criminal Court against the background of the tension between the State-centric theory of international law on the one hand, and cosmopolitanism on the other, and discussed how the cosmopolitan ethos of the ICC should be promoted in an international system of sovereign states which might feel threatened by that very ethos (Margariti, 2017). According to Patrick Hayden, the ICC represents the constructive pursuit of a form of cosmopolitan law enforcement (Hayden, 2004, p. 90). Both the R2P and the Rome Statute framework are connected by the effort to prioritize cosmopolitan aspirations over the respect for state sovereignty (Lefkowitz, 2020). Jürgen Habermas, in this context, argues that further cosmopolitanization can happen through a "juridifying" of international relations, and the ICC is a good example of how legal practice on national level can levitate to the global (Habermas, 2006).

4.3 Cosmopolitanization of International Law: Universality

Norms of international law pursuing community goals are not necessarily universally applicable. Although there are international fora, most notably the United Nations (Paterson & Breu, 2019, pp. 227–230), that are positioned to encourage the development of universally applicable norms of international law (especially the General Assembly, being composed of representatives from each member state of the UN; it serves as the main deliberative body on matters relating to international law), there are only a few truly universal treaties (ratified by all UN member states).[8] The universality of international law is constantly undermined by the general consensual nature of international law and its consequent fragmentation.[9]

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to protect its populations, the international community must be prepared to take appropriate collective action, in a timely and decisive manner and in accordance with the UN Charter (Pillar Three)." See Ban Ki-moon. Responsibility to Protect: Timely and Decisive Response, Report of the Secretary-General, A/66/874-S/2012/578.

[7] The Rome Statute of the International Criminal Court is the treaty that established the International Criminal Court. See ICC, Rome Statute of the International Criminal Court; United Nations, Treaty Series, Vol. 2187, No. 3854.

[8] All UN members are parties to only eight international treaties, namely, the Vienna Convention for the Protection of the Ozone Layer; the Montreal Protocol on Substances that Deplete the Ozone Layer; the UN Framework Convention on Climate Change; the UN Convention to Combat Desertification; and the Geneva Conventions (First, Second, Third, Fourth).

[9] Part II of the Vienna Convention on the Law of Treaties, 23 May 1969, United Nations, Treaty Series, vol. 1155, p. 331 and "Fragmentation of International Law: Difficulties Arising from the

However, international conventions are not the only source of legal norms since states are also bound by international customs and general principles of international law.[10] The most fundamental norms are believed to be accepted and recognized by the international community of states as a whole and *thus* universally applicable.[11] The so-called peremptory norms of general international law (jus cogens) seek to reflect and protect fundamental values of the international community. It is generally accepted that the laws prohibiting slavery, genocide, piracy, and acts of aggression or illegal use of force are jus cogens; some suggest that certain human rights provisions (e.g., those prohibiting racial discrimination) come under the category of jus cogens as well (Woolaver, 2021). As such, peremptory norms are considered to be hierarchically superior to other rules of international law, and no derogation from them is permitted. According to Hannikainen, "a legal community may find it necessary to establish peremptory norms for the protection of such overriding interests and values of the community itself" (Hannikainen, 1988, pp. 5–12). Pellet describes them as norms paving the way towards a more "moral value oriented public order" (Pellet, 2006, p. 87). Tomuschat understands peremptory norms of general international law as "the class of norms that protect the fundamental values of the international community" (Tomuschat, 2015, p. 8). Their universal application and intention to pursue values of the international community clearly echo cosmopolitanism ideals.

In addition, some obligations arising from international law are recognized as obligations *erga omnes* – towards all, and therefore a state owes obligations to the international community. According to the ICJ, whereas norms of international law based on the principle of reciprocity are about individual advantages and disadvantages for states or about the maintenance of a contractual balance, obligations *erga omnes* reflect certain universal values, shared interests, or preferences.[12] More specifically, there are two types of obligations: (a) obligations of a traditional type that exist in relation to another particular state or other states on a bilateral basis and (b) obligations which are a concern of all states and in the protection of which all states have a legal interest.[13] A breach of the obligations that a state owes to the international community (obligations *erga omnes*) can be invoked by any state and not just

Diversification and Expansion of International Law. Report of the Study Group of the International Law Commission, Finalized by Martti Koskenniemi, A/CN.4/L.682." 2006.

[10] Statute of the International Court of Justice, Art. 38.

[11] ILC Report. (2019) Peremptory norms of general international law (jus cogens). International Law Commission. United Nationas, A/74/10, http://legal.un.org/ilc/reports/2019/english/chp5.pdf

[12] "Fragmentation of International Law: Difficulties Arising from the Diversification and Expansion of International Law. Report of the Study Group of the International Law Commission, Finalized by Martti Koskenniemi, A/CN.4/L.682." 2006.

[13] Ibid.

by individual beneficiaries.[14] According to the ICJ, *erga omnes* rights are distinguished by their character and the importance of the rights and obligations involved.[15]

4.4 Cosmopolitanization of International Law: Individualism

Pogge argues that humanity lies in the center of cosmopolitanism: "Cosmopolitan positions centrally include evaluative and normative views; they assess and prescribe. The central idea guiding these moral assessments and prescriptions is that of including all human beings as equals" (Pogge, 2012, p. 10). In other words, universal application and promotion of community goals do not make international law cosmopolitan unless it is based on the conviction that all human beings are members of a community of fate and that they share common human values that transcend the limits of nation states (Anderson-Gold, 2001; Moka-Mubelo, 2017). Only in the last century did international law begin to acknowledge the rights and duties of individuals. The Nuremberg tribunal acknowledged that individuals have criminal law obligations under the laws of war/armed conflict, while human rights are identified by a network of international instruments.[16] The faith in fundamental human rights, in the dignity and worth of the human person, and in the equal rights of men and women has been explicitly recognized also by the peoples of the United Nations in the cornerstone of the current system of global governance – the United Nations Charter.[17] Particular human rights were further elaborated in the Universal Declaration of Human Rights (UDHR), proclaimed in 1948. It is worth noting that it had been drafted by representatives with different legal and cultural backgrounds from all regions of the world. The UDHR's cosmopolitan ethos is evident. The very

[14] Article 48, International Law Commission, Draft Articles on Responsibility of States for Internationally Wrongful Acts, November 2001, Supplement No. 10 (A/56/10), chp.IV.E.1, available at: https://www.refworld.org/docid/3ddb8f804.html

[15] *Legal Consequences of the Construction of a Wall in the Occupied Palestinian Territory, Advisory Opinion,* reproduced in document A/ES-10/273 and Corr.1. See also ILM vol. 43 (2004) p. 1009, paras. 155 and 159.

[16] There are 9 core international human rights instruments, namely, the International Convention on the Elimination of All Forms of Racial Discrimination (1965); the International Covenant on Civil and Political Rights (1966); the International Covenant on Economic, Social and Cultural Rights (1966); the Convention on the Elimination of All Forms of Discrimination against Women (1979); the Convention against Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment (1984); the Convention on the Rights of the Child (1989); the International Convention on the Protection of the Rights of All Migrant Workers and Members of Their Families (1990); the International Convention for the Protection of All Persons from Enforced Disappearance (2006); and the Convention on the Rights of Persons with Disabilities (2006). In addition, there are numerous regional human rights treaties such as the European Convention on Human Rights, the Inter-American Convention on Human Rights, or the African Charter on Human and Peoples' Rights. See United Nations Human Rights Office of the High Commissioner. "The Core International Human Rights Instruments and Their Monitoring Bodies."

[17] Preamble, Art 1, United Nations, Charter of the United Nations, 24 October 1945, 1 UNTS XVI.

first Article reads as follows: "All human beings are born free and equal in dignity and rights. They are endowed with reason and conscience and should act towards one another in a spirit of brotherhood." Patrick Hayden views the emergence of the system of international human rights law as well as of international humanitarian law as a gradual conversion of imperfect into perfect obligations and of cosmopolitan morality into cosmopolitan law (Hayden, 2004, p. 80). Cosmopolitan ideas have not only affected the subject matter of international law norms, but they have also contributed to the development of its procedural and institutional innovations, such as the concept of universal jurisdiction,[18] or the establishment of international criminal and human rights courts (Baynes, 2009).

4.5 Cosmopolitanization of International Law: Neither Cosmopolitan Nor Non-cosmopolitan

Overall, the establishment of a world state in which all human beings would be fellow citizens and a cosmopolitan institutional order would ensure that all persons have equal rights and duties (Dufek, 2013) appears to be a utopian vision even in the twenty-first century. However, according to Brian Barry, cosmopolitan morality does not commit its adherents to any particular institutional arrangement, including a world state (Baynes, 2009, p. 39). The cosmopolitan ideals may also (though not equally) be reflected by humanity being organized in a society of states that retain their separate statehoods while subjecting themselves to the requirements of international covenants and some universal principles (Brown, 2009). In fact, current international law is shaped by multiple centrifugal and centripetal forces affecting its cosmopolitization. Universally applicable norms, peremptory norms, obligations *erga omnes*, and rights and obligations of individuals arising from international law undoubtedly strengthen the cosmopolitan nature of international law, whereas the concept of state sovereignty and the prohibition of interference in internal affairs as well as the general tendency to exclude individuals from access to both norms of international law and adjudicatory bodies undermine cosmopolitan ideals in international law.

[18] See the Convention on the Prevention and Punishment of the Crime of Genocide, Dec. 9, 1948, 78 UNTS 277.

4.6 Cosmopolitanization of International Law: Areas Recognized as Res Communis Omnium

Though we acknowledge the abovementioned difficulties associated with the implementation of cosmopolitan ideas into both national and international law, areas where states are prevented from exercising state sovereignty appear to be uniquely positioned to succeed in incorporating cosmopolitan ideals into international law. These areas include the high seas, the deep seabed, and outer space. The regimes governing these areas, arising from either international treaties[19] or customary international law, are based on the principle of non-appropriation. These areas, traditionally referred to as *res communis omnium*, are open for access and use to all and are not susceptible to occupation and sovereignty (Klabbers, 2017). The exclusion of territorial sovereignty over these areas stimulated the incorporation of cosmopolitan ideas since there is no alternative in this case except chaos.

More specifically, all states shall exercise the freedom of the high seas,[20] but only with due regards for the interests of other states in their exercise of the freedom of the high seas.[21] The regime governing the high seas recalls A. R. Bernstein's understanding of cosmopolitanism (any actions that may significantly affect anyone's vital, fundamental, or otherwise important interests of all human beings should be properly taken into account in practical deliberations) (Bernstein, 2011). The regime governing the deep seabed is even more cosmopolitan and may recall the utopian visions associated with legal cosmopolitanism. The UNCLOS declares the deep seabed and its resources the *common heritage of mankind* and that all rights to the resources have been vested in mankind as a whole, on whose behalf the International Seabed Authority shall act (all state parties are ipso facto members of the Authority).[22] In addition, it states that all activities in the area shall be carried out for the benefit of mankind as a whole, irrespective of the geographical locations of States, and whether they are coastal or land-locked, and taking into particular consideration the interests and needs of developing States and of peoples who have not attained full independence or any other self-governing status

[19] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, 1967, 610 UNTS 205; Convention on the Law of the Sea, Dec. 10, 1982, 1833 UNTS 397.

[20] Including freedom of navigation; freedom of overflight; freedom to lay submarine cables and pipelines, subject to Part VI; freedom to construct artificial islands and other installations permitted under international law; freedom of fishing, being subject to the conditions laid down in the UNCLOS; and freedom of scientific research. Convention on the Law of the Sea, Dec. 10, 1982, 1833 UNTS 397.

[21] See Article 87, Convention on the Law of the Sea, Dec. 10, 1982, 1833 UNTS 397.

[22] Arvid Prado, who first announced the principle of the common heritage of mankind, identified its three central concepts: (1) the absence of private property rights, (2) international management of all uses of the common heritage, and (3) sharing of benefits derived from such use. See broader context (White, 1982, p. 535).

recognized by the United Nations in accordance with General Assembly resolution 1514 (XV) and other relevant General Assembly resolutions.[23]

5 Searching for Cosmopolitan Principles in International Space Law

Space law is a new branch of international law driven by the development of space technologies and humans' desire to address fundamental questions about our place in the universe and the history of our solar system. Since the 1960s space law has been elaborated primarily under the auspices of the United Nations. The Committee on the Peaceful Uses of Outer Space (COPUOS) was instrumental in the creation of five sets of principles and five international treaties on space-related activities.

The fundamental legal principles applicable to activities in outer space were enshrined in the Outer Space Treaty (OST) in 1967. In other words, the OST provided the basic framework for international space law. The Treaty was largely based on the principles already acknowledged by the United Nations General Assembly.[24] Thus, the OST is often referred to also as the "Principle Treaty" or the "Constitution of Space Law" (Viikari, 2012). Subsequent treaties were expected to be concluded once new problems emerge, and a more detailed regulation is needed.[25]

5.1 The Outer Space Treaty

Although the OST sets forth legal principles aimed at regulating the area recognized as res communis omnium, it has been ratified or acceded to by only 111 states (UN COPUOS Legal Subcommittee, 2021). Having said that, the OST can hardly aspire to be viewed as a universally applicable treaty. Nonetheless, most of the key principles enshrined in the OST (the non-appropriation principle, the requirement that space activities shall be carried out for the benefit and in the interest of all countries, and astronauts being granted the status of "envoys of mankind") constitute peremptory norms. They cannot be amended or ignored by any states which eventually withdraw from the OST. "As peremptory rules of general international law, they are destined to protect the vital interests of the international community as a whole," according to Cestmir Cepelka and Jamie HC Gilmour (1970, p. 49).

[23] See Articles 136 and 140, Convention on the Law of the Sea, Dec. 10, 1982, 1833 UNTS 397.

[24] See G.A. Res. 2222, 21 U.N. GAOR, Supp. (No. 16) 13, U.N. Doc. A/6316(1966); G.A. Res. 1721A, 16 U.N. GAOR, Supp. (No. 17) 7, U.N. Doc. A/5100(1962); https://core.ac.uk/download/pdf/147638686.pdf

[25] Such was the process for the conclusion of the first three specific treaties – the Rescue Agreement of 1968, the Liability Convention of 1971, and the Registration Convention of 1976. All three treaties were widely ratified. See (United Nations, 2017).

It should be noted that the res communis omnium character of outer space fundamentally affected our understanding of the principles enshrined in the OST. According to Frank Dunk, the OST should obtain an elevated legal status as a treaty not simply constituting an international binding agreement between a set of states but establishing the broad legal framework for an entire specific area (F. von der Dunk, 2015, pp. 55–60). Its most cosmopolitan principles include the following:

5.2 The Non-appropriation Principle (The OST and Customary International Law)

Outer space is considered res communis omnium – an area open for access and use to all and not susceptible to occupation and sovereignty (Klabbers, 2017). As stated above, these areas are uniquely positioned for success in incorporating cosmopolitan ideals into international law. According to Article II of the Outer Space Treaty, outer space is not subject to national appropriation by claims of sovereignty, by means of use or occupation, or by any other means.[26] The exclusion of territorial sovereignty is referred to as the principle of non-appropriation (Zhang, 2019). It is worth noting that this principle is considered a part of customary international law (Freeland, 2017; Jakhu & Freeland, 2016; Paliouras, 2014) and a norm of jus cogens (Cepelka & Glimour, 1970; Jakhu et al., 2017, p. 123; Rathore & Gupta, 2020). As a consequence, the non-appropriation principle is universally applicable, regardless of whether states ratified or acceded to the OST or not (Cepelka & Glimour, 1970, p. 47).

5.3 Any Space Activities Shall Be Carried Out for the Benefit and in the Interest of All Countries (The OST and Customary International Law)

Cestmir Cepelka and Jamie HC Gilmour point out that general international law did not traditionally impose any limitation on the use of areas recognized as res communis omnium because freedom of action was accepted as a consequence of the notion of inexhaustibleness of natural resources on the high seas (Cepelka & Glimour, 1970, p. 47). However, the OST does impose such a limitation. More specifically, Article I of the OST reads as follows: “The exploration and use of outer space (…) shall be carried out for the benefit and in the interest of all countries,

[26] Article II, Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, 610 U.N.T.S. 205.

irrespective of their degree of economic or scientific development, and shall be the province of all mankind."[27]

Article I of the OST is understood as a limitation to the rights granted by the same article, namely, the freedom of exploration, use, and access. Stephan Hobe argues that "freedoms of outer space activities are not granted in an unlimited way, but only under the condition that such activities are undertaken for the common benefit of all states" (Hobe, 2009, p. 38). It is worth noting that the UN General Assembly's Declaration on Space Benefits suggested that no general obligations to grant benefits to non-space-faring nations are incumbent upon the space-faring nations.[28] Hence, Article I of the OST should be read as a clause enabling non-space-faring members of the international community to participate more actively in space exploration and use (Hobe, 2009, p. 38). The requirement that space activities shall be carried out for the benefit and in the interest of all states is also considered a part of customary international law and a norm of jus cogens. As a consequence, this requirement is universally applicable, regardless of whether the states ratified or acceded to the OST or not (Cepelka & Glimour, 1970, p. 47). Having said that, Article I of the OST effectively prevents developed states from prioritizing their national interests over the interests of developing states.

The legal nature of outer space as res communis omnium and the cosmopolitan nature of Article I have been further elaborated in the principle of due regard. Article IX of the OST refers to the obligation of state parties to conduct all their activities in outer space with due regard to the corresponding interests of all other state parties. Sergio Marchisio explains that Article IX functions as another limitation to the freedom of exploration and use of outer space provided for in Article I of the OST. In other words, states should ensure that the exercise of their rights and freedoms in outer space does not interfere with or compromise the rights and freedoms of other states (Marchisio, 2009, p. 175). Marchisio underlines that the notion of "corresponding interests" recalls the fact that there are no unilateral interests in outer space because "space activities carried out by a given state should be in accordance not only with its own interests, but also with the interests and rights of the remaining state parties" (Marchisio, 2009, p. 176).

[27] Article II, Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, 610 U.N.T.S. 205.

[28] Ibid.; 'UN General Assembly Resolution 51/122 of 4 February 1997' http://www.unoosa.org/oosa/oosadoc/data/resolutions/1996/general_assembly_51st_session/ares51122.html

5.4 Astronauts Regarded as Envoys of Mankind (The OST and Customary International Law)

According to Article V of the OST, state parties shall regard *astronauts as envoys of mankind in outer space* and shall render them all possible assistance in the event of an accident, distress, or an emergency landing on the territory of another state party or on the high seas, as well as in carrying out activities in outer space and on celestial bodies.[29] It is worthy to mention that the original purpose of Article V of the OST was twofold. From the historical perspective, the wording of Article V reflects the Cold War and the rivalry between the USA and the Soviet Union in the exploration of outer space. Article V aimed at preventing astronauts from being subject to incorrect treatment in case of an unforeseen emergency landing in the territory of their country's rival (F. G. von der Dunk & Goh, 2009, p. 95). And from the cosmopolitan/humanitarian perspective, the OST stipulates that astronauts should be treated equally regardless of their state citizenship, national identity, religious affiliation, ethnicity, or place of birth and are those who explore and use outer space on behalf of mankind. This notion is further emphasized in paragraph 3 of Article V of the OST, which stipulates the compulsory notification of all space phenomena which are likely to constitute a danger to the lives of astronauts (Cepelka & Glimour, 1970, p. 48). The assumption that astronauts are members of a universal community is deeply cosmopolitan.

5.5 Cosmopolitan Ideals Enshrined in the Moon Agreement

Achievements of states in the exploration and use of the Moon and other celestial bodies in the 1960s and 1970s brought the need to define and develop vague provisions of the OST. The Moon Agreement was adopted in 1979 with an intention to enable further progress in the exploration and use of outer space.[30] It is worth noting that the Moon Agreement does not only build on the cosmopolitan ideals already enshrined in the Outer Space Treaty, but it also includes various new and innovative concepts that further strengthen the cosmopolitan nature of international space law.

With regard to scientific investigation of the Moon's minerals or other substances, the Moon Agreement aims to ensure that all countries, irrespective of their degree of economic or scientific development, have equal access to samples of those minerals. On the one hand, all state parties have the right to collect on and remove from the Moon samples of minerals and other substances; on the other hand, state parties shall have regard to the desirability of making a portion of such samples

[29] Article V, The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, 1967, 610 UNTS 205.

[30] Preamble, Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (adopted 5 December 1979, entered into force 11 July 1984) 1363 UNTS 21 (the Moon Agreement).

available to other interested state parties. What is more, such samples should also be made available to the international scientific community for scientific investigation.[31]

Environmental protection is traditionally built on the cosmopolitan ideals since it aims to address challenges which transcend national borders, such as ensuring biodiversity. By the same token, the Moon Agreement aims to prevent the disruption of the existing balance of the Moon environment by its harmful contamination. It is worth noting that consideration may be given to the designation and subsequent preservation of areas of the Moon in which state parties or the UN Secretary-General has a special scientific interest.[32]

The Moon Agreement also further broadens the application of certain provisions already included in the OST that reflect cosmopolitan ideas. More specifically, any person on the Moon shall be regarded as an astronaut within the meaning of Article V of the OST. Hence, all states carrying out activities on the Moon shall render all possible assistance to any person on the Moon in the event of an accident or distress,[33] and therefore, all states shall regard all astronauts as envoys of mankind.

Most importantly, the Moon Agreement acknowledged *the benefits which may be derived from the exploitation of the natural resources of the Moon*[34] and declared the Moon and its natural resources the *common heritage of mankind*. In contrast to the UNCLOS including a comprehensive regime governing the utilization of natural resources located on the deep seabed, the Moon Agreement stipulates that the regime for the management of space resources shall be established when such exploitation is about to become feasible.[35] Nonetheless, the Moon Agreement specified the main purposes of the future regime: the orderly and safe development of the natural resources of the Moon; the rational management of those resources; the expansion of opportunities in the use of those resources; and an equitable sharing by all state parties in the benefits derived from those resources, whereby the interests and needs of the developing countries, as well as the efforts of those countries which have contributed either directly or indirectly to the exploration of the Moon, shall be given special consideration.[36]

The erga omnes character of the obligations related to the exploration and use of outer space enshrined in the Moon Agreement is explicitly declared in its Article 15. Consequently, each state party may assure itself that the activities of other state

[31] Article 6, Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (adopted 5 December 1979, entered into force 11 July 1984) 1363 UNTS 21 (the Moon Agreement).

[32] Article 7, Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (adopted 5 December 1979, entered into force 11 July 1984) 1363 UNTS 21 (the Moon Agreement).

[33] Article 10, Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (adopted 5 December 1979, entered into force 11 July 1984) 1363 UNTS 21 (the Moon Agreement).

[34] Preamble, Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (adopted 5 December 1979, entered into force 11 July 1984) 1363 UNTS 21 (the Moon Agreement).

[35] Article 11, Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (adopted 5 December 1979, entered into force 11 July 1984) 1363 UNTS 21 (the Moon Agreement).

[36] Ibid.

parties are compatible with the provisions of this Agreement. What is more, a state party which has reason to believe that another state party is not fulfilling the obligations incumbent upon it pursuant to the Moon Agreement or that another state party is interfering with the rights which the former state has under the Moon Agreement may request consultations with that state party. Each state party participating in such consultations and seeking a mutually acceptable resolution of any such controversy shall bear in mind the rights and interests of all the state parties involved.[37] Such a provision should be viewed as a clear demonstration of the move well beyond bilateralism towards a legal system grounded not in an exchange of rights and duties but in an adherence to a normative system (Fassbender, 2012, p. 140).

Having said that, the Moon Agreement has a potential to create one of the most cosmopolitan regimes (together with the regime governing the utilization of natural resources located on the deep seabed under the UNCLOS). However, the Moon Agreement has been ratified/acceded to by only 18 states, and its widespread acceptance remains elusive (Svec et al., 2020). Especially the common heritage of mankind character of space resources and the equitable distribution of the proceeds earned from their mining are considered highly controversial among governments (Davis & Lee, 1999, pp. 19–20). The rejection of the Moon Agreement has caused a situation in which space activities carried out by most of the space-faring states are governed only by the ambiguous principles applicable to any space activities enshrined in the Outer Space Treaty and customary international law.

6 Conclusion

Our intention in this chapter was to demonstrate that responsible cosmopolitan states have a solid basis on which they can build their intentions to cosmopolitanize the world because, as we have shown, a national policy driven by cosmopolitan ideals may be translated into both national and international law. While national law may not be considered as an ideal tool for pursuing cosmopolitan ideals due to the reasons explained in depth in this chapter, it can play an important role in this regard. The chapter revealed that, for instance, asylum law, environmental law, or even criminal law may be surprisingly cosmopolitan. In addition, chapter 7, analyzing the legal issues related to space mining, may serve as a fascinating example of national law having the potential to reflect cosmopolitan ideals.

There is no doubt that responsible cosmopolitan states should be primarily focused on international legal instruments (see chapter 6) if they strive to take the most available instruments in a non-cosmopolitan world to cosmopolitanize it despite the fact that they still reflect international rights instead of cosmopolitan

[37] Article 15, Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (adopted 5 December 1979, entered into force 11 July 1984) 1363 UNTS 21 (the Moon Agreement).

rights; however, they still can bear cosmopolitan ideas. The transnational nature of international law effectively addresses barriers preventing national law from fully incorporating cosmopolitan ideas, including the very concept of state sovereignty and territorially limited jurisdiction. However, this Chapter revealed that even current international law is shaped by multiple centripetal forces preventing its smooth cosmopolitanization. On a positive note, from the long-term perspective, the cosmopolitanization of international law appears to be unstoppable in the context of the procedural cosmopolitanization of the world, fulfilling the words of Immanuel Kant about the emergence of a federation of republics. Universally applicable norms, peremptory norms, obligations *erga omnes*, and rights and obligations of individuals arising from international law became an integral part of modern international law.

Though we acknowledge the abovementioned difficulties associated with the implementation of cosmopolitan ideas into both national and international law, areas where states are prevented from exercising their state sovereignty appear to be uniquely positioned to succeed in incorporating cosmopolitan ideas into international law. Especially the regime governing the deep seabed, based on the concept of the common heritage of mankind, may recall the utopian visions of Stoics.

We argue that outer space represents a unique opportunity to further materialize cosmopolitan visions since it may be (in contrast to the high seas and the deep seabed) permanently inhabited soon. Our analysis of international space law revealed that an area in which all human beings would be fellow citizens and a cosmopolitan institutional order would ensure that all persons have equal rights and duties does not sound utopian at all. Most importantly, if we accept that cosmopolitan morality does not commit its adherents to any particular institutional arrangement, and cosmopolitan ideals may be reflected by humanity being organized in a society of responsible cosmopolitan states that retain their separate statehoods while subjecting themselves to the requirements of international covenants and some universal principles, the path to a cosmopolitan order may be less steep, tough, and dusty than one would expect. In fact, cosmopolitan ideals are already deeply rooted in international space law, which paves the road to a future cosmopolitan order.

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References

Acemoglu, D. (2020). Trump won't be the last American populist: The conditions that produced him need to be understood to be addressed. *Foreign Affairs*. https://www.foreignaffairs.com/articles/united-states/2020-11-06/trump-wont-be-last-american-populist. Accessed 20 Sept 2021.

Anderson-Gold, S. (2001). *Cosmopolitanism and human rights*. University of Wales Press.

Baynes, K. (2009). Cosmopolitanism and international law. *Nomos, 49*, 219–239.

Beardsworth, R. (2011). *Cosmopolitanism and international relations theory*. Polity.
Beardsworth, R., Brown, G. W., & Shapcott, R. (2019). Introduction. In *The state and cosmopolitan responsibilities* (pp. 1–12). Oxford University Press. https://doi.org/10.1093/oso/9780198800613.003.0001
Beck, U. (2006). *The cosmopolitan vision*. Polity.
Bernstein, A. R. (2011). Moral cosmopolitanism. In D. K. Chatterjee (Ed.), *Encyclopedia of global justice* (pp. 711–717). Springer. https://doi.org/10.1007/978-1-4020-9160-5_329
Brown, G. W. (2009). *Grounding cosmopolitanism : From Kant to the idea of a cosmopolitan constitution*. Edinburgh University Press.
Buchanan, A. E. (2007). *Justice, legitimacy, and self-determination: Moral foundations for international law*. Oxford University Press.
Bull, H. (2002). *The anarchical society* (3rd ed.). Columbia University Press. Accessed 5 Mar 2014.
Caney, S. (2005). *Justice beyond Borders. A global political theory*. Oxford University Press.
Cepelka, C., & Glimour, J. H. C. (1970). The application of general international law in outer space. *Journal of Air Law and Commerce, 36*(1), 30–49.
Charney, J. I. (1993). Universal international law. *American Journal of International Law, 87*(4), 529–551. https://doi.org/10.2307/2203615
Chatterjee, D. K. (Ed.). (2011). *Encyclopedia of global justice*. Springer.
Conklin, W. E. (2010). The myth of Primordialism in Cicero's theory of *jus Gentium*. *Leiden Journal of International Law, 23*(3), 479–506. https://doi.org/10.1017/S092215651000018X
Davis, M. E., & Lee, R. J. (1999). Twenty years later – The Moon agreement and its legal controversies. *Australian International Law Journal, 6*, 9–22.
Delanty, G. (2012). Introduction: The field of cosmopolitanism studies. In *Routledge handbook of cosmopolitanism studies*. Routledge.
Domingo, R. D. (2019). Roman law and global constitutionalism. *San Diego International Law Journal, 21*(1), 217–240.
Dufek, P. (2013). Why strong moral cosmopolitanism requires a world-state. *International Theory, 5*(2), 177–212. https://doi.org/10.1017/S1752971913000171
Fassbender, B. (2012). Article 1 (2). In B. Simma, H. Mosler, A. Paulus, & E. Chaitidou (Eds.), *The charter of the United Nations: A commentary* (3rd ed.). Oxford University Press.
Freeland, S. (2017). Common heritage, not common law: How international law will regulate proposals to exploit space resources. In *QIL: Questions of international law* (pp. 19–33).
Ganim, J. (2010). Cosmopolitanism and Medievalism. *Exemplaria, 22*(1), 5–27. https://doi.org/10.1179/104125710X12670926011716
Habermas, J. (2006). *The divided west* (Vol. 1). Polity Press.
Hannikainen, L. (1988). *Peremptory norms (jus Cogens) in international law: Historical development, criteria, present status*. Finnish Lawyers' Publishing Company.
Hathaway, J. (1995). New directions to avoid hard problems: The distortion of the palliative role of refugee protection. *Journal of Refugee Studies, 8*(3), 288–294.
Hayden, P. (2004). Cosmopolitanism and the need for transnational criminal justice: The case of the international criminal court. *Theoria: A Journal of Social and Political Theory, 104*, 69–95.
Held, D. (2010). *Cosmopolitanism: Ideals and realities*. Polity.
Hobe, S. (2009). Article I. In S. Hobe, B. Schmidt-Tedd, K.-U. Schrogl, & G. M. Goh (Eds.), *Cologne commentary on space law. Vol. 1, outer space treaty*. Carl Heymanns Verlag.
Honoré, T. (2002). *Ulpian: Pioneer of human rights*. Oxford University Press.
The International Law Association's Committee on International Human Rights Law and Practice. (2000). *Final Report on the Exercise of Universal Jurisdiction in Respect of Gross Human Rights Offences, in Report of the 69th Conference of the International Law Association 4*.
Jakhu, R. S., & Freeland, S. (2016). The relationship between the outer space treaty and customary international law. *SSRN Electronic Journal, 53*(9), 1689–1699. https://doi.org/10.2139/ssrn.3397145
Jakhu, R. S., Nyampong, Y. O. M., & Pelton, J. N. (2017). *Space mining and its regulation* (1st ed.). Springer International Publishing : Imprint: Springer. https://doi.org/10.1007/978-3-319-39246-2

Kant, I. (1795). *Perpetual Peace: A philosophical sketch*.
Kant, I. (2010). Idea for a universal history. In D. Held & G. W. Brown (Eds.), *The cosmopolitan reader* (pp. 17–26). Polity.
Klabbers, J. (2017). *International law 2nd edition* (2nd ed.). Cambridge University Press. https://doi.org/10.1017/9781316493717
Kleingeld, P. (1999). Six varieties of cosmopolitanism in late eighteenth-century Germany. *Journal of the History of Ideas, 60*(3), 505–524. https://doi.org/10.1353/jhi.1999.0025
Lefkowitz, D. (2020). The legitimacy of international law. In *Philosophy and international law: A critical introduction* (1st ed.). Cambridge University Press. https://doi.org/10.1017/9781316481653
Marchisio, S. (2009). Article IX. In S. Hobe, B. Schmidt-Tedd, & K.-U. Schrogl (Eds.), *Cologne commentary on space law. Vol. 1, outer space treaty* (p. 256). Carl Herymanns Verlag.
Margariti, S. (2017). State sovereignty, cosmopolitanism and the international criminal court. In *Defining international terrorism* (Vol. 15, pp. 27–61). T.M.C. Asser Press. https://doi.org/10.1007/978-94-6265-204-0_2
Miller, D. (2007). *National responsibility and global justice*. Oxford University Press.
Moka-Mubelo, W. (2017). A cosmopolitan human rights regime. In *Reconciling law and morality in human rights discourse* (Vol. 3, pp. 169–199). Springer International Publishing. https://doi.org/10.1007/978-3-319-49496-8_7
Nagel, T. (2005). The problem of global justice. *Philosophy & Public Affairs, 33*(2), 113–147.
Naldi, G. J. (1990). The extraterritorial application of National Laws edited by Dieter Lange and Gary born. *Arbitration International, 6*(2), 178–179. https://doi.org/10.1093/arbitration/6.2.178
Nathwani, N. (2000). The purpose of asylum. *International Journal of Refugee Law, 12*(3), 354–379. https://doi.org/10.1093/ijrl/12.3.354
Paliouras, Z. A. (2014). The non-appropriation principle: The Grundnorm of international space law. *Leiden Journal of International Law, 27*(1), 37–54. https://doi.org/10.1017/S0922156513000630
Paterson, C., & Breu, S. U. (2019). *Law, ethics and society: Historical and contemporary perspectives*. Johann Heinrich Pestalozzi University Press.
Pellet, A. (2006). Comments in response to Christine Chinkin and in defense of jus cogens as the best bastion against the excesses of fragmentation. *Finnish Yearbook of International Law, 17*, 83–90.
Pogge, T. (1992). Cosmopolitanism and sovereignty. *Ethics, 103*(1), 48–75. https://doi.org/10.1086/293470
Pogge, T. (2012). Cosmopolitanism: A path to peace and justice. *The Journal of East-West Thought, 4*(2), 9–32.
Randall, K. C. (1988). Universal jurisdiction under international law. *Texas Law Review, 66*, 785–788.
Rathore, E., & Gupta, B. (2020). Emergence of Jus Cogens principles in outer space law. *Astropolitics, 18*(1), 1–21. https://doi.org/10.1080/14777622.2020.1723353
Rawls, J. (1999). *The law of peoples: With "the idea of public reason revisited"*. Harvard University Press.
Simma, B. (1994). From Bilateralism to Community Interest in International Law. *Collected Courses of the Hague Academy of International Law*, *250*. https://doi.org/10.1163/1875-8096_pplrdc_A9789041104199_02
Svec, M., Bohacek, P., & Schmidt, N. (2020). Utilization of natural resources in outer space: Social license to operate as an alternative source of both legality and legitimacy. *Oil, Gas & Energy Law*, *1*. Available at www.ogel.org/article.asp?key=3872
Taylor, P. (2019). The common heritage of mankind: Expanding the oceanic circle. In *The future of ocean governance and capacity development* (pp. 142–150). Brill/Nijhoff. https://doi.org/10.1163/9789004380271_025
Tomuschat, C. (2015). The security council and jus cogens. In E. Cannizzaro (Ed.), *The present and future of jus Cogens*. Sapienza Università Editrice.

UN COPUOS Legal Subcommittee. (2021). *Status of International Agreements relating to activities in outer space as at 1 January 2021 (A/AC.105/C.2/2021/CRP.10)*. UN COPUOS Legal Subcommittee.

United Nations. (2017). *International space law: United Nations instruments*. UNOOSA.

Viikari, L. (2012). Natural resources of the moon and legal regulation. In V. Badescu (Ed.), *Moon*. Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-27969-0

von der Dunk, F. (2015). In F. G. von der Dunk & F. Tronchetti (Eds.), *Handbook of space law*. Edward Elgar Publishing. https://doi.org/10.4337/9781781000366

von der Dunk, F. G., & Goh, G. M. (2009). Article V. In S. Hobe, B. Schmidt-Tedd, & K.-U. Schrogl (Eds.), *Cologne commentary on space law. Vol. 1, outer space treaty* (p. 256). Carl Heymanns Verlag.

White, M. V. (1982). The common heritage of mankind : An assessment the common heritage of mankind: An assessment. *Case Western Reserve Journal of International Law, 14*(3), 509–542.

Woolaver, H. (2021). Sovereign equality as a peremptory norm of general international law. In *Peremptory norms of general international law (Jus Cogens)* (pp. 713–739). Brill/Nijhoff. https://doi.org/10.1163/9789004464124_026

Wyatt, S. J. (2019). *The responsibility to protect and a cosmopolitan approach to human protection*. Springer International Publishing. https://doi.org/10.1007/978-3-030-00701-0

Zhang, W. 'Laura'. (2019). Extraterritorial jurisdiction on celestial bodies. *Space Policy, 47*, 148–157. https://doi.org/10.1016/j.spacepol.2018.11.002

Zolo, D. (2000). The lords of peace: From the holy Alliance to the new international criminal tribunals. In B. Holden (Ed.), *Global democracy, key debate* (pp. 73–86). Routledge.

Responsible Cosmopolitan State in Space Politics

Nikola Schmidt

1 Introduction

Previously in chapter "International Space Law as the Transiting Path to Cosmopolitan Order", we showed how moral cosmopolitan ideas translate into legal cosmopolitan instruments. In this chapter, we will show how a responsible cosmopolitan state should behave to continue this process of cosmopolitanizing. At the end of the chapter, we briefly sketch out four cases that are thoroughly studied in the following part of the book, as separate chapters.

One might ask why the *responsible cosmopolitan state* is the right way to go. We would then have to ask why moral cosmopolitanism is considered moral. The responsible cosmopolitan state is a middle-way concept introduced by Wallace Brown (2011), with an interestingly moderate aim – to re-engage with the state as a site of cosmopolitan responsibility, in response to a series of failures of liberal internationalization (Beardsworth et al., 2019). As globalist political ideas fail to deliver the promised good from moral cosmopolitanism, given the complexity of addressed problems, populists proposing quick fixes are emerging, and we have to say, generally with devastating consequences. We are writing this book at the time of the coalition army pullout from Afghanistan. Some of us worked there during the reconstruction. The consequences of Donald Trump's "quick fix" and Joe Biden's full misunderstanding of the situation led to the complete political collapse and re-emergence of Taliban that is already bringing doom to the local society. From the moral cosmopolitan perspective, the international community failed completely, and it cannot be clearer than it is. In the light of this unprecedented failure, moral

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cosmopolitan ideals are once again emerging as a guide for responsible foreign policy reflecting cosmopolitan responsibilities.

However, responsible cosmopolitan states are not in an easy situation, because it is a tricky matter to bring about a good while employing force to do so, and there is not a clear global consensus as to legitimate uses of power to enforce cosmopolitan rights. At the same time, all states are responsible for the security of their citizens, which seemingly became a dilemma for the USA just a month after the pullout, when the generals claimed that Taliban will let Al Qaeda grow. This is also a perfect example how our personal rights delivered by our states cannot and should not be separated from our cosmopolitan rights and responsibilities. Self-isolation led to tragic consequences in history many times; however, simply put, free riders never ride for long.

Cosmopolitan theorists have been studying how we can build a cosmopolitan world state, but Kant already argued that this "state" should emerge as a leading example, from a single state that will be worth following, as republicanism on the national level will simply levitate further on the global level, probably in the shape of a federation above the states (Kant, 1795). The world is, from the perspective of global governance by international organizations, security regimes, and international law, significantly more complex today than it was at the end of the eighteenth century, but Kant's words are probably addressing still the same problem. Building a world state on the basis of our current nation-state practices would probably lead to despotism and conflict. Nurturing cosmopolitan principles on the level of a state can bring us the group of like-minded states Kant envisioned. The European Union being a case in point; but, if we want to live in a peaceful world, we need to proceed further. Our take on this transition process from nation-states to any cosmopolitan world governance is based on technology-driven cases in space, because, as we demonstrated in the preceding chapter "International Space Law as the Transiting Path to Cosmopolitan Order", space has special characteristics – not only physically (space without borders, presence based on orbital mechanics, surface presence, and survival strictly dependent on technology) but also legally, given the current international law governing space activities.

Despite the fact that large states have more capacities to drive space programs and political influence on the international level, small states can bear significant power on the international level as well: Firstly, through exercising the equality principle between states provided by the UN Charter; secondly, small states can choose a specific scientific and technological niche (the Czech Republic chose laser technology; see chapter "High-Energy Systems Today and Tomorrow") that can translate into inclusive foreign policy (see chapter "Peaceful Use of Lasers in Space: Challenges and Pathways Forward"), and as they do not have tons of these niches, such a niche could become a centerpiece of their scientific foreign policy; thirdly, critical knowledge useful for any global debates is not dependent on the size of the country, but on the authority of the expert, despite the fact that the expert might represent more his/her own personality than the country of origin (in space law, Vladimir Kopal from the Czech Republic was exactly that authority that outgrew the size of his country).

Even though a single small state cannot easily influence visible or significant global challenges, it can still pursue global responsible politics that will be visible and provocative enough to gain attention by, e.g., constructing security-sensitive technology or gain traction from the other small states to create a group of like-minded states. Therefore, small states can have a voice that is heard. It is just a matter of their imagination, focus, determination, decisiveness, courage, and coordination that something can be changed globally.

The following chapter balances between exploring certain theoretical concepts (responsibility, sovereignty, cosmopolitanism) and practical cases possibly constituting the role of a cosmopolitan responsible state in space politics and, as such, builds on the conclusions from the previous chapter.

2 Responsibility

The concept of *responsibility* cannot be easily explained in its own broader philosophical sense on several pages. We must cling to a chosen interpretation to develop the argument here; however, before we begin, a short insight into its broader sense will help the reader to dive into the philosophical depth that the concept *responsibility* provides.

Responsibility etymologically comes from the Latin *respondere*, to respond, answer a call. Traditional metaphysical interpretation understands *responsibility* as the accountability of a free subject. A sovereign capable of acting should respond when he/she determines it is necessary; however, this interpretation immediately raises a question: when is it necessary to respond? That is an ethical question, and because responsibility in philosophical thought has made a century-long voyage, the most recent arguments, e.g., by Jacques Derrida, focus on ethicality of ethics. Ethics is nothing that a philosopher should define, but rather study the processes that lead us to define norms in an ethical framework. Derrida said: "if by ethics one understands a system of rules, of moral norms, then no, I do not propose an ethics" (Derrida, 2004). Ethics, as a normative framework, can work as a mirror to morally assess actions, but, as Derrida pertinently puts it, there is no universal ethics, only processes leading to consensuses. Therefore, responsibility requires broader consensus in a social community, in order to be considered ethical – in a cosmopolitan perspective, global community reflecting principles of moral cosmopolitanism. I would argue here that despite the fact that some ethical questions remain dilemmatic, some consensus over ethics is not made democratically, because the majority might tend to decisions that are truly unethical, public opinion over capital punishment in many democratic countries being the case in point. Descriptive ethics would describe what the majority considers ethical, while normative ethics looks for answers as to what is the right behavior – how one ought to behave morally. While Derrida is visibly reserved about having a normative ethical position, it is apparent that without it one would not know when to respond.

The dominant perspective on responsibility in history was coined by Aristotle, who constructed responsibility as an act of securing the domain depending on us, which is *up to us* or *in us*, and we should make critical decisions with virtue; however, Aristotle never precisely conceptualized to what *in us* refers, but the fact that a free agent is accountable to act (or not to act) is the principle of *author* and *cause*. This approach actually creates the principle of a free subject able to act voluntarily – to be responsible – and prevailed in (some) philosophical thought until today. The concepts of voluntariness and involuntariness depend on decision and deliberation; they establish rational agency, with a focus on efficiency and, as such, create the basis for responsibility (Broadie, 1991, p. 124). The guidance of responsibility is related to what Aristotle called *virtue*, a characteristic based on what Socrates called self-knowledge – an ability to be aware of every fact, its context, and therefore the consequences of decisions. Virtue is the basis of normative ethics that tell us what is right and wrong, and one could live a happy life if, and only if, one lives a life governed by virtue.

Nietzsche in his piece The Will to Power questions morality by asking "What are our evaluations and moral tables worth? What is the outcome of their rule? For whom? In relation to what?—Answer: for life" (Nietzsche, 1968, p. 148). His approach opened a new discussion about the basis of morality, a basis for ethical behavior, a normative ethics, a framework giving the reason a substance that is meant to be secured by responsible agents: *when it is necessary to respond,* not only in virtue, making our life happy, but for life itself. For example, Sartre reflected *human existence* as being identified with an absolute responsibility for itself. This can happen thanks to the invention of a *groundless freedom*. Heidegger talks about responsible engagement in answering the call of *being*. Kant defines responsibility in *universal terms*, as a reason of humankind to be responsible across generations (future humanity) and not only to humans but to all things and nature (the current environmental movement, putting emphasis on the state of the planet for future generations, mixes *future humanity* and the *state of nature* we depend on) actually introducing the importance of intergenerational solidarity that is not anthropocentric but covers all life. Levinas, in contrast to Kant, defines the self as a responsibility for *other human*, but with a focus on a singular other. Derrida then deconstructs responsiveness that engages as a responsible decision (Raffoul, 2010, pp. 4–5). Reflecting the abovementioned philosophical perspectives on responsibility, one can argue why Kant's universalism is so popular in cosmopolitan thought and especially in cosmopolitanism linked to space politics perceiving our future with the planet as a referential object.

Derrida interestingly plays with the responsibility of knowing, which can be quite directly applied to the ethicality of ethics beyond planetary defense efforts as a whole, mainly to the observation phase: "not knowing, having neither a sufficient knowledge or consciousness of what being responsible means, is of itself a lack of responsibility. In order to be responsible, it is necessary to respond to or answer to what being responsible means" (Derrida, 1996, p. 25). We do not know whether there is an asteroid on a collisions course, but we do know means by which to obtain the knowledge and avoid the collision. In this way, what is ethical is not necessarily

the planetary defense efforts per se, but the fact that some are aware of the necessity to obtain that knowledge about orbital paths of asteroids. This is explicitly evident with respect to the two groups working on planetary defense, represented by astronomers looking for asteroids and engineers directing attention to the necessity to have the most effective means for their deflection, without knowledge of whether such means are even necessary (nuclear explosive device as the point in case). In this regard, far more comprehensive is Derrida's call for a scheme of application, to avoid presupposing our ethical senses, but put our efforts on the weight of questioning the ethicality of our ethics. Following this thinking, being a responsible state in planetary defense requires assessing every corner of possible implications (self-knowledge), because defending the planet will not necessarily bring only good (understanding all possible contexts). This is very important, because many members of the planetary defense community are keen to see states act: adopting planetary-defense-related policies, developing nuclear explosive devices with an argument "why should we avoid the most effective means we have," pushing the international community to some commitments, etc. Virtue here would mean understanding how complex and tricky planetary defense policy is in the global political system of nation-states inclining to independent, unilateral decisions, based on the imagination of sovereignty as political autonomy, while planetary defense itself is a great opportunity for humanity to do something good all together.

Raffoul (2010) talks about four fundamental concepts of responsibility: (1) the belief that the human being is an agent or a subject – "responsibility as the authentic response of the self to the call"; (2) the notion that the subject is a voluntary agent – responsibility emanating from the free will principle (Aristotle with voluntariness, Kant with transcendental freedom, Levinas with focus on singular others, etc.) is the capacity to begin absolutely; (3) the reliance on causality – "responsibility being defined as the cause of the act"; and (4) the assumption that the responsible being is a rational subject – "the basis for ethical responsibility is rational agency and subjectivity." We are going to use these fundamental concepts without referring to the critique by Nietzsche, who calls them fictions, constructions, or interpretations, but not realities; however, his criticism is what brought us the perspective on responsibility of one being responsible for one's actions and being responsible for the consequences of one's actions. Later on, in the ethical analysis of global governance by institutions, the ethical basis transforms to the irresponsibility to act or not to act (Erskine, 2003), therefore, including consequences of *not acting* when it was necessary, and we were aware about it – we had the particular knowledge. The whole Responsibility to Protect could be considered the case in point here.

If we possess consciousness of the consequences of our actions (or inactions!), then we are not only responsible for the past but can be responsible for the future. Hans Jonas (following Kant) in this sense talks about the "future-oriented ethics" putting emphasis on preservation of the future for the coming generations (Jonas, 1985, pp 25–31). Jonas adds nature to the reference object of preserving humanity, in the sense of having the future of humanity in mind. Humanity should be able to preserve itself and nature as well, given the impact humanity has on nature. In this regard, Jonas is close to Anthony Burke's security cosmopolitanism, where Burke

enlarged the Kantian categorical imperative to *global categorical imperative*: "act as if both the principles and consequences of your action will become global, across space and through time, and act only in ways that will bring a more secure life for all human beings closer" (Burke, 2013a). Finally, the discussion above on responsibility can be understood as *moral responsibility*, and to transform it into political action, it has to become a *political responsibility*; Beardsworth argues that the distinction between moral and political is the fact that political responsibility is driven by political duty towards global challenges; therefore, it is up to politicians to take their moral responsibilities and transform them into political actions driven by political responsibility (Beardsworth, 2015).

To summarize this section, responsibility could be considered to be a concept that is fulfilled by an actor, related to a referent object, electrified by knowledge, and guided by virtue. The actor in current global political system is a nation-state. Nation-states tend to have as a referent object their own citizens, given the social contract principle; however, nation-states through political responsibility reflecting their moral responsibility in a globalized age must take into consideration global challenges and global consequences of their decisions, or they are failing to fulfil their duties, given the legitimacy we transfer to them even on the national level. Knowledge is provided by various actors: scientists, engineers, social scientists, and any other actors producing knowledge. And politicians should be guided by their virtue, reflecting moral responsibilities to which they should adhere; however, as knowledge electrifies, it has ever had the power to change the relation between an actor and a reference object. New knowledge charges the actors' responsibility in various shapes, as the reference object (citizens) calls for reflection of that new knowledge. Virtue remains in the hands of those who bear the burden to decide responsibly in the interest of all and of nature.

3 Sovereignty

When it comes to the concept of sovereignty, the first idea coming to the mind is independence of decision from any authority; however, there can be more than one sovereignty. Internal sovereignty of the government to make decisions independent of other authorities and to introduce laws is one; however, even the government is limited by the state constitution. External sovereignty is usually perceived as total political independence of any other external authorities – radical autonomy (sometimes recognized as "autarchy"), independence, and freedom of decision from all external powers – and yet we have international law limiting such behavior of a nation-state, and, understandably, we have other states willing to govern over their territory. Therefore, sovereignty understood by those who tend to promote illiberal democracies (Orbán, 2014) is simple, radical, conflictual, and dangerous.

Sovereignty is a complex term, but radical realists like Donald Trump would think that sovereignty provides them (as leaders) full power of free, random decision-making. It is true that some realist thought is based on such a radical

understanding of sovereignty. Those would say that states exist independently of other states, while even neorealists would accept that the existence of a state is not natural but constructed, through the recognition by other states, which is definitely not a natural power. Therefore, the meaning behind the concept of sovereignty has been fluid, at least from the Peace of Westphalia, which for some never coined sovereignty as the independence of European actors or as non-intervention (Piirimäe, 2010). Critics of absolute power behind the concept of sovereignty not only criticize power-laden talks influencing decision-makers forgetting international treaties signed by their predecessors; they also criticize the inability to see the emancipatory potential behind it and for its tendency to forget all responsibilities beyond the borders of the state introduced by moral cosmopolitanism or, simply put, by a post-war vision of liberal democracy. For example, one sees *autonomy as absolute independence* of decision, while others see *autonomy as the ability* to decide with reason as a community. In fact, the concept of sovereignty is "fatally riddled by vicious ambivalence" (Kalmo & Skinner, 2010).

However, a certain line of understanding the concept of sovereignty is useful for our cosmopolitan argument. As said, some tend to understand *sovereignty* in the radical form of *political autonomy* free of international obligations or cooperation, which is the classical perspective used by most realists and geopolitical thinkers (see chapter "Cosmopolitan Visions Under the Critical Sight of Realist(ic) Geopolitics"). Others argue that the state is sovereign to the extent the others recognize its existence. Therefore, we can clearly talk about *relational sovereignty*, because self-determination has never been purely about internal affairs, about self-determination, but about others recognizing the act of self-determination. Declarations of independence would have limited effect if other states did not recognize new political entities. In this perspective, preserving sovereignty is required to maintain harmonious international relations, to preserve a predictable political environment in which political actors can nurture mutual confidence. International law is finally a codification of these relations, providing us with confidence in international relations, setting up processes to develop transparency and deliver predictability. As such, international law is a system of principles suppressing anarchy, emanating from *positive international morality* (Bull, 2002), and a tool for harmonization of international relations. Responsible cosmopolitan states should strive for deepening these ties, as they bring predictability, transparency, harmony, and finally peace. To what extent states have already stipulated cosmopolitan principles in international space law is discussed in the preceding chapter "International Space Law as the Transiting Path to Cosmopolitan Order".

Those who argue that states possess sovereignty in the radical form of total political autonomy tend to see such a nation-state as having total freedom to conduct any *sovereign* action and derive outcomes of global anarchy from it, or at least a power-related world in which the powerful decide, in all situations and at any time, and norms have no impact on international relations at all. Those who perceive the situation from the perspective of relational sovereignty, on the other hand, also fail to acknowledge the dynamics between states and supranational entities, such as the European Union. The EU is not ultimately sovereign (from the perspective of

radical autonomy), nor are its member states, because they have developed this Community to make cooperation smoother on the continent (MacCormick, 1993). This is the empirical criticism of state sovereignty (as radical political autonomy), and it obviously says that there is no such sovereign in the world today. One would argue that the EU is unique and a halfway house, towards a federalized Europe; however, even a federalized Europe will not be sovereign, given the responsibilities it will have towards others, effectively dismantling the idea of radical political autonomy. Other criticisms argue that sovereignty is not compatible with the rule of law, because law limits actions, while sovereignty is supposed to be absolute (Eleftheriadis, 2010). The state is not absolute, as *prince* could be in history. Politicians executing power on behalf of a state are limited by its constitution, international treaties, or by normative regimes, such as human rights. Talking about the absolute power of a sovereign state in the current philosophical and political reality is simply futile – there is no room for such talk. In this light, calls to drop the concept of sovereignty at all are not anomalous.

However, some are taking interesting attempts to save sovereignty and have begun talking about *sovereignty as autonomy* (Geenens, 2017). Geenens' argument is strong, as he says that sovereignty is not necessarily about the amount of power, but the fact that a community can decide on its own and govern itself regardless of the external environment that may influence it. Geenens interestingly take Kant's practical reason and autonomy as the line of argumentation and says that the attribution of autonomy is "the assumption on which we operate as soon as we use reason to determine our actions" (Geenens, 2017, p. 8). He then interprets Kant by linking reason to the consequences of our actions independent of our instincts. This is critical, because reason used as capacity to understand consequences of our actions beyond our borders is meant to be *autonomy*. In the academic debate over self-governance, autonomy is not used only as independence or freedom of decision, but exactly as capability to self-govern. Bluntly put, provoking a neighboring tribe will not bring peace to my own; how should such leaders govern? Responsibly?

If we, again, link Geenens' way of understanding of sovereignty with cosmopolitan security introduced by Anthony Burke and his *global categorical imperative*, sovereignty as autonomy is exactly in line with Burke's cosmopolitan imagination. Autonomy here means the ability to imagine consequences of our actions, and responsibility in cosmopolitan terms refers not only to ourselves, to our community bounded by state borders or singular others, but to the community as a global society (including the biosphere). As Geenens argue, sovereignty is not about absolute power, but about "a specific perspective adopted by the members of a political community" (Geenens, 2017, p. 9). Cosmopolitan political community is humanity. How can such ideas be linked to the practical politics of a nation-state that is – by violating moral cosmopolitan principles – in dissonance with cosmopolitan thought?

4 Cosmopolitanism and Practical Politics

The core idea of this book and our take on the research (and related activities in policy recommendations we have been conducting during the research (Schmidt, 2021; Schmidt & Ditrych, 2019; Svarovska & Schmidt, 2022; Švec et al., 2020)) differs from classical cosmopolitan thought, by accepting states as agents of future cosmopolitan order. We could not approach our objectives differently, as our intention was to use some of the recent cosmopolitan thought and use it in practical policy recommendations. The concept of *responsible cosmopolitan state* (Brown, 2011) provided us with a middle ground between utopian theorizing and acquiescence to the status quo.

Classical cosmopolitans consider the ideal world order to be a world state (Dufek, 2013; Scheuerman, 2014) based generally on human rights universalism (Jones, 2010) derived from the principles of moral cosmopolitanism (Pogge, 1992). Others look for a moral and ethical basis for statist cosmopolitanism (Ulaş, 2017; Ypi, 2008) or to directly bring states back to the debate as agents of cosmopolitan politics (Brown, 2011), which in the end was the most influential take in our policy approach. An interesting subsequent development concerning this renewal of the debate for including states in cosmopolitan thought is a study of various focused policies that fulfil cosmopolitan principles on the state level, making them responsible cosmopolitan states (Beardsworth & Shapcott, 2019). Yet this book did not in any way consider the issue of space, despite the fact that international space law embodies cosmopolitan ideas per se; space does not have borders and will never have given the orbital mechanics (see the preceding chapter "International Space Law as the Transiting Path to Cosmopolitan Order").

Moral cosmopolitan principles precisely defined by Pogge are crucial in any arguments made by cosmopolitans, whether focused on a world state, cosmopolitan justice, or statist cosmopolitans focusing on states' responsibility. They are *individualism*, *universalism*, and *generality*:

> Three elements are shared by all cosmopolitan positions. First, *individualism*: the ultimate units of moral concern are *human beings*, or *persons* – rather than, say, family lines, tribes, ethnic, cultural, or religious communities, nations, or states. The latter may be units of concern only indirectly, in virtue of their individual members or citizens. Second, *universality*: the status of ultimate unit of moral concern attaches to *every* living human being *equally* – not merely to some subset, such as men, aristocrats, Aryans, whites, or Muslims. Third, *generality*: this special status has global force. Persons are ultimate units of moral concern *for everyone* – not only for their compatriots, fellow religionists, or suchlike. (Pogge, 1992)

Building on moral cosmopolitan principles as a predisposition of moral global order, we do not necessarily end in a world state. Our interest in this chapter is the question whether we can base the foreign policy of a state on cosmopolitan principles or to what extent small states adopting cosmopolitan principles as a normative framework in technoscientific projects can become agents of global change.

Many people argued, and argue, that intentions to change the reference object from citizens of a state to global citizens for the (responsible) nation-state is futile

and worthless, but, as we know, arguments that it was possible on the EU level and why should it not work on the world level are not uncommon (Habermas, 2001). However, Habermas argued that world citizen identity cannot be created around civic solidarity that emerged with nation-states, but will need to be based on moral universalism (Habermas, 2001, p. 108), a framework of normative ethics we discussed above. The knowledge we produce around planetary defense could serve the purpose here, but it is far from the "awareness" strategy adopted generally by the planetary defense community, which is actually common securitizing of the threat of asteroid impact.

However, as we argued above, responsibility is not necessarily a solid concept (like any other), and it is up to enlightened people to set up policies responsibly. Elsewhere in this volume, we show that not every national law must necessarily serve national interests exclusively (see chapter "Space Mining: Attempts to Materialize Cosmopolitan Ideas Enshrined in International Space Law"). The case in point is of course respect for human rights and related asylum laws for refugees. Arguing for this shift from national to global interests, from exclusively national to globally inclusive interests, or from responsibility towards nation to responsibility towards humanity is not a solitary argument, because our own enormous creativity and the destructive potential behind human reason require not national but global moral principles and related responsibility; as Burke puts it: "humanity is not man's destiny, the space in which man is completed as a project, but is instead a moral answer to its powers" (Burke, 2011). If this philosophical claim is put back on the ground of daily human practice, we can say that global business and the drive of technological innovation "to make our lives easier, happier, smoother, posh" embody human reason in its clarity, in human virtue, creativity, agility, or curiosity. However, saying so means that human reason is global, as business is global without significant barriers, but its regulation, to keep it within some barriers, to avoid destruction of the biosphere of which we are undeniably a part, is a constant struggle, a never-ending mission to save the Earth from our own destructive potential. Understanding this dynamic is the key to being attuned to the principles of responsible cosmopolitan state. Having power and capabilities for destruction means that adopting moral cosmopolitan principles has potential to do some comparable good.

In order to help develop cosmopolitan political reality, states should look to global commons that can be of benefit to all, but one has to act to steer the behavior of the state towards being a responsible state (Bull, 2002). A good state does not act on the basis of selfish national interest, but rather consciously and continuously develops the international character of national (foreign) politics (Lawler, 2005). As Dufek argues in the first chapter of this volume, the idea of responsible cosmopolitan state is primarily aimed at smaller or mid-size states, because, as they cannot exercise great-power politics, they can be expected to have more significant room for incorporation of cosmopolitan elements in their foreign policy. Small states have an interest in having a reliable global regime to restrain the powerful from doing whatever they decide. This mission is not necessarily fully dependent on one enlightened personality, although such a person could be significantly beneficial; rather, the mission lies in our collective ability to develop a horizontal network of

cosmopolitan responsibility, a networked set of interdependencies and relations that *force* states to act with cosmic perspective (Burke, 2013b). All of this resonates in Kant's words. Kant (1795) foresaw the emergence of a federation overarching republican states as a result of a continuous process, in which like-minded states follow a leading example (see chapter "International Space Law as the Transiting Path to Cosmopolitan Order" for a broader debate on this topic). Kant argued that adherence to a supranational entity would be a result of peaceful intentions by republican states that do not seek conflict, but harmony on a global level, actually motivated by security.

In this regard, we argued for a normative framework surrounding large technical systems with inherent security implications, because, if built, they have potential to have constitutive effects towards cosmopolitan global governance (Schmidt & Ditrych, 2019, 2021). Put bluntly, the actual political representatives of states will simply not have any other options than to adhere to the newly emerging security regime, providing them with transparency, confidence, and predictability, or in the alternative to be threatened by newly built large technical systems. Kant's reflection on the destructiveness of human power and related need for a moral framework to steer it is becoming even more relevant, as near-future problems, such as climate change, will require large technical systems to be controlled. Moral cosmopolitan ideas will be necessary, not only for the legitimacy purposes of building such system but also for obtaining sustainable consensus based on changing conditions influencing its operation. Climate change is a good example, because it is not going to be "fixed" (as an asteroid threat could be); it has to be controlled consciously towards the *desirable end*, and we need to find a consensus as to what shape of climate we will live in, not what climate is comfortable to us here in Central Europe, but what climate on the global scale will make nature flourish. For example, we would bet that Russia would never be willing to lower global temperatures for national interests, by a northern cargo route from Asia to Europe; therefore, if they accede to preindustrial temperatures, it will be from the responsible cosmopolitan state perspective.

Human activity will wildly continue, but our survival on this planet, or at least dignified life under comfortable conditions, is directly dependent on those who will think responsibly and with virtue about consequences of our behavior. Gareth Evans was talking about global citizenship as something that is supposed to be above our identification with national citizenship; in his words good citizenship comes with reflections on the global consequences of our actions (Evans & Grant, 1992), and Evans was a foreign policy minister of Australia. The argument made by Geenens, saving sovereignty from various attacks, might not have the following intentions, but let us use his words for the clarification of our argument. While many authors argue that the concept of sovereignty should be dropped altogether (Kalmo & Skinner, 2010), Geenens reconceptualizes sovereignty in Kant's words. If his arguments about sovereignty as the autonomy of a community to make collective reasonable decisions on reflections of our actions are used with respect to a community of cosmopolitan responsible states (like-minded states seeing the rationale behind inclusive/multilateral foreign policy), we can clearly talk about a *global village of*

responsible states driven by their conscious citizens. These citizens could be a global epistemic community with reflective research programs (Adler & Haas, 1992), not just an epistemic community that shares the same interest in a technical discipline, but an epistemic community that shares cosmopolitan values and, at the same time, is capable of developing large technical systems that require a conscious approach by their political representatives, playing the role on behalf of a responsible cosmopolitan state in its foreign policy.

Sovereignty is, therefore, not a state of absolute power or total political autonomy, but could be considered as a state of responsible governance of a political entity or a community of political entities, a political community, that is able to sensitize the seriousness of the situation (climate change), the moral responsibility to act if we can and know (planetary defense), the moral principles of human equality (space mining), and the necessity for cosmopolitan security (high-power systems). When the community can sensitize these dynamics between natural phenomena, technological capacity, and political community, it has the power of a sovereign to effect change in world affairs governed by virtue.

5 Principles of a Responsible Cosmopolitan State

One of the reasons why we think that the application of the concept of a responsible cosmopolitan state to space politics has the potential to bring back cosmopolitan ideas to the everyday practice of global political multilateralism is the fact that international space law contains clearly cosmopolitan ideas (see chapter "International Space Law as the Transiting Path to Cosmopolitan Order"). The following list is a brief insight into the general principles we have found crucial in shaping a responsible cosmopolitan foreign policy – mainly in space politics based on the inspiration of the policy research on our cases discussed below.

A. Sovereignty as autonomy.

   Following the arguments in this chapter, a responsible state reflects the interests of other political entities, follows all three of the main moral cosmopolitan principles, and considers the broad consequences of its decisions. It governs responsibly in the sense that power brings responsibility rather than a free opportunity without ethical consequences.

B. Global responsibility.

   A responsible state reflects on the broad consequences of its decisions beyond its borders as if they were happening within its borders. National interest cannot be in conflict with the interests of others – it is morally unbearable to burn coal when it would cause acid rain in other countries or to not deflect an asteroid heading toward Earth if one has the knowledge and means to act.

C. Cosmopolitan identity.

   Cosmopolitan identity does not replace national identity; it does enrich our identities in various roles. Responsible politicians explain why we have to care

for the fate of people on the opposite side of the planet the same way as the way we learnt in the European Union (depending on the particular nation, of course). Global identity reflects local identities and vice versa, which leads to a mutual cultural enrichment of our lives.

D. Reflection of the world's complexity.

The main problem is not how to avoid or reverse climate change, how to deflect asteroids, or how to make space mining legal, but how to ensure sustainable human and biosphere flourishing. This objective as a reference provides a responsible beginning for acknowledging complexity, cohesion, and interconnectivity of human activity as well as our role in the biosphere. A responsible cosmopolitan state protects its national parks with the same fierceness as that when it protects the Amazon forest.

E. Technology governance.

Technology innovation is not in the hands of states as it has been slowly shifting towards the private sector since World War II. The private sector usually focusses strictly on profit, understandably, if there is no qualitative guidance from the governing power. Responsible states should focus on normative frames telling the private sector what is and is not a desirable end for the society. The dystopian multiverse under construction by Facebook is a case in point, especially when we already know clearly what the motivations of the company in the preceding years have been.

F. Decentralization.

Decentralization does not deprive power of legitimacy. While the vertical governance structure (from mayors, through governments, to the UN Security Council) could retain the role of a normative power, the horizontal structures, including epistemic communities of expert groups, could have more power to act (e.g., to build large technical systems). This shift has the potential to mobilize knowledge for political action and deepen democratic deliberative dynamics. The horizontal structure can become a substance for diffuse reciprocity in the multilateral relations and motivate the vertical governance power to set up a functioning principle of indivisibility in the multilateral relations.

G. Interconnection and interdependence.

Interconnection of global capacities serves to deepen the networked mutual interdependence. A responsible cosmopolitan state would support not only "national" industry but also the growing horizontal interconnectedness on all levels. Supporting epistemic communities in developing security-sensitive technologies (e.g., high-power lasers) is not only about allowing them to do so but also about parallel efforts in introducing a security regime locking the transnational epistemic communities (or the private sector) within the desirable normative frame when the technology is developed and operated. That would require active cooperation on the international level and introducing principles of security multilateralism.

H. Benefit sharing.

Global problems, from climate change to planetary defense, will require massive public investments. Responsible states should be able not only to prop-

erly tax their citizens in this respect but also to find means to avoid the emergence of monopolies that would cause an accidental enrichment of selected entities controlling whole sectors. Space mining has exactly this potential, while it can also provide means to solve many troubles on Earth.

6 Four Cases in Which States Can Be Responsible in Space Politics

The book considers four cases, planetary defense, space mining, high-energy systems, and orbital debris, as cases with potential to constitute more inclusive, cosmopolitan governance. High-energy systems and orbital debris overlap somewhat, as we consider lasers for more applications such as propulsion, orbital debris removal, and sometimes even planetary defense. Therefore, in some parts of the book you may found references to only three cases (planetary defense, space mining, high-energy systems).

Our point here is to demonstrate why these space-related technoscience projects can help (even small) states to gain attention and constitute more cosmopolitan and therefore, for them, more inclusive, global governance. The cases are discussed in detail in separate chapters in the following part. Therefore, the following brief introduction to them only summarizes some of the constitutional characteristics that can be translated into the cosmopolitanizing of the world by responsible cosmopolitan states.

6.1 Planetary Defense

Planetary defense is a mission that includes the observation of asteroids (or comets), to identify whether some of them are on a collision course with Earth, but also includes mission designs and mission demonstrations to deflect such near-Earth objects (NEOs). Deflection missions are based on technological concepts and can vary from a kinetic impactor that is certainly unproblematic from the international security perspective, but a deflection mission could, on the contrary, also consist of a nuclear explosive device (NED), which are currently limited to mission concepts. Because nuclear detonations in space are banned by international law, no demonstration missions are possible.

Therefore, planetary defense can be a completely civilian mission (NASA's DART mission along with ESA's HERA mission and all the huge global observation programs by astronomers; see chapter "Technology Readiness and Small States Contributions in Planetary Defense") or could quickly convert into a military mission, becoming a national security issue to others, when a nuclear-equipped state becomes interested in the idea of "solving" the asteroid threat on its own. The

options for a small state are thus limited to the civilian mission participation, as nuclear states do not let others close to their nuclear program; however, the security dynamics behind NED and the uncertainty that a nuclear power will ever act (against international law) to deflect an asteroid not aiming for its own territory creates some possibilities for small states. They can argue for their right to defend themselves and establish a community of like-minded states.

The latter scenario is currently happening in the DART/HERA mission. However, DART/HERA is still a civilian mission conducted by scientists that we can call a planetary defense community. The central governance problem is that any other state than the USA is currently dependent on a call to NASA in case of a threat. At the same time, most of the 200 states cannot develop their own "national" planetary defense program. One way forward is to establish a *security community* that would be based on two multilateral principles: indivisibility and diffuse reciprocity. While the former delivers collective security to all members regardless of the size of their contribution, the latter is fulfilled by non-financial but technological and scientific contributions based on their economic performance (Schmidt, 2021).

Small states can participate in observation programs, and they certainly do. Small states can contribute to international collaborative space missions (e.g., the current and only demonstration mission under preparation is a double DART and HERA mission) demonstrating that humanity has the capability and knowledge to deflect an asteroid; however, small states can be left out of the business if the risk corridor (a line of possible impact across the globe) does not include space powers capable of deflecting it. This is a well-known problem, and large space powers do not seem to be keen to legally commit themselves to defend the world, regardless of the path of the risk corridor. The responsibility to act, if we have the knowledge and capability, is one of the key cosmopolitan normative instruments that states should adopt before they commit themselves to action. Small states can contribute by developing or producing some parts, but a cosmopolitan, or multilateral, authority should decide to act using the capacities of all states included in global planetary defense policy, regardless of their economic development. While OST reserve the use of space for all, by saying that "the use and exploration (…) shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development," this clause does not touch planetary defense, and if so, then vaguely; however, as we demonstrated previously in chapter "International Space Law as the Transiting Path to Cosmopolitan Order", space law is driven by moral cosmopolitan ideals. Asking for cosmopolitan governance of planetary defense does not include utopian visions, but similarly responsible willingness. Producing normative instruments should be the first step, multilateral or cosmopolitan authority a subsequent one.

Despite the low probability of impact of a big asteroid, smaller asteroids are still capable of wiping out a whole city and are impacting once in several decades. It is a clear opportunity for small states to shape a global security regime and involve all. Materializing these ideas might look difficult, but, as we said, we are not reinventing the wheel: the United Nations has already been filled by cosmopolitan obligations, whether morally normative or legal, that can already serve the purpose of

cosmopolitanizing planetary defense. We all share responsibility for each other's security (United Nations General Assembly, 2004); therefore, it is our responsibility to establish functioning cosmopolitan planetary defense policy (see chapter "Addressing Global Governance Gaps In Planetary Defense"). It is up to the responsible cosmopolitan states to act, and the *planetary defense security community* based on multilateral principles is one way we recommended (Schmidt, 2021).

6.2 Space Mining

In the case of space mining, what we have been observing in recent years is the attempt of some countries to break the silence by introducing their own national laws permitting the mining of space resources. The USA began with its own national law, Luxembourg followed, and finally a third country, United Arab Emirates, did not let the world wait too long for its own national law. While each of these countries defends their move in relation to international law slightly differently (see chapter "Space Mining: Attempts to Materialize Cosmopolitan Ideas Enshrined in International Space Law"), their shared objective is to allow national industry to proceed with space mining; however, as we can see, despite these national laws, space mining as a practice has not yet been initiated. Three problems as to why mining has not yet been commenced are usually discussed: First, the current lack of a vibrant resource market in space (NASA stated many times its willingness to buy water in space or is trying to motivate businesses to have resources for the Artemis program; however, that is not a market) and the price and possibility of mission failure of space mining for possible Earth consumption make massive investments in space mining irrational; second, the low maturity of necessary technologies, which can be solved quite quickly if demand emerges; third, legal uncertainty about the legality of space mining in general leaves possible space mining companies in legal limbo, which does not offer them a vision of sustainable operations.

It is planned that the first problem, demand, will be solved by space agencies, as the pioneers of a permanent presence in space and buyers of various services delivered by companies that could be interested in buying certain resources in space. The second problem, technological readiness, is not an unsolvable obstacle; rather it is more about good practices and tested technologies. Simply put, if the demand emerges, technologies will as well. Various concepts are tested in laboratories around the world, so the technology is not in the category of distant future (see chapter "Asteroid Prospecting and Space Mining"). The third problem, legal uncertainty, is the most evident issue the international community is intensively discussing. We have extensively explained the cosmopolitan responsible approach to space mining in our forthcoming article, as a possible solution to the deadlock of the current legal debate reflecting cosmopolitan ideas (Schmidt & Svec, 2021), and we elaborate on this problem in detail in chapter "Space Mining: Attempts to Materialize Cosmopolitan Ideas Enshrined in International Space Law".

All the attempts of these and other countries willing to follow suit in allowing space mining using national legislation are based on textual interpretation of the Outer Space Treaty (OST) and are arguing that the international law does not ban space mining explicitly. That is correct, but, as we show in chapter "International Space Law as the Transiting Path to Cosmopolitan Order", international space law has incorporated a number of cosmopolitan ideals in international law that characterize space as a province of mankind; ask states to use space with other states, irrespective on their economic development; make all astronauts envoys of mankind; ban appropriation of territories: etc. All of these ideals are norms that should guide us responsibly forward and should help guide our foreign policy in nurturing international relations. A responsible cosmopolitan state would not celebrate the fact that mining is not banned, but would actively work on a regime based on these cosmopolitan principles that will pass muster at the United Nations and will be welcomed by those actors who see their operations as responsible as possible and as sustainable as possible.

The purpose in writing OST was not to allow space mining, but rather to provide a platform for *positive international morality* (Bull, 2002), a predictable regime of behavior-harmonizing activities in space and the avoidance of possible conflict. We have to say that the adopted laws are having the effect of breaking the deadlock, but as, e.g., the disclaimer of the US Commercial Space Launch Competitiveness Act says that all activities must be in accordance with international law, they might finally help to establish an international mining regime, rather than simply enable mining for their national entities.

The role of small states in this topic seems to be another good opportunity for the construction of a global regime by responsible cosmopolitan states. Mining can be a source of conflict or leverage for global law harmonization that would avoid it. It is up to the responsible states to propose an inclusive strategy, based on cosmopolitan responsibility, and leading to harmonized operations of all.

6.3 High-Energy Systems

Small states can also focus on a technical niche, massively fund a specific research vector, and support the construction of "large technical systems" that have potential to become a global security issue that will require discussions on its security governance. This dynamic is what we have been exploring in possible applications of high-power lasers for space (not necessarily only in space). A great example is the Breakthrough Initiatives project Starshot, which aims to construct a 220 GW laser (Parkin, 2018). Its application is to accelerate one-gram probes called nano-probes at 20% of the speed of light and visit the Proxima Centauri star system within 20 years; however, every state generally sensitive about new technologies may consider Starshot as a threat to its space assets, despite assurances by the Breakthrough Initiatives that the whole system will be strictly focused to a point approximately 60 k km from the Earth, where a swarm of nano-probes will be waiting to be beamed

towards Proxima, actually incapable of harming any satellite crossing the light at a low Earth orbit. Starshot laser needs to be in southern hemisphere, given the location of Proxima Centauri, and at as high an altitude as possible, to reduce the power loss of the laser beam in the atmosphere. In this perspective, Chile's Atacama Desert is the proper place to host the Starshot system.

The mere existence of this system can force states to discuss a possible global security regime, and it is definitely a great opportunity for small states to offer to play a role in brokering the accords. We have introduced the initiative on Peaceful Use of Lasers in Space (see chapter "Peaceful Use of Lasers in Space: Challenges and Pathways Forward") (www.lasers4space.com) that should address exactly this problem. One might argue that small states could then blackmail others, but this is not the case. Lasers have multiple applications, and their usage as a propulsion system for Starshot is probably the most remote from today's practical needs in, e.g., removing orbital debris. The argument is the same: small states do not want to see a super-power rivalry over lasers that are useful for civilian (Starshot) or practical (debris) purposes, but an international peace and working security regime enabling their usage exactly for those civilian and practical purposes. At the same time, in nuclear technology, nuclear states do not let small non-nuclear states get too close to their nuclear program; however, in the case of lasers, small states can nurture their capability to develop them. Just the fact that they demonstrate the willingness and can show off world-class laboratories could trigger interest from the powerful states, to discuss a security regime as soon as possible. The mere existence of those security-sensitive systems, or even discussions to pursue them, could be a proper platform for discussions that are driven by responsible cosmopolitan states and could kick-start possible future cosmopolitan governance (Schmidt & Ditrych, 2019).

6.4 Orbital Debris

While orbital debris can be merged with the previous topic of high-power lasers, we decided to treat it separately. Debris is a very pragmatic problem that can be addressed by various approaches, while high-energy systems are, more or less, a category of technology for various purposes. The main reason to have debris separated in this book is the fact that it is a possible threat to everyone, it does not respect borders, and its growing population will force the international community into some accord about its solution sooner or later. Small states can argue that space powers used available orbits, while they might not have even the opportunity to do so, if orbits are congested by debris. Therefore, orbital debris can be compared to climate change, from the perspective of differentiated liability and a general requirement for sustainability (Svarovska & Schmidt, 2022).

Another perspective on orbital debris and the role of small states is quite similar to that pertaining to high-energy systems. Australia has been open about their laser at Mt. Stromlo having the capacity to eliminate orbital debris (Kearsley, 2021). Our team visited Mt. Stromlo at the beginning of our research project; we were

introduced to the technology, but we were not notified of the capability to remove the debris from orbit, in addition to its capability to detect debris in orbit; however, it was clear to us at that time that such small installations can emerge literally everywhere, very quickly. In fact, it is just about the power (see chapter "High-Energy Systems Today and Tomorrow") of the laser, and the world is covered by laser-ranging installations that map orbital debris to the size of millimeters. In our view, the development from ranging to deorbiting was inevitable. In this regard, we realized that some states can quite easily come out with an announcement that they hold technologies in civilian hands that could be perceived by other states as a threat to national security. States announcing such a reality may become a log in the eye for space powers concerned that their massive satellite constellations would be threatened by other states possessing such lasers and being from "another" ideological camp on the globe. As Starlink or Project Kuiper is emerging in the USA and laser capabilities can emerge anywhere, it is clearly foreseeable that some sort of security regime for lasers is necessary.

7 Conclusion

The chapter went from philosophical concepts of responsibility and sovereignty to discussions about foreign policy driven by cosmopolitan ideas and finally to a list of four possible cases in space that have potential to become foreign policy priorities of responsible cosmopolitan states. These technoscience projects differ from clearly national security topics and clearly civilian projects. We agree with strong moral cosmopolitans who say that our rights on the national level cannot be different than those on the global level, because if politicians on the national level fail to deliver decisions that have an impact beyond the borders that still have an impact on their own citizens, they still fail to deliver.

Whether we talk about planetary defense and a possible asteroid impact wiping out an entire city, or space mining leaving people behind, despite the cosmopolitan nature of international space law, or high-power lasers being the niche of a state, or orbital debris effectively disallowing new scientific missions to space, all of those cases perfectly suit those politicians who are willing to behave in responsible cosmopolitan way. All those cases are mature enough to become foreign policy of responsible cosmopolitan states willing to establish a community of like-minded states. Interstellar travel using one-gram nano-probes is not science fiction, but a well-reviewed concept; orbital debris is increasing, and active removal is apparently inevitable; space mining debates are currently very hot, and where they end depends on active participation. Planetary defense is not only about observations but huge international missions of many space agencies.

However, all of these topics are barely grasped by small states without a space program, but it is mainly up to them to establish a community of like-minded states to shape a peaceful future.

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References

Adler, E., & Haas, P. M. (1992). Epistemic communities, World order, and the creation of a reflective research program. *International Organization, 46*(01), 367. https://doi.org/10.1017/S0020818300001533

Beardsworth, R. (2015). From moral to political responsibility in a globalized age. *Ethics & International Affairs, 29*(1), 71–92. https://doi.org/10.1017/S0892679414000781

Beardsworth, R., & Shapcott, R. (2019). *The state and cosmopolitan responsibilities*. Oxford University Press.

Beardsworth, R., Brown, G. W., & Shapcott, R. (2019). Introduction. In *The state and cosmopolitan responsibilities* (pp. 1–12). Oxford University Press. https://doi.org/10.1093/oso/9780198800613.003.0001

Broadie, S. (1991). *Ethics with Aristotle*. Oxford University Press.

Brown, G. W. (2011). Bringing the State Back into cosmopolitanism: The idea of responsible cosmopolitan states. *Political Studies Review, 9*(1), 53–66. https://doi.org/10.1111/j.1478-9302.2010.00226.x

Bull, H. (2002). *The anarchical society* (3rd ed.). Columbia University Press. Accessed 5 Mar 2014.

Burke, A. (2011). Humanity after biopolitics: On the global politics of human being. *Angelaki, 16*(4), 101–114. https://doi.org/10.1080/0969725X.2011.641348

Burke, A. (2013a). Security cosmopolitanism. *Critical Studies on Security, 1*(1), 13–28. https://doi.org/10.1080/21624887.2013.790194

Burke, A. (2013b). The good state, from a cosmic point of view. *International Politics, 50*(1), 57–76. https://doi.org/10.1057/ip.2012.28

Derrida, J. (1996). *The gift of death*, trans. David Wills. University of Chicago Press.

Derrida, J. (2004) *Jacques Derrida, penseur de l'évènement*. Interviewed by Jérôme-Alexandre Nielsberg for l'Humanité, 28 January 2004. Accessed at http://www.humanite.fr/2004-01-28_Tribune-libre_-Jacques-Derrida-penseur-de-levenement.

Dufek, P. (2013). Why strong moral cosmopolitanism requires a world-state. *International Theory, 5*(2), 177–212. https://doi.org/10.1017/S1752971913000171

Eleftheriadis, P. (2010). Law and sovereignty. *Law and Philosophy, 29*(5), 535–569. https://doi.org/10.1007/s10982-010-9077-7

Erskine, T. (Ed.). (2003). *Can institutions have responsibilities? Collective moral agency and international relations*. Presented at the BISA/ISA Joint Special Workshop, "Can Institutions Have Morals?," Palgrave Macmillan.

Evans, G., & Grant, B. (1992). *Australia's foreign relations: In the world of the 1990s*. Melbourne University Press.

Geenens, R. (2017). Sovereignty as autonomy. *Law and Philosophy, 36*(5), 495–524. https://doi.org/10.1007/s10982-017-9295-3

Habermas, J. (2001). *The postnational constellation: Political essays*. Polity Press.

Jonas, H. (1985). *The imperative of responsibilities: In search of an ethics for the technological age*. University of Chicago Press.

Jones, C. (2010). Human rights and moral cosmopolitanism. *Critical Review of International Social and Political Philosophy, 13*(1), 115–135. https://doi.org/10.1080/13698230903326299

Kalmo, H., & Skinner, Q. (Eds.). (2010). *Sovereignty in fragments: The past, present and future of a contested concept*. Cambridge University Press.

Kant, I. (1795). *Perpetual peace: A philosophical sketch*.

Kearsley, J. (2021). World-first laser to shunt deadly space junk out of orbit. *9NEWS*. News. https://www.9news.com.au/technology/laser-world-first-to-shunt-deadly-space-junk-out-of-orbit-canberra-technology-news/0f45c207-98a0-4077-a406-69f6173de8b3. Accessed 8 Nov 2021.

Lawler, P. (2005). The good state: In praise of ?Classical? Internationalism. *Review of International Studies, 31*(03), 427–449. https://doi.org/10.1017/S0260210505006571

MacCormick, N. (1993). Beyond the sovereign state. *The Modern Law Review, 56*(1), 1–18. https://doi.org/10.1111/j.1468-2230.1993.tb02851.x

Orbán, V. (2014, July 26). *Speech at the XXV. Bálványos Free Summer University and Youth Camp, on-line*. Băile Tuşnad. https://budapestbeacon.com/full-text-of-viktor-orbans-speech-at-baile-tusnad-tusnadfurdo-of-26-july-2014/

Nietzsche, F. (1968). *The will to power, trans*. Walter Kaufmann and R. J. Hollingdale. Vintage/Random House.

Parkin, K. L. G. (2018). The breakthrough Starshot system model. *Acta Astronautica, 152*, 370–384. https://doi.org/10.1016/j.actaastro.2018.08.035

Piirimäe, P. (2010). The Westphalian myth and the idea of external sovereignty. In H. Kalmo & Q. Skinner (Eds.), *Sovereignty in fragments: The past, present and future of a contested concept*. Cambridge University Press.

Pogge, T. (1992). Cosmopolitanism and sovereignty. *Ethics, 103*(1), 48–75. https://doi.org/10.1086/293470

Raffoul, F. (2010). *The origins of responsibility*. Indiana University Press.

Scheuerman, W. E. (2014). Cosmopolitanism and the world state. *Review of International Studies, 40*(3), 419–441. https://doi.org/10.1017/S0260210513000417

Schmidt, N. (2021). *Building planetary defense governance: A proposal for multigenerational, financially sustainable and scientifically beneficial planetary defense governance*. Institute of International Relations.

Schmidt, N., & Ditrych, O. (2019). *Kick-starting cosmopolitan governance through science: The case of a Giant laser system*. Institute of International Relations.

Schmidt, N., & Ditrych, O. (2021). Space community as an enabler of cosmopolitan ideas through large technical systems. *Space Policy*. https://doi.org/10.1016/j.spacepol.2022.101485

Schmidt, N., & Svec, M. (2021). Breaking the deadlock in the space mining legal debate. *New Space*, https://doi.org/10.1089/space.2021.0049

Svarovska, N., & Schmidt, N. (2022). Cosmopolitan approach to the issue of orbital debris. In *Cosmopolitan responsible state in space politics planetary defense, asteroid mining, civilian high-energy systems in the light of bright future for humanity [FORTHCOMING]*. Springer International Publishing.

Švec, M., Boháček, P., & Schmidt, N. (2020). Těžba ve vesmíru: aktuální příležitost pro českou republiku prosazovat multilaterální mezinárodní řád. 3.

Ulaş, L. (2017). Transforming (but not transcending) the state system? On statist cosmopolitanism. *Critical Review of International Social and Political Philosophy, 20*(6), 657–676. https://doi.org/10.1080/13698230.2015.1048071

United Nations General Assembly. (2004). *A more secure world: Report of the high level panel on threats*. Challenges and Change. A/59/565.

Ypi, L. (2008). Statist cosmopolitanism. *Journal of Political Philosophy, 16*(1), 48–71. https://doi.org/10.1111/j.1467-9760.2008.00308.x

Part III
Space Projects with Potential to Enable Cosmopolitan Governance

Addressing Global Governance Gaps in Planetary Defense

Petr Boháček

1 Introduction

Planetary defense deals with the threat of impacts by dangerous asteroids and comets, also named as near-Earth objects (NEOs), and the means of their discovery, monitoring, characterization, deflection, or impact disaster management. From the global governance perspective, it is a nascent and highly technical area. Notwithstanding, that is precisely the reason to look critically into the limits of its contemporary governance model. Besides the biannual Planetary Defense Conference, which allows scientists and public officials to practice scenarios of an incoming asteroid, in 2014 the United Nations General Assembly (UNGA) endorsed the creation of a dedicated international expert body, the Space Mission Planning Advisory Group (SMPAG), and the International Asteroid Warning Network (IAWN). SMPAG meets biannually to prepare processes for an international response in case of an asteroid threat and to "exchange of information, development of options for collaborative research and mission opportunities, and to conduct NEO threat mitigation planning activities."[1] The group has established a work plan, which deals with the selected communication, technical, policy, and legal issues of international planetary defense collaboration. Its membership is made of 17 national space agencies or authorities, and the expert group reports to the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS). SMPAG works closely

[1] See "Terms of Reference V2.0 – SMPAG – Cosmos." https://www.cosmos.esa.int/web/smpag/terms_of_reference_v2

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with the IAWN, which coordinates NEO monitoring campaigns and shares information among 30 observatories and entities across the globe.

Within the SMPAG, nation-nominated experts are tasked with completing an adopted 11-item work plan. Although SMPAG's role is solely advisory, there are no established international decision-making mechanisms or governance frameworks for planetary defense. The SMPAG Legal Report discusses the international legal framework of planetary defense[2] and also mentions possible ad hoc decision bodies for planetary defense. The report cites the United Nations Security Council (UNSC), the United Nations General Assembly (UNGA), and the COPUOS as the potential existing bodies and also mentions the possibility of establishing an ad hoc decision-making body for planetary defense. Building upon the report, this chapter makes several arguments about the ill suitability of the existing UN framework for global governance of planetary defense. These failings are primarily due to its low effectivity, inclusivity, and thus sustainability. We then turn to suggest principles upon which an ad hoc decision-making body for planetary defense could be established and address the global governance gaps of the UN framework. Our proposal depends on the willingness of small states to become advocates of a change in which they join cosmopolitan and local responsibility together.

2 Global and Unpredictable Threat

Before taking on the governance discussion, we need to underscore some key characteristics that define the asteroid threat. We will focus on the description of two key aspects of planetary defense, its globality, and uncertainty. Firstly, the risk of large NEO of 1-km diameter or larger, which would cause a global catastrophe or even extinction, is generally considered low, with nearly 80%[3] of those circling our planet already discovered. The main risks lie in the estimated undiscovered NEOs that are unlikely to cause a global event but can essentially hit anywhere with significant local consequences. In the estimated total NEO population, the undiscovered objects account for 0.2% in the 1-km or larger category, 7% in the 300–1000-m category, and 54% in the 140–300-m category. From these estimates, the main threat of an asteroid impact is the undiscovered 140-m or larger objects that amount to 25,000.[4] Since asteroids are discovered by observing the sunlight reflection on their surface, this requires them to be in opposition of the Earth and the Sun to be observable.

[2] See Ad-Hoc Working Group on Legal Issues to SMPAG. 2020. "Planetary Defence Legal Overview and Assessment." https://www.cosmos.esa.int/documents/336356/336472/SMPAG-RP-004_1_0_SMPAG_legal_report_2020-04-08.pdf

[3] It is necessary to say that all the percentages are derived from statistical projections of total asteroid populations, which is causing discrepancies between projections. For example, the Minor Planet Center mentions 98% of discovered asteroids >1 km.

[4] These numbers were presented on behalf of the IAWN status report in March 2021.

Asteroids spending most of their time between the Sun and the Earth are nearly impossible to detect from the ground.

The second key characteristic is the difficulty of predicting the impact area of the objects. Even small uncertainty in an object's trajectory, rotation, size, or density makes predicting impact areas very difficult. Once a potentially dangerous NEO has been discovered, it requires follow-ups and additional observations to confirm its trajectory and rotation and estimate its size and shape. This can prove complicated without effective cooperation because the opportunity to observe it can pass quickly. Nighttime observation of sunlit NEOs can be disrupted by bad weather or air moisture or promptly deteriorate if the asteroid passes away from the Sun. Observing the reflected sunlight from the NEOs' surface on the night sky is not only a way to discover them but also for estimating their size. The measurements based on the absolute magnitude of their brightness (H) and the ratio of the surface's light reflection (albedo) only allow us to estimate their size only in wide ranges, which complicates further the impact prediction (Crowe, 2019).

An option to lower the uncertainty is a flyby or rendezvous mission to a NEO. Mission viability depends on rocket launch opportunities at the time the NEO passes through an area reachable by Earth-launched probes. Using standby prospecting satellites, either placed on a Lagrange point in space or prepared to be quickly deployed from Earth, can allow us to directly prospect a hazardous NEO. However, these options remain to be studied and would take years to prepare and deploy. The predicted area of impact remains to be mainly defined by the NEO's orbital plane of intersection with the Earth. Without sufficient knowledge about size and density, more detailed impact information is difficult to gather. This means that impact predictions are made in the form of an impact corridor that can span thousands of kilometers horizontally across Earth but be only hundreds of kilometers wide (Rumpf et al., 2019). Therefore, the underlying characteristic of planetary defense is that while all countries are threatened, the eventually predicted impact corridor will likely include only several countries, and the final impact will be at one area. This dynamic is essential to consider when looking at the contemporary global governance mechanisms in which several countries decide over the rest of the globe.

3 Global Governance Issues

The question of how humanity can manage itself in the face of complex planet-wide issues has no easy answer. Governance of any form is faced with complicated dilemmas. One of the most notable ones is the dilemma between effectivity (effective problem-solving) and inclusivity (inclusive participation) (Dahl, 1994). Exclusive governance of a small number of decision-takers can offer effective decisions and quick consensus. An epistemic authority can justify its decision upon scientific objectivity and claim it can deliver the most effective and evidence-based solutions. Yet effectivity or science themselves are not sole sources of legitimacy. They do not make up for inclusivity and representation. The trade-off in favor of

exclusive decision-making comes at the expense of ignoring the interests of the excluded and in effect undermining the acceptance of such authority, its decisions, and thus effectivity of such governance. On the other hand, inclusivity (meaning representation) can come at the costs of making consensus impossible and even lead to irrational but popular decisions in choice-insensitive areas, where personal preferences play little importance in choosing the right solution. The benefits of inclusive decision-making are that a person's true interest to decide in their own best interest does not guarantee they have the knowledge and capability to actually do so. These dilemmas are even more problematic to address on the global scale and highly technical field of planetary defense.

3.1 Governing by Criticality and Scientific Authority

Planetary defense is a highly technical area that encapsulates astronomical observations, orbital calculations, the geology of NEOs, space engineering, rocket science, and emergency management and disaster relief. Therefore, we could assume that to successfully detect and deflect a threatening NEO, so-called PHO – potentially hazardous object – science will give us all the answers and solutions. Another assumption comes from the idea that once humanity faces a global challenge of such astronomical proportions, we will pull together, throw away our differences, unite under our shared enemy, and realize our shared civilizational fate. Planetary defense thus ought to be governed by scientific objectivity and unbiased criticality to protect humanity. However, we should view these simple assumptions skeptically, especially in light of the recent pandemic. Criticality and scientific authority are not sufficient sources of legitimacy or best problem-solving, especially in the existing international political environment.

When a critical situation occurs, for example, the recent pandemic, a state of emergency or exception is declared in many countries, suspending normal political processes due to the crisis in favor of quick and effective problem-solving. Emergencies are generally viewed as acceptable circumstances to prioritize effectivity over deliberative and inclusive decision-making. This also happens on the international level. During the 2003 SARS-CoV-1 epidemic, the World Health Organization (WHO) relied on criticality and scientific justifications to extend their competencies. This included never before seen power moves by the WHO, namely, (a) public naming and shaming of countries that did not comply with the WHO guidelines in contrast with the previous WHO policy not to directly criticize its member states and (b) issuing explicit travel warnings for affected territories, in contrast to never been given such a mandate to do so in the past (Hanrieder & Kreuder-Sonnen, 2014). These developments have led some to a conclusion that scientific objectivity can in times of emergency provide the authority and justification for needed international measures that might go against national interests. States themselves retrospectively accepted and therefore legally validated such broadening of powers of an international organization at their expense, which

ultimately improved global governance. What certainly helped the case was the empirically widely shared recognition of the seriousness of the threat, the common interest in containing the virus, and the prevalent trust that the WHO was well equipped to deal with it (Maffettone & Ulaş, 2019).

However, in 2020 the reactions to the next SARS outbreak, this time a SARS-CoV-2 pandemic, were different, and neither scientific authority nor criticality provided authority strong enough to prevail over national interests. The behavior of many states, including China and the USA, in defiance of the WHO guidelines or in an attempt to influence WHO communication during the ongoing SARS-CoV-2 pandemic, proved a different global dynamic. It was the nation-first approaches to vaccinations and personal protective equipment as well as abrupt border closures that characterized the international response. Nations and even alleged allies would compete between themselves to secure deliveries of the biggest amounts of vaccine productions, seize companies with valuable intellectual property, ban exports of vaccines to other places, or shield patents of life-saving vaccines from the worst-hit nations. Deliveries of scarce personal protection equipment, swab tests, and later vaccines have become tools of the geopolitics of the big powers. Vaccine diplomacy saw nations trying to gain political influence with exclusive deliveries, ultimately weaponizing knowledge and technology for national interests. The scientific discussion about the origin of the SARS-CoV-2 virus was overtaken by a war of accusing narratives between nations.

Such experiences cannot be overlooked and provide critical lessons for the discussion about planetary defense. Moreover, they illustrate the limits of the belief that scientific objectivity or global criticality can enable strong global action, strengthen the role of international institutions in solving global challenges, and tame the rival nationalistic nature of nation-states. Instead, scientific objectivity and criticality became geopolitical weapons. There is no reason to believe that an asteroid threat would produce different reactions, especially given the existing international coordination of planetary defense. The UN-mandated SMPAG and IAWN bodies provide a global epistemic authority for planetary defense, with exhaustive and excellent expertise on all aspects of planetary defense. Three threshold criteria warrant different actions from the SMPAG and IAWN bodies.[5] The first one is an IAWN notification for the SMPAG for all objects with an impact probability above 1% and diameter higher than 10 m or a measured brightness magnitude of 28. The second one warrants terrestrial preparedness and determination of an impact corridor in the case an object larger than 20 m or brighter than magnitude of 27 reaches impact predictability higher than 10% within the next 20 years. The third threshold triggers the SMPAG to plan characterization missions and actions for objects with impact predictability above 1% and larger than 50 m in diameter or brightness magnitude of 26 within the next 50 years. However, there are caveats.

[5] See Recommended Criteria & Thresholds for Action for Potential NEO Impact Threat. https://www.cosmos.esa.int/documents/336356/1879207/SMPAG-RP-003_01_0_Thresholds%26Criterion_2018-10-18.pdf/58eb84ae-e3b6-1b08-9465-d25c548c5c9b.

The IAWN body puts together only 30 participants, including mainly individual observatories and only five space agencies. The IAWN relies mainly on the data of the Minor Planet Center (MPC), the single worldwide database and analytical hub of NEOs, which falls under the International Astronomical Union. However, despite its high precision, excellent capabilities, and openness, the MPC is funded by NASA, the US space agency, and its data consists almost exclusively from the US observational sensors (Spahr, 2014). For example, Russia (only a SMPAG member) runs its own Planetary Defense office that produces authoritative NEO observations outside of IAWN or MPC. The lack of data sharing and integration can lead to the emergence of different epistemic realities, meaning that different sensors can produce slightly different observations. Such discrepancies can then be easily exacerbated by the security sensitivity of planetary defense and used for national purposes. Just as the data and science put forward by the WHO or top peer-reviewed medical journals did not provide fully credible and respected epistemic authority during the SARS-CoV-2 pandemic, any convincing scientific arguments proposed by the SMPAG, IAWN, or MPC can be challenged. Without an adequate representation and inclusivity, the recommendations of UN-mandated planetary defense scientific authorities in the form of SMPAG and IAWN can be either rejected by other observations or also subjected to the influence and interests of the dominant actors producing them.

Furthermore, in the case of fast-approaching objects, the absence of precise decision-making mechanisms opens the door for a complete suspension of any inclusive political process. The design and nature of prospecting or deflecting missions could become a tool for gaining political influence over most threatened areas. We could even assume that the specific trajectory of the threatening object could be blamed on a rival nation. Therefore, scientific objectivity nor criticality cannot be considered as sufficient sources of authority for global governance of planetary defense. An element of inclusivity, in terms of adequate representation, is required; it would be the existing exclusive and nationally oriented environment shaping the recommendations.

3.2 Inclusivity and Effectivity in the UN Framework

While we cannot assume that scientific authority and criticality will provide the necessary authority for planetary defense governance, we need to consider whether the inclusivity of the UN would provide acceptance and legitimacy for such governance or in other words sustainability, resilience, and geopolitical stability. However, the problematic nature of the global security architecture and the related shortfalls of the UNSC and UNGA are rather a significant source of geopolitical instability. An asteroid threat can exacerbate the growing irrelevance and instability of the UN framework challenged by the tectonic shifts of power in the world. This shift is represented by the weakening of the post-WWII Western dominance, overall power shift from the West to the East, the proliferation of powerful technologies (space,

nuclear, cyber, AI, biotech) that undermine the exclusive legal possession of a nuclear weapon as the ultimate source of the power of the UNSC permanent members, and the increasing geopolitical multipolarity (with the rise of new state and non-state actors). This section thus critically looks at whether the existing UN framework can provide the necessary inclusivity and effectivity for planetary defense decision-making.

3.2.1 United Nations General Assembly

The United Nations General Assembly (UNGA) consisting of all 193 member states can be considered the most representative body in the UN framework for decisions of planetary proportions. In the dilemma between inclusivity and effectivity, the tilt is clearly towards the former. The UNGA resolutions are not binding. Theoretically, UNGA decisions' legitimacy is compensated by the more inclusive and representative nature of the body.

An essential part of decision-making is informed consent. The complexity of planetary defense means that if presented with information, not all member states would have the capacity to unpack the issue, analyze their situation, and decide what position is in their best interests. In cases of uneven access to information, countries can be heavily influenced by bigger powers. In the area of space activities, the UNGA's Committee on the Peaceful Uses of Outer Space (COPUOS) serves as a specialized expert forum. This is where the SMPAG would warn the international community and recommend adequate measures to address an asteroid threat, should it cross defined thresholds warranting an action, according to the thresholds described above. With the COPUOS consisting of only 95 members states, without the participation of wide regions of sub-Saharan Africa, Southeast Asia, or the Balkans and the Baltics, the access to this critical knowledge and development of national capabilities to understand such threat is certainly limited, hard to be considered inclusive or accessible. And suppose the COPUOS puts forward such warnings and recommendations to the UNGA plenary. In that case, decision-making processes in the UNGA would also be problematic due to the disproportionate distribution of votes across the global population.

The disproportionate distribution of votes in the UNGA between different parts of the world results in an inappropriate representation among populations within the contemporary nation-state system. Since votes of countries like China, India with their billion-plus populations, and small Pacific, Caribbean, or European nation-states with populations in tens of thousands, are given equal weight, security interests or even survival of all areas and peoples are simply not included equally across the globe. Issues of general nature require a simple majority approval; resolutions concerning security require a two-thirds majority to pass. A simple majority in the UNGA can be formed by small states representing only 3.5% of the world population, and two-thirds can be made up only by 8.6% of the world population. While such a scenario is rather theoretical, big powers are very skilled in garnering the support of small countries for their interests at the UN, and given the large

disproportion, the vast majority of the world population can be simply outvoted by the majority of some states at the UNGA.

As a result, the areas most threatened by a potential asteroid impact can be by design outvoted in this body. This systematic neglect of some of the most populous parts of the world undermines the legitimacy of the multilateral world architecture, in which such a small portion of the world population can outvote the vast majority. More dangerously, it means that some portions of the world can be outright ignored in case of an asteroid threat, resulting in the globally limited resources, space capabilities and planetary defense missions, and efforts to protect only the areas with stronger voice and representation in the UNGA. This carries serious risks of geopolitical instability on which we deliberate later on. In the question of effectivity, the UNGA produces only non-binding resolutions unlike the UNSC that could therefore have more direct power in planetary defense governance.

3.2.2 United Nations Security Council

Despite the clear trade-off between effectivity and inclusivity in favor of exclusivity, the UNSC can hardly be considered an effective decision-making body on international security topics. And even though UNSC resolutions are legally binding and could supersede any international treaty or international legal obligations, finding consensus among the five permanent members (P5) of the UNSC or specifically, among their diverse interests, is unique.

During the Cold War period of geopolitical bipolarity, consensus could be achieved by power balancing between the USA and USSR and their shared interest of preventing dominance by the other. The brief period of unipolarity following the fall of the Soviet Union and the Communist block did open up possibilities for a more active UNSC. The tragedies in the Balkan Wars or the Rwandan genocide have tilted the balance between sovereignty and human rights as the building blocks of the UN system towards the latter. Yet the resulting new international doctrines with global good and human rights protection at their core, such as the Responsibility to Protect (R2P), remained to be governed and decided on by the national interests of the permanent member states of the UNSC. This is a design flaw of the system built on nation-states. The prime example of this is the abuse of the R2P norm in the case of the 2011 Libyan intervention, in which a globally accepted humanitarian goal to protect civilians in Libya was used for a specific political goal of the intervening UNSC permanent members – the regime change in the country.

Without adequate global inclusivity, even globally good intentions fall prey to particular interests, as was the case with the R2P. Even a global norm for a global good cannot be truly pursued in an environment defined by national interests. Even universalistic norms, however noble they are, depend on the surrounding political dynamic. In the UNSC, this dynamic is characterized by the privileged permanent members, who will continue to maintain their privilege at any cost. The P5, representing roughly 25% of the world population, remains the ultimate decision-makers of the body thanks to their veto powers and also superior knowledge of the system

and its processes and procedures. The exclusivity of the UNSC decision-making is not limited to the veto power itself; it also extends to operating procedures, where the elected UNSC members do not possess the procedural, practical, negotiating, and institutional experiences and knowledge in the Council (Tourinho et al., 2016).

Further, the UNSC members define what the exceptions to the normal political process are through strategic negotiations between their national interests (Rychnovská, 2014). The exclusivity of the United Nations Security Council in its effect leaves up security and survival of all nation-states in the hands of the five permanent members. The securitization in the UNSC is defined by its legal and institutional setup, thus by the P5 countries. Suppose a globally beneficial intention to deflect a NEO on an impact trajectory with Earth is to be decided on in the UNSC. It will be subject to dominant national interests represented at the UNSC during the event. Those systemic forces would trump any honest effort that would genuinely, most effectively, and legitimately protect states and peoples within the impact corridor but outside of the UNSC.

Despite its exclusivity, it is the UNSC that remains the main global decision-making body on security issues, whose resolutions are binding. National interests and constituting national politics of permanent UNSC members are the deciding factors over global security. All parts of the world outside the P5 constituency and territory are thus left without their voice, importance, and equal consideration. This setup, combined with the changing geopolitics, global distribution of power, and the rise of new state and non-state actors, risks creating instability instead of successfully defending the planet from NEOs.

3.2.3 Sources of Geopolitical Instability

The exclusion of some actors from the process can leave decisions over the planetary defense to be viewed as a threat to those left out from the process since they would not possess any means to affect the decisions taken. With the absence of any guaranteed direct participation over questions of the nation's survival, areas along the impact corridor will seek to ensure their survival through different means and ways if the situation occurs, especially since every country has the responsibility, obligation, and right to protect its own territory, population, and sovereignty. Without participation, the endangered left-out actors are stripped of any tools within the realm of the international rules-based order to protect themselves from harm and in the case of small or centralized countries possibly even an existence due to the asteroid threat. States left out from the decision-making process would seek to create or find new means through which their vital interests would be protected.

In the past, the consequences of exclusion from decision-making over global issues affecting all could be mitigated within the bipolar or unipolar geopolitical environment. The contemporary multipolar division of power is much less stable and is more vulnerable to such turbulences. An exclusion from planetary defense decision-making of any country subject to serious asteroid threat along the impact corridor would invite aspirants for more global power to cater to those excluded.

Regional powers with space-faring capabilities that are left out of the UNSC system or underrepresented within the UN could seek to formalize their global status and pursue their own planetary defense mission. The motivation would be to seek the legitimization of their global weight and gather international support by catering to the disenchantment of other left-out nations. Nascent regional space-faring powers with global aspirations could guarantee planetary defense protection to those left out. Similarly, nuclear-armed nations guarantee protection to other like-minded non-nuclear states. The dual-use nature of deflection technology, including launching capability, rendezvous, and proximity operations or kinetic impacts, would make this a question of military strength.

The main negative consequence here is the emergence of rival planetary defense efforts. The exclusion of any actors in combination with the shifting distribution of power and ill-representation of the UN framework would simply lead them to seek another way to secure their vital interests. The dual-use nature of the planetary defense technology needs to be considered here. Heavy launch vehicles for space exploration during the Cold War were a tool to develop the most powerful intercontinental ballistic missiles, and planetary defense technology also has significant dual-use potential. The risk is not necessarily that North Korea or Iran would find further legitimization of their development of ballistic missile or nuclear device technologies; the risk is that other countries would be pushed to follow in that direction if they were serious about ensuring safety for their own population. Such a development in the area of planetary defense would lead to the ultimate weaponization of space.

Overall, the exclusivity but also ineffectiveness of both the UNSC and UNGA make the existing frameworks very problematic for planetary defense decision-making. Given the direct linkage to national security and even nation's survival can lead to an emergence of rival planetary defense missions, their ineffective overlapping, mutual disruptions of deflection or prospecting missions, and in general severe geopolitical instability with wider global implications in all areas. Groups of nations lying along an impact corridor but without adequate space-faring capabilities would invite actors to tame them into their own planetary defense protection. Due to the uncertainty over the impact areas for a long period of time, possibly decades until either observation opportunities arise or a prospecting mission is deployed, this process can be very gradual. Furthermore, the exclusive nature of the UNSC rests not only on the results of the Second World War but also on the only legal but arguably illegitimate possession of nuclear weapons by the P5. This itself carries serious consequences for the prospects of using nuclear weapons for deflection, which due to the inequality in their possession represent a clear limit for the global capability to defend humanity from NEOs.

3.2.4 Existing Governance Barrier for Planetary Defense

One of the areas where the gap in the global governance of planetary defense already limits our ability to defend the Earth from dangerous asteroids and comets is the use of a nuclear explosive device (NED) as means for deflection. While the question of technical benefits and negatives of NED deflection of rocky and often porous asteroids remains the subject of rigorous scientific debates, the utility of NED lies especially in its potential to deflect fast-approaching comets, for which we have fewer tools to address. However, the use of a nuclear explosive device to deflect a NEO could be a source of much more negative consequences on global security and the international order than the impact of a non-extinction size object. While the legal use of nuclear explosive devices for planetary defense is prohibited under international law according to the SMPAG Legal Report, in particular circumstances of consent, distress, and necessity, non-compliance with these treaties could be potentially accepted. Despite this potential loophole in the legal framework for the use of NED for planetary defense, there are no loopholes in the normative framework of the non-proliferation regime. A failure to either immediately reject the use of a NED within the existing global governance framework or adopt a new globally inclusive treaty that approve its use, risks causing negative consequences that could further complicate cooperation of space-faring nations on the ground as well as on the Earth's orbit and cause larger societal and economic instability or disruption of global supply chains.

The reason is that a declaration of the intent to use a NED or its mere possibility risks a dismantlement of the current arms control and non-proliferation regime. It sends a signal that nuclear weapons are a legitimate and indispensable tool for ensuring the security, survival, and sovereignty of nation-states. In this regard, Smetana has put forward several arguments (Smetana, 2018). Firstly, the use of a NED would leave out states to be dependent on only five legally nuclear-armed nations – the five permanent members of the UNSC. Moreover, the use of nuclear NED not only carries the danger of political dependency on the group of five countries (the P5) but also undermines the global nuclear disarmament regime. The development and use of NEDs could undermine the fragile arms control and disarmament regime. Firstly, the peaceful use of nuclear technology described under the Non-Proliferation Treaty (NPT) Article V has never materialized. The principle was eventually dismissed by the NPT Review conferences and the 1996 Comprehensive Test Ban Treaty. Secondly, a NED would require testing, development, and production of new warheads, whose prohibition represents the cornerstone of the non-proliferation regime. The third key point made by Smetana concerns the way the NPT, as the main base of the global nuclear order, was made as a time-limited transformative regime with the goal of its permanent future extension from "nuclear equity" to "equality" of zero state in nuclear armaments (Smetana, 2015, 2018). The inherent conflict within the NPT between nuclear-weapon states and non-nuclear-weapon states would be exposed and demonstrated should the use of nuclear weapons be sanctioned for planetary defense. Despite its technical benefits, the associated risks exposed by international relations scholars beg the question of whether the use

of a NED for planetary defense would have more destabilizing effects than the impact itself. The severe consequence of the NED legitimization is that any state could justify the development and possession of nuclear weapons for the purpose of the protection of their sovereignty – as the building block of the international system – and the security and safety of their populations. Representation itself has a critical value for the resilience, diversity, and overall sustainability of the system. The implied negative consequence is that to ensure these essential interests of nation-states, the development and acquisition of nuclear explosive devices would be perceived as legitimate and required. The above-described perils and the potential breakdown of the non-proliferation regime and de-stigmatization of nuclear weapons testing, development, production, and use without a proper new normative regime represent serious negative consequences for the pre-launch preparation period. Yet, the effect of the use of a NED can be mitigated by inclusive and global decision-making free of other negative consequences described above.

4 Principles for Ad Hoc Planetary Defense Body

Given the criticism presented above of the existing global governance framework, the option of an ad hoc body for planetary defense mentioned in the SMPAG Legal Report should be explored in more detail. When and how and under what principles should the body be established needs to be clearly defined. Such topics ought to be subject to globally inclusive discussions, conferences, expert deliberations, and further research. Notwithstanding, we put forward some ideas on a way it could be approached.

We pointed out that the underlying source of the possible geopolitical destabilization in the current governance framework of planetary defense is the possible emergence of rival planetary defense efforts. This originates in the fact that the existing governance mechanisms underrepresent those affected by asteroid strikes. The impact corridor is unlikely to include only countries with space-faring capabilities or capacity to contribute to the planetary defense observations or deflection missions. Yet that would not justify their exclusion from the decision-making over the efforts. At the same time, member states with planetary defense capabilities cannot be expected to simply turn over their high-tech, dual-use, and expensive resources to those that are the most threatened.

A possible way around this is to have the most capable nations carry out the planetary defense efforts but for those efforts to be finally managed, governed, and sanctioned by an ad hoc body made up of the most affected areas. This would mean areas along the impact corridor or threatened coastal areas in case of an impact in the ocean. With the main NEO hazard being in asteroids between 140 and 1000 m, or so-called city killers, the most affected areas would be cities and urban areas. For this reason, the ad hoc body should be made of areas represented proportionately based on their population along the impact corridor or potential impact wave to truly represent the affected populations. This stands in conflict with the UN

representative system based on "one nation, one vote." But because this underrepresentation is precisely the source of geopolitical instability, it needs to be addressed.

However, the complicated predictability of the impact area makes the question about who should have what to say in the topic very tricky. The predictions about the precise extent of impact corridors would decide about the inclusion of a certain area in the decision-making. What the magnitude of impact warrants an area to be included needs to be defined. An ad hoc body would have to be established based on the impact corridor estimates by the UN-mandated SMPAG and IAWN bodies, which have their own limitations mentioned above. The impact corridor estimates would define what areas and populations will get a say over the planetary defense efforts and which not. They can still be subject to intense geopolitical pressures. But if the parties involved in the ad hoc body would be based on the area's population size and not countries, the political play motivated by national interests would have significantly lower logic. With clear definitions at what point, based on what impact corridor estimates and with what proportional representation an ad hoc planetary defense decision-making body is established, planetary defense governance can be improved to avoid geopolitical instability and failure in defense of the planet Earth.

5 Cosmopolitan Metamorphosis

The globalized reality created by the rise of global risks and challenges is not a source of world's transformation but of its metamorphosis. Ulrich Beck describes it as not only a change of some parts of human civilization but as a complete change of its metaphysics (Beck, 2016). Ideas on how to react to it range from the rise of inward-looking nationalist populism to ideas of Cosmopolitan responsible states. In this regard, Anthony Burke as one of the key Cosmopolitan political scientists points out that the nation-state can never be truly good from the cosmic perspective, but it can at least do good (Burke, 2013). Acknowledging the limits of Cosmopolitan outlook on behalf of a country, whose authority as a political unit is defined by its service to territorially defined interests, is critical. It links directly with Ulrich Beck's Cosmopolitan vision and its principle stating that Cosmopolitanism without provincialism is empty, and provincialism without cosmopolitanism is blind (Beck, 2006).

Still, the need for change in global governance mechanisms in face of global threats is becoming imperative not only from the non-Western part of the world but also among the Western societies who have as the architects of the existing multilateral world order benefited from it the most. The recent tide of nationalism, populism, and strong resentment towards international cooperation and organizations has been correlated with the negative effects of globalization (Bearce & Scott, 2019). While global inequality has been decreasing, national inequality has been growing, explains Francois Bourguignon (Bourguignon, 2016), noting that the Gini coefficient in 1990–2010 rose by two points for all countries on average and by five percent in the USA only between 1990 and 2013. The vote against economic

globalization by some sectors of society that depend on it might seem to some as irrational, especially since it resulted in the election of politicians whose policies will be even more damaging to their voters negatively affected by globalization. But it is a representation of a very rational and substantial problem – the problem that globalization and technological progress does not bring equal benefits to everyone. Bruno Latour (2018), a renowned science and technology studies (STS) researcher, summarizes the issue by underlining the tensions between scientific decision-making and the demand of the popular voice by calling it "the habitual vice of epistemology, which consists of attributing to intellectual deficits something that is quite simply a deficit in shared perceptions." Unless there is an adequate element of inclusivity, scientific authority or criticality does not provide sufficient global legitimacy but also is subject to misuse. They can also be viewed as unjust and illegitimate, inviting wider social disturbance, incompliance, and instability. Basing representation on the specific details of the asteroid threat would be a step towards inclusivity in global decision-making.

The ad hoc governance model, which would give political representation and decision-making power over planetary defense to the affected areas and populations along the impact corridor rather than to established nation-states, could be seen as disadvantaging mainly small states that enjoy the same level of representation as the biggest ones in the UN. In a situation an impact corridor crosses small states but also populated areas of a large state, the representation of a bigger state would increase and lower the decision power of the smaller state relative to the "one state-one vote" principle. But it is precisely small states that mostly rely on (a) a functioning international rules-based order in their independence, political autonomy, and sovereignty and (b) geopolitical stability, so they do not become a mere battleground of competing influences of global powers. Developing functioning global decision-making mechanisms based on more inclusive representation would follow their long-term interests in preventing geopolitical instability or weakening of the international rules-based order. Therefore, the model of impact corridor-based representation is not built on the idea that countries can become enlightened and effectively globally responsible, as such expectation goes directly against the core logic of nation-states as territorially defined political units. Given the big voting strength of small nations in achieving any meaningful change, this approach depends on their ambition to pursue their own interests in the changing globalized world by ensuring global governance mechanisms remain stable and functional. Unlike world powers, small states realize more directly the dependence of their own interests on others and the entire world society. They are more directly affected by many global challenges, including the asteroid threat, and possess growing political, financial, and technological power due to growing urbanization. Small states pursuing their own interests are thus the embodiment of the provincialism becoming the main substance of cosmopolitanism in reaction to the metamorphosis of the world towards the global.

6 Conclusion

Scientifically complex questions or global issues are not excused from the need for representation and inclusiveness just because it is difficult. Quite the opposite. Representation is critical for both the effectivity and sustainability of global governance, to ensure that large swaths of the world population are not left out or that scientific authority is not used as a tool for advancing particular interests. The challenge here is not how to eliminate these considerations from the decision-making but how to ensure they translate into rational and justifiable decisions. Planetary defense is no different in this.

On the global level, the absence of inclusivity in addressing global challenges can easily backfire, especially as the global governance architecture based on the centuries-old system of nation-states meets the fragile modernity. The fast proliferation of technologies and empowerment of non-state actors or new non-Western powers as well as the rise of new global challenges meet the complete lack of effective or legitimate governance mechanisms, creating an explosive combination. An asteroid threat has the potential to inflate these factors out of proportion, leading to an overall uprooting of what we consider as a given world order. As a solution, this chapters hint towards an ad hoc decision-making model based on the actually affected populations and areas by the threat of asteroids. Conceptually, this means substituting nationality for impact as the main principle of representation in global decision-making. Small states are the suitable drivers of such change. They represent the decentralization of the international system towards more local political units amid increasing urbanization. Cosmopolitanism in this sense comes from the local in a bottom-up manner, not the other way around. Small states also possess significant voting strength in the international system. Lastly, an asteroid impact represents the biggest threat to densely populated urban centers. Simply put, just as we couldn't successfully deflect an asteroid based on the seventheenth-century physics and astronomy, we cannot deflect it based on the seventheenth-century political system of nation-states. In this regard, we put a heavy focus on inclusivity and representation that is not based on the old territorial categories of nation-states but on reality and functionality. The automatic creation of the ad hoc decision-making body for planetary defense based on the predicted impact corridor does not have to be always perfectly inclusive. It does, however, shift the decision-making away from the powerful towards those affected and offers a governance mechanism built on reality, functionality, sustainability, and not on history or pure distribution of power. Failure to settle these issues now will result in them being solved in an undesirable manner with undesirable consequences in the situation of an actual crisis.

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References

Bearce, D. H., & Scott, J. J. (2019). *Popular non-support for international organizations: How extensive and what does this represent?*

Beck, U. (2006). *The cosmopolitan vision*. Polity.

Beck, U. (2016). *The metamorphosis of the world: How climate change is transforming our concept of the world*. Wiley.

Bourguignon, F. (2016). How the rich get richer as the poor catch up. *Foreign Affairs, 95*(1), 11–15.

Burke, A. (2013). The good state, from a cosmic point of view. *International Politics, 50*(1), 57–76. https://doi.org/10.1057/ip.2012.28

Crowe, W. (2019). What are NEOs and the technical means and constraints of solar system mapping? In N. Schmidt (Ed.), *Planetary defense: Global collaboration for defending earth from asteroids and comets* (pp. 33–48). Springer. https://doi.org/10.1007/978-3-030-01000-3_3

Dahl, R. A. (1994). A democratic dilemma: System effectiveness versus citizen participation. *Political Science Quarterly, 109*(1), 23. https://doi.org/10.2307/2151659

Hanrieder, T., & Kreuder-Sonnen, C. (2014). WHO decides on the exception? Securitization and emergency governance in global health. *Security Dialogue, 45*(4), 331–348. https://doi.org/10.1177/0967010614535833

Latour, B. (2018). *Down to earth: Politics in the new climatic regime* (1st ed.). Polity.

Maffettone, P., & Ulaş, L. (2019). Legitimacy, metacoordination and context-dependence. *International Theory, 11*(1), 81–109. https://doi.org/10.1017/S1752971918000258

Rumpf, C. M., Mathias, D., Farnocchia, D., & Chesley, S. (2019). Projecting asteroid impact corridors onto the earth. In *2019 IEEE Aerospace Conference* (pp. 1–7). Presented at the 2019 IEEE Aerospace Conference. https://doi.org/10.1109/AERO.2019.8741912

Rychnovská, D. (2014). Securitization and the power of threat framing. *Perspectives, 22*(2), 9–31.

Smetana, M. (2015). Nuclear infrastructure, strategic hedging, and the implications for disarmament. In *Global nuclear disarmament: Strategic, political, and regional perspectives* (pp. 44–60). Routledge. https://doi.org/10.4324/9781315735856

Smetana, M. (2018). Weapons of mass protection? Rogue asteroids and the normative pitfalls of nuclear explosions in space. In N. Schmidt (Ed.), *Planetary defense – Global collaboration for saving earth from asteroids and comets (forthcoming)*. Springer.

Spahr, T. (2014). *International asteroid warning network: Recent updates and MPC summary* (p. 10).

Tourinho, M., Stuenkel, O., & Brockmeier, S. (2016). "Responsibility while protecting": Reforming R2P implementation. *Global Society, 30*(1), 134–150. https://doi.org/10.1080/13600826.2015.1094452

Space Mining: Attempts to Materialize Cosmopolitan Ideas Enshrined in International Space Law

Martin Švec and Nikola Schmidt

1 Introduction

This chapter aims to analyze international legal regimes governing utilization of natural resources located in areas recognized as res communis omnium, to demonstrate an important paradigm shift from the national interest-driven approach to the global interest-driven regime reflecting cosmopolitan ideas. Special attention is given to the regime governing deep seabed mining created by the United Nations Convention on the Law of the Sea. This regime represents the most cosmopolitan regime ever established. Natural resources located on the deep seabed have been declared the common heritage of mankind, and their exploration and exploitation shall be either carried out or controlled by the International Seabed Authority – a body representing mankind as a whole. We argue that an ownership of natural resources located in the deep seabed vested in *mankind* constitutes an important step in the materialization of cosmopolitan ideas.

During the diplomatic discussions preceding the Outer Space Treaty and its drafting, delegates did not devote due attention to the space mining, as the technological readiness did not make space mining technically possible in the early 1960s; however, recent developments on the commercial space market, emerging start-ups, and recently adopted national space mining laws in several countries have revealed how important it is to discuss limits imposed by the international space law.

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Acknowledging that there is no universal approach as to how natural resources located in the areas recognized as res communis omnium should be governed and how cosmopolitan ideas should be translated into an international natural resource management regime, we discuss the most relevant principles of international space law. Future legal regimes governing the utilization of space resources will be primarily affected by the non-appropriation principle and the requirement that space activities shall be carried out for the benefit, and in the interest of, all countries, arising from both customary international law and the Outer Space Treaty. As a consequence, outer space should be considered as an area recognized as res communis omnium, and developing countries should not be prevented from gaining profit from the utilization of space resources. Given the scarcity of easily accessible space resources, ideas like benefit-sharing in the form of capacity-building or exchange of expertise may effectively lead to an unequal distribution of benefits, because developing countries are unlikely to commence their own space mining missions fast enough to benefit from space resource utilization directly.

The last part of the chapter looks at recent efforts to formulate space mining legal regimes, both national and international – national laws adopted by the USA, Luxembourg, the UAE, and Japan – as well as discussions about potential legal models for activities in exploration, exploitation, and utilization of space resources within the United Nations Committee on the Peaceful Uses of Outer Space. What is more, we have included the Building Blocks for the Development of an International Framework on Space Resource Activities and the Vancouver Recommendations on Space Mining. Both initiatives have been driven by various stakeholders, such as industry, international organizations, academia, and NGOs.

We acknowledge that national space mining law appears to be the most effective tool to regulate space mining; however, it remains the most controversial one, unless states behave in a responsible cosmopolitan way. The following legal analysis reveals that a cosmopolitan approach to space mining not only is morally right but also reflects core ideals enshrined in international space law. What is more, we argue that a cosmopolitan approach to space mining is the only approach enabling the long-term sustainability of outer space activities. We believe and show in the following text that the sharing of benefits that may be derived from the exploitation of natural resources in areas recognized as res communis omnium represents a unique opportunity to further implement cosmopolitan ideas in international practice.

2 From Permanent Sovereignty over Natural Resources to *Common Heritage of Mankind*

The World Bank's study, published in 2006, aimed to answer an important question: "Where is the wealth of nations?" It revealed that the wealth embodied in natural resources makes up a significant proportion of the wealth of most nations, often more than the wealth embodied in produced capital. In other words, natural resource management is a key aspect of economic development (World Bank, 2005). Natural

resources play an indispensable role in meeting the needs of society and modern economies; what is more, countries richly endowed with natural capital have the potential to derive significant current income from natural resources (Peras et al., 2021).

Natural resources have always been treated in a special way. Subterranean natural resources, such as oil, gas, and minerals, often belong to the state, and their utilization is heavily regulated. The body of domestic administrative law sets forth conditions under which natural resources may be explored and exploited (agreements, licenses, concessions, environmental regulation) as well as conditions under which the property rights are transferred to non-state actors (taxes, royalties) (Viñuales, 2011, p. 207). Territorial sovereignty allows states to utilize natural resources located within their territory exclusively, in accordance with their national interests.[1]

Given their importance in meeting the needs of society and economies, as well as their unequal distribution on the Earth's surface (Armstrong, 2011), natural resources became increasingly subject to intense competition and conflicts (Engel & Krof, 2005). According to Oli Brown and Michael Keating, the most potentially contentious issues include ownership of the resource; allocation of power for managing access to, or developing, the resource; and the distribution of resource revenues (Brown & Keating, 2015, p. 2).

2.1 Permanent Sovereignty over Natural Resources

The right to *enjoy benefits which may be derived from the exploitation of the natural resources over which states exercise sovereignty* was explicitly declared by the United Nations General Assembly in 1962 as permanent sovereignty over natural wealth and resources (Schrijver, 2015). This fundamental principle of international law recognized the sovereign right to natural resources – the inalienable right of all states to freely dispose of their natural wealth and resources in accordance with their national interests and with respect to their economic needs.[2] As such, permanent sovereignty over natural wealth and resources should be viewed as a materialization of the horizontal system of international law built on the concept of state sovereignty. Although Resolution 1803 (XVII) echoes the spirit of international cooperation in the field of economic development, permanent sovereignty over natural resources explicitly prioritizes interests of individual countries and allows

[1] See United Nations General Assembly Resolution 1803 (XVII) of 14 December 1962, *Permanent Sovereignty Over Natural Resources.*

[2] United Nations General Assembly Resolution 1803 (XVII) of 14 December 1962, *Permanent Sovereignty Over Natural Resources reads as follows:* "The right of peoples and nations to permanent sovereignty over their natural wealth and resources must be exercised in the interest of their national development and of the well-being of the people of the State concerned."

them to retain for themselves benefits from the utilization of natural resources located within their territory (Schrijver, 1997).

Permanent sovereignty over natural resources should be understood as a correction of historical injustice of violent appropriation of natural resources, against the background of the process of decolonization – it gave inalienable rights to the formerly colonized countries. A key moral component as well as justificatory principle to the permanent sovereignty over natural resources is the right of self-determination (Gümplová, 2020; Hobe, 2015; Schrijver, 1997).

2.2 Utilization of Natural Resources Beyond National Jurisdiction

However, permanent sovereignty over natural wealth and resources may be invoked by states only in relation to natural resources found within their territory, in other words within the limits of their jurisdiction. The need for more resources was for centuries solved by exploration of new territories (understood as res nullius)[3] or conquest. Nonetheless, all areas rich in natural resources have been discovered, and all UN members shall refrain in their international relations from the threat or use of force against the territorial integrity or political independence of any state.[4] Today, most of the accessible terrestrial natural resources fall under the sovereignty (jurisdiction) of some state, except natural resources located in areas beyond national jurisdiction, such as Antarctica, the high seas, or the deep seabed. These natural resources were for centuries either hardly accessible (states were not able to sustain a permanent presence in these areas) or undiscovered. When states cannot exercise their sovereignty over particular areas, they cannot become an exclusive beneficiary of natural resources located therein.

Antarctica may serve as a good example on which to elaborate. Already in the late 1700s and early 1800s, early Southern Ocean explorers, sealers, and whalers claimed for their countries the islands, and once the Antarctic continent was discovered, states engaged in expeditions and made territorial claims. Great Britain did so in 1908, and other six countries followed, namely, Argentina, Australia, Chile, France, New Zealand, and Norway (British Antarctic Survey et al., 2021). It is worth noting that the territories claimed by Argentina, Chile, and Great Britain overlap to some extent and this overlap was a source of dispute among the three countries on numerous occasions (Benedetto, 1986, p. 253). The plurality of territorial claims over Antarctica was temporarily resolved in 1959 by adopting the Antarctic Treaty that effectively froze all these claims.[5] It became clear that the

[3] The territorial ontology underpinning res nullius is that exclusive territorial possession is preeminent – and natural – legal geography. It assumes that unowned space is not beyond possession; it is simply awaiting transformation into a possession. For more details, see (Collis, 2017).

[4] See Art. 2(4) of the United Nations Charter.

[5] See Art. 4 of the Antarctic Treaty.

utilization of natural resources should be addressed at the international level, as this approach has potential to overcome possible legal disputes or even conflicts.

To avoid, or at least diminish, the possibility of an unregulated scramble for minerals, as well as disputes about ownership, the Convention on the Regulation of Antarctic Mineral Resource Activities (CRAMRA) was adopted in 1988. The regime established by the CRAMRA aimed at promoting opportunities for the fair and effective participation of all parties and stressed the special situation of developing countries. It also encouraged the involvement of interested countries that were not contracting parties to either the Antarctic Treaty or CRAMRA, international organizations, and NGOs.[6] CRAMRA has never entered into force, since it was not ratified by Australia and France (Rothwell, 1990, p. 286). Nonetheless, attempts to establish an inclusive regime on the utilization of natural resources in Antarctica constitute an important paradigm shift from the national interest-driven approach (translated into permanent sovereignty over natural resources) to the global interest-driven regime, reflecting cosmopolitan ideas.

In contrast to the regime established by the Antarctic Treaty (freezing territorial claims), there are terrestrial regimes excluding territorial sovereignty whatsoever – areas recognized as *res communis omnium*.[7] Terrestrial areas traditionally referred to as *res communis omnium* include the high seas and the deep seabed. They are open to all for access and use and are not susceptible to occupation and sovereignty.[8] Since this chapter is focused primarily on nonliving natural resources, such as minerals, oil, or gas, the regime governing the high seas will not be further addressed. Our attention will be focused on the regime governing the deep seabed established by the United Nations Convention on the Law of the Sea (UNCLOS).

2.3 *UNCLOS and the Regime Governing Deep Seabed Mining: The Most Cosmopolitan Regime Ever Established*

Until its conceptualization in UNCLOS, the *common heritage of mankind* was viewed as an embodiment of agreed moral and political guidelines, in which the community of nations has undertaken a moral commitment to follow in good faith in the elaboration of a legal regime for the area beyond the limits of national

[6] See Preamble, Arts. 2.3, 6, and 34 of CRAMRA and (Beck, 1989, p. 23).

[7] Origins of the concept of *res communis omnium* may be found in Roman law. The text of jurist Marcianus, preserved in the Digest of Justinian, is considered to be the first formal pronouncement in recorded legal theory on the legal status of the sea and the right of man to use the sea and its products, though it must be noted that Marcianus only dealt with the status of the sea in private law. See P.T. Fenn, Justinian and the Freedom of the Sea, *Am. J. Int. Law*. 19 (1925) 716–727. www.jstor.com/stable/2188310; W.J. Zwalve, The Introduction to the Jurisprudence of Holland and the Doctrine of the Free Seas, Grotiana. 30 (2009) 49–64.

[8] J. Klabbers, International Law 2nd Edition, Second Edi, Cambridge University Press, 2017. https://doi.org/10.1017/9781316493717

jurisdiction (Brown, 1971; Sybesma-Knol, 1977, pp. 673–674). The origins of the *common heritage of mankind* as a legal concept may be found in the late 1960s.

In 1967, the Maltese delegation to the UN, led by its Chairman Arvid Pardo, proposed that the UN should take action on the seabed issue and might pass a declaration that the seabed and ocean floor were the *common heritage of mankind* (Pardo, 1973; Sybesma-Knol, 1977). According to Arvid Pardo, the *common heritage of mankind* should comprise three central concepts (White, 1982, p. 535):

1. Absence of private property rights, i.e., the right to use but not own resources
2. International management of all uses of the common heritage
3. Sharing of benefits derived from such use

As a result of difficult and hard political negotiations, the concept of *common heritage of mankind* found its way into the UNCLOS.

First, pursuant to Art. 137 of the UNCLOS, states are precluded from claiming or exercising sovereignty or sovereign rights over any part of the deep seabed and its resources. In other words, the deep seabed constitutes *res communis omnium*. Second, natural resources located on the deep seabed (the UNCLOS refers to this area as "the Area") have been declared *common heritage of mankind*.[9] Moreover, any exploration and exploitation shall be either carried out or controlled by the International Seabed Authority (ISA) – a body representing mankind as a whole.[10] By the same token, exploration and exploitation of seabed minerals in the Area can only be carried out under a contract with the ISA or by the Enterprise, which was initially conceived as a separate organ and empowered by UNCLOS to engage in prospecting and mining in the Area, as well as the transporting, processing, and marketing of minerals recovered from the Area. M. Bourrel explains that the main idea was for the Enterprise to buy the mining technology from commercial operators or to enter into joint ventures with them (Bourrel et al., 2018, pp. 3–4; Churchill & Lowe, 1999, p. 244). Realized profits would have to be distributed, as part of the *common heritage of mankind*, by the ISA.[11] However, the Enterprise has never been set up.

To reflect the interests of mankind, the ISA comprises of a variety of bodies, such as Assembly, Council, Legal Commission, Technical Commission, Finance Committee, and Secretariat, and envisages the establishment of the Enterprise. Their composition aims to reflect the diversity of the international community while taking into consideration the contribution of particular countries (major investors) as well as potential consequences on other countries. The Council is composed of countries divided into five groups – major consumers, major investors, major

[9] Art. 136–137, United Nations Convention on the Law of the Sea (adopted 10 December 1982, entered into force 16 November 1994) 1833 UNTS 3 (UNCSLOS).

[10] "*Activities in the Area shall be organised, carried out and controlled by the Authority on behalf of mankind as a whole (…),*" see Art. 153, United Nations Convention on the Law of the Sea (adopted 10 December 1982, entered into force 16 November 1994) 1833 UNTS 3 (UNCSLOS).

[11] Art. 170 and Annex IV, United Nations Convention on the Law of the Sea (adopted 10 December 1982, entered into force 16 November 1994) 1833 UNTS 3 (UNCSLOS).

exporters, developing states, and equitable geographic representation.[12] Hence, inclusiveness, diversity, and cosmopolitanism are the key principles on which the ISA is based. Economic advantages of deep seabed mining, most likely in the form of royalties paid to the ISA, are to be shared for the "benefit of mankind as a whole," with particular emphasis on developing countries that lack the technology and capital to carry out seabed mining for themselves (Lodge, 2017).

Prof. Kiss in this context argues that in the discussions surrounding the drafting of the provisions of the UNCLOS related to deep sea mining, the benefit-sharing aspect was very strongly stressed, and indeed the whole complex machinery that was created is aimed at ensuring that developing countries receive a part of the direct economic profits that the exploitation of deep sea mineral resources is supposed to yield (Kiss, 2017, p. 438).

Having said that, the regime established by the UNCLOS (together with the Agreement on Part XI) represents the most progressive and the most cosmopolitan resource management ever established. Overall, ownership vested in *mankind,* once no state could assert sovereignty in derogation of that right, constitutes an important step in the materialization of cosmopolitan ideas. UNCLOS shows us that the absence of sovereignty does effectively stimulate the implementation of cosmopolitan ideas into a legal regime. It can be concluded that the *common heritage of mankind* builds on inclusiveness and prioritizes the interests of mankind over the interests of individual countries, making the concept cosmopolitan per se.

3 Space Resources as Exhaustible Resources in an Area Recognized as Res Communis Omnium

3.1 Principles of International Space Law

The Outer Space Treaty (OST) was the first major international agreement governing the use of outer space and codified the general legal principles the United Nations had previously adopted via resolution in order to govern activities in outer space.[13] According to both customary international law and Art. 2 of the OST, outer space is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means. The preclusion of appropriation and the exclusion of territorial sovereignty are referred to as the *principle of non-appropriation* (Zhang, 2019). Being an area recognized as *res communis omnium*,

[12] In accordance with paragraph 15 of Section 3, of the Annex to the Agreement, the Council shall consist of 36 members elected by the Assembly. For more information, see https://www.isa.org.jm/authority/council/members

[13] See G.A. Res. 2222, 21 U.N. GAOR, Supp. (No. 16) 13, U.N. Doc. A/6316(1966); G.A. Res. 1721A, 16 U.N. GAOR, Supp. (No. 17) 7, U.N. Doc. A/5100(1962); https://core.ac.uk/download/pdf/147638686.pdf

outer space is well positioned to bear cosmopolitan ideas (see chapter "International Space Law as the Transiting Path to Cosmopolitan Order").

The OST, often referred to as the "Principle Treaty" or the "Constitution of Space Law" (Viikari, 2012), laid down fundamental principles of international space law, such as the following:

- The exploration and use of outer space, including the Moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind (Art. 1 of the OST).
- Outer space and celestial bodies are free for exploration and use by all states on the basis of equality.
- Outer space is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.
- The Moon and other celestial bodies shall be used by all state parties to the Treaty exclusively for peaceful purposes.

It is important to explain a difference between the so-called common benefit clause enshrined in the OST/customary international law (*exploration and use of outer space shall be carried on for the benefit and in the interests of all countries and shall be the province of all mankind)* and the concept of *common heritage of mankind* found in the UNCLOS. Only the concept of *common heritage of mankind* requires an absence of private property rights, international management of all uses of the common heritage, and sharing of benefits derived from such use. It is important to emphasize that ownership of space resources per se is not precluded by the OST (Svec et al., 2020), since it does not declare space resources as the *common heritage of mankind*.

When the OST was drafted, exploitation of space resources was not considered feasible. Thus, the treaty does not contain any specific reference to the utilization of space resources, despite France's mostly agreed-upon (by other delegations) interpretation that the "free use of space" mentioned in the OST comprises natural resource exploitation (Dembling & Arons, 1967, p. 431). At that time, it was believed that more detailed regulation is to be adopted when new problems emerge. In this line, the Rescue Agreement,[14] the Liability Convention,[15] and the Registration Convention were adopted.[16] The utilization of space resources was addressed a

[14] The Agreement on the Rescue of Astronauts, the Return of Astronauts, and the Return of Objects Launched into Outer Space. See United Nations, *International Space Law: United Nations Instruments* (UNOOSA 2017) available at https://www.unoosa.org/res/oosadoc/data/documents/2017/stspace/stspace61rev_2_0_html/V1605998-ENGLISH.pdf.

[15] The Convention on International Liability for Damage Caused by Space Objects. *See* United Nations, *International Space Law: United Nations Instruments* (UNOOSA 2017) available at https://www.unoosa.org/res/oosadoc/data/documents/2017/stspace/stspace61rev_2_0_html/V1605998-ENGLISH.pdf.

[16] The Convention on Registration of Objects Launched into Outer Space. *See* United Nations, *International Space Law: United Nations Instruments* (UNOOSA 2017) available at https://www.unoosa.org/res/oosadoc/data/documents/2017/stspace/stspace61rev_2_0_html/V1605998-

decade later via the Moon Agreement.[17] All these treaties were first negotiated and adopted by the UN General Assembly as legally nonbinding resolutions.

Motivation for the conclusion of the Moon Agreement is clearly expressed in its preamble. States were well aware of benefits that may be derived from the exploitation of the natural resources of the Moon and other celestial bodies, and they aimed to prevent the Moon from becoming an area of international conflict.[18] Both UNCLOS and the Moon Agreement were negotiated in the 1970s, when the *common heritage of mankind* principle was clarified, and its constituent elements specified. Developing nations especially embraced an international regime based on the *common heritage of mankind* principle, since they feared that states with the greatest economic and technological capabilities would reap the greatest rewards (Brilmayer & Klein, 2001, p. 726; Buxton, 2004, p. 694). In fact, the Moon Agreement was the first international treaty declaring its natural resources as the *common heritage of mankind*.

In contrast to the UNCLOS, the Moon Agreement does not include a regime on the utilization of space resources itself. It only declares that its state parties undertake to establish an international regime, including appropriate procedures to govern the exploitation of the natural resources of the Moon, as such exploitation is about to become feasible.[19] Nonetheless, the Moon Agreement laid down truly cosmopolitan contours of such a future regime. According to Art. 11(7) of the Moon Agreement, the main purposes of the international regime shall include (a) the orderly and safe development of the natural resources of the Moon, (b) the rational management of those resources, (c) the expansion of opportunities in the use of those resources, and (d) an equitable sharing by all state parties in the benefits derived from those resources, whereby the interests and needs of the developing countries, as well as the efforts of those countries which have contributed either directly or indirectly to the exploration of the Moon, shall be given special consideration.

Although the Moon Agreement has been endorsed the UN General Assembly, only 18 states have ratified/acceded to it.[20] It is worth noting that the *common heritage of mankind* character of space resources and the equitable distribution of benefits were highly controversial among many countries (most notably for the USA)

ENGLISH.pdfhttps://www.unoosa.org/res/oosadoc/data/documents/2017/stspace/stspace61rev_2_0_html/V1605998-ENGLISH.pdf.

[17] The Moon Agreement "The Agreement Governing the Activities of States on the Moon and Other Celestial Bodies." See United Nations, *International Space Law: United Nations Instruments* (UNOOSA 2017). available at available at https://www.unoosa.org/res/oosadoc/data/documents/2017/stspace/stspace61rev_2_0_html/V1605998-ENGLISH.pdfhttps://www.unoosa.org/res/oosadoc/data/documents/2017/stspace/stspace61rev_2_0_html/V1605998-ENGLISH.pdf

[18] The Preamble, The Moon Agreement "The Agreement Governing the Activities of States on the Moon and Other Celestial Bodies." *See* United Nations, *International Space Law: United Nations Instruments* (UNOOSA 2017) available at available at https://www.unoosa.org/res/oosadoc/data/documents/2017/stspace/stspace61rev_2_0_html/V1605998-ENGLISH.pdf.

[19] Art. 11 (6) of the Moon Agreement.

[20] It is worth acknowledging that no spacefaring nation has ratified the Moon Agreement.

(Davis & Lee, 1999; Griffin, 1981, p. 743; Rosenfield, 1981). As a result, the international regime on the utilization of space resources envisaged by the Agreement has never been created (or even proposed). Hence, cosmopolitan visions enshrined in the Moon Agreement have not materialized.

3.2 All Space Activities Shall Be Carried Out for the Benefit and in the Interest of All Countries and Shall Be the Province of All Mankind

The failure of the Moon Agreement left a substantial gap in international space law. More specifically, most of the countries having ambitions, either to establish a sustainable human presence on the Moon or to continue in the deep space exploration (utilization of space resources is critical in both cases), are bound only by customary international law and legal principles enshrined in the OST. In other words, space mining is regulated as it was in the late 1970s.

Since the OST leaves considerable room for interpretation, it is difficult to predict what the future legal framework for the utilization of space resources will look like. Most importantly, the OST does not use the term *common heritage of mankind*, but rather uses the term *province of mankind*, and *exploration and use of outer space, including the moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries (and) shall be the province of all mankind*.[21]

According to Professor Armel Kerrest, *province* seems associated with the idea of territory or the responsibility over a territory, thus giving the notion of control rather than property and possible wealth (Buxton, 2004, p. 698; Kerrest, 2001). In other words, as long as space resources are not declared the *common heritage of mankind*, they may be appropriated by anyone. There are just a few (but important) limitations arising from the OST – the appropriation of space resources should not constitute a territorial claim; and mining operations shall be *carried out for the benefit and in the interests of all countries*. It is important to emphasize that the requirement that *outer space shall be used for the benefit and in the interests of all countries* allows significantly broader interpretation than the *common heritage of mankind*.

Until now, most of the activities carried out in outer space did not prevent others from undertaking the same activities. Hence, the requirement that *outer space shall be used for the benefit and in the interests of all countries* arising from Art. 1 of the OST as well as customary international law was easily met when countries carrying out space activities supported developing countries in building their own space capabilities. The UN General Assembly's Declaration on Space Benefits in this context stated:

[21] Art. 1 of the OST.

> All States, particularly those with relevant space capabilities and with programmes for the exploration and use of outer space, should contribute to promoting and fostering international cooperation on an equitable and mutually acceptable basis. In this context, particular attention should be given to the benefit and the interests of developing countries and countries with incipient space programmes stemming from such international cooperation conducted with countries with more advanced space capabilities. [22]

However, natural resources are unique – they are exhaustible. Exploitation of space resources (at one location, especially Moon craters) by one country does effectively prevent other countries from benefiting as well. Having said that, one should ask whether the requirement that o*uter space shall be used for the benefit and in the interests of all countries* could be satisfied by the mere promoting and fostering of international cooperation, without any significant regime regulating the utilization of space resources. During the drafting of the OST, developing countries emphasized that fulfilling the interests of all countries *irrespective of their economic or scientific development* is about international equality per se (Dembling & Arons, 1967, p. 429).

4 At the Brink of the Space Mining Age

In recent years, utilization of space resources has become an increasingly important topic. Despite the recent technological development and financial capabilities of commercial companies, there are no significant investments into space mining concepts or even building the infrastructure necessary for the whole chain of activities to actually enable mining (from remote/orbital/in situ prospecting to mining, processing, transportation, and consumption). The lack of specific regulation is by many perceived as a significant barrier effectively discouraging private investors (Marquez, 2017; Svec et al., 2020). Hence, the establishment of a legal framework for the utilization of space resources has appeared again on the agendas of many governments, including Luxembourg,[23] the European Space Agency,[24] Japan,[25] the USA,[26] and UAE.[27] It is worth noting that there are several alternatives, differently reflecting cosmopolitan ideas. The most remarkable attempts to address legal uncertainty surrounding space mining are to be discussed.

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[22] UN General Assembly Resolution 51/122 of 4 February 1997.

[23] See Luxembourg Space Agency's SpaceResources. Lu Initiative at https://space-agency.public.lu/en/space-resources/the-initiative.html

[24] See European Space Agency's Space Resources Strategy at https://exploration.esa.int/web/moon/-/61369-esa-space-resources-strategy

[25] See Japan's outline on space policy at https://www8.cao.go.jp/space/english/index-e.html

[26] National Space Policy of the United States of America at https://www.space.commerce.gov/policy/national-space-policy/

[27] See National Space Policy of the United Arab Emirates at https://space.gov.ae/Documents/PublicationPDFFiles/UAE_National_Space_Policy_English.pdf

The Moon Agreement declaring space resources the *common heritage of mankind* constituted the most cosmopolitan approach; however, it has only 18 contracting parties. The rest of the international community is bound only by general principles arising from the OST and customary international law. Although both the OST and customary international law reflect strongly cosmopolitan ideas, they allow a broad range of interpretations. In other words, it remains to be seen how cosmopolitan the future regime on space mining will be.

Currently, there are several noteworthy initiatives. All of them claim to build on the legal principles arising from the OST and customary international law; however, each of them addresses and interprets cosmopolitan ideas of international space law differently. One would expect that outer space-related issues should be addressed by organs that were created for these purposes, particularly the Committee on the Peaceful Uses of Outer Space (COPUOS) – the UN body set up by the UN General Assembly in 1959 to govern the exploration and use of outer space for the benefit of all humanity: for peace, security, and developments.

However, the very first legal framework aimed at addressing the utilization of space resources has been adopted at the national level, via the 2015 US Commercial Space Launch Competitiveness Act. Opposition to any unilaterally adopted frameworks immediately sparked a debate at the UN COPUOS on potential legal models for activities in exploration, exploitation, and utilization of space resources. In the meantime, Luxembourg, the United Arab Emirates, and Japan followed the US unilateral approach and adopted national frameworks on space mining. In addition, potential legal regimes governing space mining are discussed by other stakeholders, such as academics and private actors (commercial companies). The most remarkable initiatives include the Hague International Space Resources Governance Working Group and the Vancouver Recommendations on Space Mining.

4.1 National Law

Being occupied by issues, such as capacity-building in space law, review and possible revision of the principles relevant to the use of nuclear power sources in outer space, or space debris mitigation, the UN COPUOS has paid since its establishment only little attention to the utilization of space resources. When commercial companies incorporated in the USA recognized a business opportunity in space mining, they identified the absence of a necessary legal framework as a fundamental barrier. Since they had no tools to affect discussions at the international level, they started to press the US for the adoption of a national regime.

This effort resulted in the adoption of the 2015 US Commercial Space Launch Competitiveness Act, including the Title IV dedicated to space resource exploration and utilization (Tronchetti, 2016; von der Dunk, 2015). Luxembourg (Law on

Exploration and Use of Space Resources, 2017)[28] (De Man, 2017), the United Arab Emirates (Federal Law No. 12 on the Regulation of the Space Sector, 2020), and Japan (the Act for Promotion of Business Activities Regarding Exploration and Exploitation of Space Resources, 2021) (Suzuki, 2021) adopted national law addressing space mining as well.[29] Without going into detail, an analysis of these laws reveals the following observations:

(a) They declared that space resources may be appropriated.
(b) The US law explicitly states that the US Congress, by the enactment of the 2015 US Commercial Space Launch Competitiveness Act, does not assert sovereignty or sovereign or exclusive rights or jurisdiction over, or the ownership of, any celestial body.[30]
(c) They are silent on the requirement that *outer space shall be used for the benefit and in the interests of all countries.*

It may be argued that national law, by definition, cannot bear cosmopolitan ideas (see chapter "International Space Law as the Transiting Path to Cosmopolitan Order"). We disagree with this premise, especially when national law aims to regulate activities in the areas recognized as *res communis omnium*. National law pursuing solely national interests exclusive to the respective nation in these areas should not be adopted unless a state seeks to intentionally undermine the cosmopolitan nature of these areas. On the contrary, once a state recognizes such areas as inherently cosmopolitan (for instance, via being a contracting party to the OST), it should endeavor to help these regimes to serve their purpose – in this case – to stimulate the use of outer space as being beneficial for all countries, irrespective of their degree of economic or scientific development. This is the moment when being a responsible cosmopolitan state does not limit the behavior of a state on foreign policy (see chapters "Reconciling Cosmopolitan Theory and Policy Practice? Responsible States as a Transitional Category" and "Responsible Cosmopolitan State in Space Politics") but can be considered as general behavior, e.g., adhering to international rules and regimes and reflecting them in national laws, actually sending signals to other states that even national laws can reflect interests of all countries.

There are several additional legal and practical reasons to strive for a cosmopolitan-oriented national law. First, a non-cosmopolitan national law may negate the very nature of the areas considered *res communis omnium* and prevent the development of cosmopolitan regimes already in place, such as OST. Second, a non-cosmopolitan national law effectively undermines foreign policy that would treat specific areas as *res communis omnium.* Third, a non-cosmopolitan national law may violate international conventions creating regimes bearing cosmopolitan ideas. Fourth, the adoption of a non-cosmopolitan (exclusive) national law would be

[28] See the original Luxembourg's Loi Du 20 Juillet 2017 Sur l'exploration et l'utilisation Des Ressources de l'espace.

[29] Federal Law No. (12) of 2019 on the regulation of the space sector, 2019.

[30] See SEC. 403 – disclaimer of extraterritorial sovereignty in the US Commercial Space Launch Competitiveness Act.

meaningless, because provisions of domestic law cannot prevail over those of international treaties.[31] In addition, the adoption of non-cosmopolitan (exclusive) national laws by states seeking to enable space mining would be counterproductive, because norms of these laws would likely conflict. Such an unpredictable and conflicting legal environment would hardly attract private investments into space mining.

We believe that national space mining law must bear cosmopolitan ideas enshrined in international space law; however, the legislative process is traditionally viewed as a manifestation of the concept of sovereignty, the principle of non-intervention, and political independence. In other words, every sovereign state has the right to conduct its internal affairs without outside interference.[32] Having said that, the ways states are accustomed to adopting national law to be applied in the areas recognized as *res communis omnium* will have to be reconceptualized (see chap. 5).

First and foremost, national legislators should pay due regard to the cosmopolitan dimension of national law they are adopting, and cosmopolitan ideas should be accordingly incorporated. With respect to the compatibility of national law with the OST, the greatest challenge appears to be the incorporation of the requirement that the exploration and use of outer space *shall be carried out for the benefit and in the interests of all countries* and *shall be the province of all mankind*. Since national legislators can hardly identify the interests of other countries, active diplomatic effort seeking to involve the rest of the international community (directly or indirectly) into the process of drafting national law or its interpretation is inevitable.[33] In conclusion, the adoption of a cosmopolitan-oriented national law is one of the options responsible cosmopolitan states have in enabling the utilization of space resources in outer space.

4.2 UN COPUOS

There is no doubt that areas recognized as *res communis omnium* should be primarily governed at the international level. In contrast to national law, international treaty, by definition, has much greater potential to bear cosmopolitan visions and, thus, should be preferred. By the same token, the UN COPUOS became the logic and key platform by which to address the utilization of space resources. In 2016, an item entitled "General exchange of views on potential legal models for activities in exploration, exploitation and utilisation of space resources" was included on the

[31] Art. 32 of the ILC's Articles on Responsibility of States for Internationally Wrongful Acts. See the annex to General Assembly Resolution 56/83 of 12 December 2001; Art. 27 of the Vienna Convention on the Law of Treaties, 1155 U.N.T.S. 331.

[32] See Article II of the UN Charter; (Jamnjead & Wood, 2009).

[33] As you can see in other chapters in this volume, a number of authors do not even accept the concept of *responsible cosmopolitan state,* because the concepts *cosmopolitan* and *state* are logical antonyms.

agenda of the UN COPUOS's Legal Subcommittee; however, since then, only little progress has been made, due to a lack of consensus on key issues among delegates. In 2019, Belgium and Greece proposed the establishment of a working group on the development of an international regime for the utilization and exploitation of space resources; however, the Legal Subcommittee only encouraged these two delegations to conduct consultations with interested delegations on the margins of the 60-second session of the UN COPUOS.[34] Afterward, the UN COPUOS endorsed the nomination by Belgium and Greece of Andrzej Misztal as moderator and Steven Freeland as vice-moderator to lead the scheduled informal consultations during the 59th session of the Legal Subcommittee (in 2020).[35] A working group under the agenda item on the general exchange of views on potential legal models for activities in exploration, exploitation, and utilization of space resources was finally established in 2021.[36]

It is worth noting that the UN COPUOS's agenda item "General exchange of views on potential legal models for activities in exploration, exploitation and utilization of space resources" does not explicitly exclude regulation of space mining at the national level. We consider an international legal framework as the most desirable; however, it is not the only legal model. Potential legal models may include a hybrid regime consisting of a parallel regulation at the national and international levels, as well as a regime based on harmonized national regulations. Having said that, the level of cosmopolitanism may vary, according to the interpretation of the requirement that outer space shall be used for the benefit and in the interests of all countries arising from the OST and customary international law.

4.3 Building Blocks for the Development of an International Framework on Space Resource Activities

The Building Blocks for the Development of an International Framework on Space Resource Activities (BB) were adopted by the Hague International Space Resources Governance Working Group in 2019. BB is the outcome of 3 years of discussions by the Hague International Space Resources Governance Working Group, a forum established to discuss legal questions regarding the use of space resources and to prepare the ground for future negotiations of an international agreement or a nonlegally binding instrument (Leiden University, 2019).

[34] See para. 280 of Report of the Legal Subcommittee on Its Fifty-eighth Session, held in Vienna from 1 to 12 April 2019, UN Doc A/AC.105/1203.

[35] See para. 258 of Report of the Committee on the Peaceful Uses of Outer Space, Sixty-second Session (12–21 June 2019); UN Doc A/74/20.

[36] "XIII. General Exchange of Views on Potential Legal Models for Activities in Exploration, Exploitation and Utilisation of Space Resources. Draft Report of the Legal Subcommittee of the UN COPUOS on Its Sixtieth Session (31 May – 11 June 2021) UN Doc A/AC.1"

First and foremost, the Hague International Space Resources Governance Working Group suggests that the utilization of space resources should be addressed at the international level (to be precise, BB aims to contribute to the development of an international framework). Although BB does not have an ambition to recommend whether the future framework should take the form of an international treaty or rather consist of national laws harmonized at the international level via nonlegally binding instruments, BB implies an important role for national law. By doing so, BB effectively responds to the existence of national space mining-related laws. More specifically, BB explicitly acknowledges national law as a potential source of resource rights.[37] In other words, BB expects the establishment of a hybrid regime with a significant role for national law, rather than the establishment of a comprehensive international regime (as envisaged by the Moon Agreement or already created by the UNCLOS). In this context, the international framework envisaged by BB aims to address potential negative externalities of such a hybrid regime, particularly to prevent disputes arising out of space resource activities.[38] By doing so, BB implicitly acknowledges the conflicting nature of the hybrid regime consisting of parallel international and national regulation.

In contrast to the above-discussed national space mining-related laws, BB aims to emphasize various cosmopolitan ideas, such as inclusiveness, the global nature of space, and its inherent tendency to openness and cooperation (Bettencourt Neto et al., 2020, p. 75). According to the BB Commentary, inclusiveness is instrumental for attaining international legitimacy. Given the different perspectives vis-á-vis space resource activities, the international framework should refer not only to countries but also to humankind as a whole (Bettencourt Neto et al., 2020, p. 17). This approach has affected the terminology used in BB. According to the authors of the BB Commentary, BB distinguishes between all countries and humankind, to reflect the contemporary architecture of the global society, which is no longer composed solely of sovereign states but also of other entities representing the many facets of social interaction (Bettencourt Neto et al., 2020, p. 55).

Moreover, BB pays due regard to the requirement that o*uter space shall be used for the benefit and in the interests of all countries* arising from the OST and customary international law. What is more, although neither the OST nor customary international law explicitly requires the sharing of benefits, Building Block 13 addresses the sharing of benefits arising out of the utilization of space resources. According to BB, the international framework should stipulate that states and international organizations that are responsible for space resource activities shall provide for benefit-sharing, through the promotion of the participation of all countries in space resource activities, in particular developing countries. BB includes several examples of benefit-sharing:

[37] See BB 8.1: The international framework should ensure that resource rights over raw mineral and volatile materials extracted from space resources, as well as products derived therefrom, can lawfully be acquired through domestic legislation, bilateral agreements, and/or multilateral agreements.

[38] See BB 4.2: The international framework should be designed to (…) (d) prevent disputes arising out of space resource activities.

(a) Development of space science and technology and of its applications
(b) Development of relevant and appropriate capabilities in interested states
(c) Cooperation and contribution in education and training
(d) Access to and exchange of information
(e) Incentivization of joint ventures
(f) Exchange of expertise and technology among states on a mutually acceptable basis
(g) Establishment of an international fund

However, most of the examples of benefit-sharing listed in the Building Block 13 recall the UN General Assembly's *Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries*.[39] In other words, BB primarily aims at creating opportunities for developed countries, either directly (joint ventures) or indirectly (exchange of expertise and technology, capacity-building). However, as stated above, it is necessary to distinguish between exhaustible and non-exhaustible resources. If the principle of "first come first served" is applicable in relation to space mining, indirect methods of benefit-sharing may be futile.

Developing countries can hardly become direct beneficiaries (even if they are supported, trained, and assisted). Since space resources are not declared *common heritage of mankind*, developing countries may directly benefit from space mining via either joint ventures or the process of reserving areas exclusively for developing states (an approach already adopted in UNCLOS). While joint ventures are mentioned among examples of benefit-sharing, reservation of specific areas for developing countries was not incorporated in BB (Bettencourt Neto et al., 2020, p. 45). The BB Commentary explains that benefit-sharing via joint ventures fits the 1996 "Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and Interest of All States, Taking into Particular Account the Needs of Developing Countries," adopted by the General Assembly of the United Nations with UNGA Resolution 51/122. Moreover, it is believed that cooperative ventures should be fair and reasonable and that they should be in full compliance with the legitimate rights and interests of the parties concerned, particularly with regard to export control limitation and intellectual property rights (Bettencourt Neto et al., 2020, p. 79).

Whereas the establishment of an international fund is included among potential examples of benefit-sharing, BB prioritizes non-monetary benefits. The Building Block states that the international framework should not require compulsory monetary benefit-sharing. More specifically, the working group decided not to include such provision, based on the premise that currently compulsory monetary sharing does not represent a suitable solution, due to the very early stage of space resource activities. It is believed that the space resource activities of the operators are not expected to return sufficient or significant profit. The working group thus favored

[39] UN General Assembly Resolution 51/122 of 4 February 1997.

the idea of an international fund; however, details of its management or its objectives were not elaborated, since these aspects should be better assessed once space resource activities have matured (Bettencourt Neto et al., 2020, p. 79).

4.4 Vancouver Recommendations on Space Mining

The Vancouver Recommendations on Space Mining (VR) is the latest contribution to the discussion about the future legal framework for the utilization of space resources. It is an outcome of the workshop organized in 2020 by the Outer Space Institute.[40] Participants of the workshop came from a wide range of countries and backgrounds, including government, industry, and academia. VR aims to augment other existing recommendations and guidelines, both the "Building Blocks" adopted by the Hague International Space Resources Governance Working Group and national space laws recently adopted.

First, VR considers the unilateral adoption of a regime via national legislation to be an inadequate response to the need to ensure that space mining is carried out in a sustainable manner. Hence, multilateral negotiations on an international regime open to states should be viewed as the most desirable alternative. This observation clearly reflects inherent limits of national law to bear cosmopolitan ideas. Issues such as long-term sustainability of space resource activities, as well as potential negative externalities associated with space mining, should be discussed at multilateral fora. According to VR, space mining activities regulated primarily at the national level cannot ensure that these activities are carried out for the benefit and in the interest of all countries (Art. 1 of the OST).

Therefore, VR recommends multilateral negotiations on an international regime for space mining. VR does not elaborate on what issues should be regulated at the international level and what issues should be left to national law; however, since the creation of international governance mechanisms, taking into account models or analogies from other areas such as deep seabed mining (the most complex scheme for common resource management) (Banet, 2020), should be taken into consideration, one may infer that an international governance mechanism should play an important role. Negotiations about such a regime should be open to all states. What is more, non-spacefaring nations and developing states should be incentivized to develop or acquire expertise that would be helpful for effective participation in the negotiations, to strengthen their legitimacy and reflect cosmopolitan ideas enshrined in international space law. In addition, due regard should be paid to an input from industry and other nongovernmental stakeholders. Regarding benefits which may be derived from the exploitation of space resources, VR supports the establishment of

[40] A network of world's leading space experts united by their commitment to highly innovative, transdisciplinary research that addresses grand challenges facing the continued use and exploration of space, comprising physical scientists, social scientists, lawyers, engineers, industry leaders, and policy-makers. See http://outerspaceinstitute.ca/

a mandatory benefit-sharing mechanism, including sharing monetary benefits (for instance, through an international fund) (The Outer Space Institute, 2020).

5 Conclusion: Cosmopolitan Ideas Enshrined in the Recent Space Mining-Related Incentives

National law appears to be the most effective tool to address the gridlock in which the international community has been caught. At the same time, it is undoubtedly the most controversial response to the lack of a legal framework for the utilization of space resources. Concerns related to unilaterally created regimes (especially the US one in 2015) were expressed by various delegations at the UN COPUOS as well as legal scholars (Boley et al., 2020). A regulation at the national level per se is not illegal; however, states adopting national space mining laws should pay due regard to their international legal obligations arising from the OST and customary international law.

The most challenging task for national legislators seems to be the requirement that *outer space shall be used for the benefit and in the interests of all countries.* We are convinced that even such a requirement may be satisfied by national law (Schmidt & Svec, 2021). Nonetheless, it would require significant creativity of legislators and active diplomatic effort seeking to involve the rest of the international community (directly or indirectly) into the process of drafting national law or its interpretation. In other words, cosmopolitan ideas enshrined in international space law should be (and must be) translated into national law. By doing so, states may not only ensure compatibility of their national laws with international law but also gain legitimacy. It is worth recalling that opposed or challenged national space mining law may effectively discourage private investors.

UN COPUOS's Legal Subcommittee has been discussing potential legal models for activities in exploration, exploitation, and utilization of space resources since 2016. On the one hand, there has been little progress on key issues. On the other hand, since all UN COPUOS members are engaged in these discussions, a potential future regime is likely to balance a wide range of expectations advocated by both developed and developing states. In conclusion, the UN COPUOS seems to be an ideal forum for the negotiation of norms built on cosmopolitan ideas.

The Hague International Space Resources Governance Working Group has proposed a relatively extensive interpretation of the requirement that *outer space shall be used for the benefit and in the interests of all countries.* In fact, BB proposes a definition already supported by the UN General Assembly. By doing so, BB effectively refused to distinguish between exhaustible and non-exhaustible resources. It is questionable whether the benefit-sharing methods suggested by BB reflect the exhaustible nature of space resources. Given the scarcity of easily accessible space resources, benefit-sharing in the form of capacity-building and exchange of expertise may effectively lead to an unequal distribution of benefits, because developing

countries are unlikely to commence their own space mining missions fast enough to benefit from space resource utilization directly. On the other hand, taking into consideration the failure of the Moon Agreement (declaring space resources the *common heritage of mankind* and seeking to establish a comprehensive international legal regime), BB's suggestion to accompany national regimes with an international framework appears to be a realistic ambition.

The Vancouver Recommendations on Space Mining undoubtedly strengthens the cosmopolitan ideas of international space law. VR is primarily focused on the process of creating the international framework. It is believed that only multilateral, inclusive, and open negotiations can meet the level of cosmopolitanism implicitly required by the OST and customary international law. It is worth noting that VR "encourages the establishment of a mandatory benefit-sharing mechanism that includes but is not limited to, the sharing of monetary benefits, for example, through an international fund." In other words, an international regime inspired by VR would enable even developing countries to gain profit from the utilization of space resources. What is more, it does recall the UNCLOS regime on seabed mining.

The cosmopolitan nature of outer space can hardly be questioned; however, there is no universal approach on how natural resources located beyond national jurisdiction should be governed and how cosmopolitan ideas should be translated into international natural resource management. This chapter aimed to make readers familiar with already existing terrestrial regimes and explain cosmopolitan principles of international space law being fundamentally relevant for the creation of an international regime governing the utilization of space resources. Since these principles leave considerable room for interpretation, potential models differ significantly. It remains to be seen how cosmopolitan future framework on space mining will look like.

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References

Armstrong, C. (2011). Global resource distribution. In *Encyclopedia of Global Justice* (pp. 441–443). Springer. https://doi.org/10.1007/978-1-4020-9160-5_286

Banet, C. (Ed.). (2020). Commercial mining activities in the deep seabed beyond national jurisdiction: The international legal framework. In *The Law of the Seabed* (pp. 139–162). Brill | Nijhoff. https://doi.org/10.1163/9789004391567_009

Beck, P. J. (1989). Convention on the regulation of Antarctic mineral resource activities: A major addition to the Antarctic Treaty System. *Polar Record, 25*(152), 19–32. https://doi.org/10.1017/S0032247400009943

Benedetto, C. (1986). Territorial claims in Antarctica: A modern way to deal with an old problem. *Cornell International Law Journal, 19*(2), 249–258.

Bettencourt Neto, O. de. (2020). In M. Hofmann, T. Masson-Zwaan, & D. Stefoudi (Eds.), *Building blocks for the development of an international framework on space resource activities: A commentary*. Eleven International Publishing.

Boley, A., Byers, M., Evans, W., Jakhu, R. S., Kendall, D., Meyer, P., & Stojak, M. L. (2020). *Open letter to honorabule François-Philippe Champagne, the Minister of Foreign Affairs*. https://www.mcgill.ca/iasl/files/iasl/open_letter_on_us_executive_order_on_space_mining.pdf

Bourrel, M., Thiele, T., & Currie, D. (2018). The common of heritage of mankind as a means to assess and advance equity in deep sea mining. *Marine Policy, 95*, 311–316. https://doi.org/10.1016/j.marpol.2016.07.017

Brilmayer, L., & Klein, N. (2001). Land and sea: Two sovereignty regimes in search of a common denominator. *N.Y.U. Journal of International Law & Politics, 33*, 703–768.

British Antarctic Survey, British Antarctic Territory, Royal Geographical Society, & Foreign Commonwealth Office. (2021). *Discovering Antarctica*. https://discoveringantarctica.org.uk/how-is-antarctica-governed/the-antarctic-treaty/making-claims/. Accessed 28 Sept 2021.

Brown, E. D. (1971). Consequences of non-agreement in a new Geneva conference. In L. Alexander (Ed.), *Proceedings of the sixth annual conference of the Law of the sea institute* (pp. 21–24).

Brown, O., & Keating, M. (2015). *Addressing natural resource conflicts working towards more effective resolution of national and sub-national resource disputes*. Chatham House for the Royal Institute of International Affairs.

Buxton, C. R. (2004). Property in outer space: The common heritage of mankind principle vs. the first in time, first in right, rule of property. *Journal of Air Law and Commerce, 69*(4), 689–707.

Churchill, R., & Lowe, V. (1999). *The law of the sea* (3rd ed.). Manchester University Press.

Collis, C. (2017). Territories beyond possession? Antarctica and outer space. *The Polar Journal, 7*(2), 287–302. https://doi.org/10.1080/2154896X.2017.1373912

Davis, M. E., & Lee, R. J. (1999). Twenty years later – The Moon agreement and its legal controversies. *Australian International Law Journal, 6*, 9–22.

De Man, P. (2017). Luxembourg Law on space resources rests on contentious relationship with international. *Framework, 189*, 1–16.

Dembling, P. G., & Arons, D. M. (1967). The evolution of the outer space treaty. *Journal of Air Law and Commerce, 3*(33), 419–456.

Engel, A., & Krof, B. (2005). *Negotiation and mediation techniques for natural resource management*. The Food and Agriculture Organization.

Griffin, N. L. (1981). Americans and the Moon Treaty. *Journal of Air Law and Commerce, 46*(3), 729–763.

Gümplová, P. (2020). Sovereignty over natural resources – A normative reinterpretation. *Global Constitutionalism, 9*(1), 7–37. https://doi.org/10.1017/S2045381719000224

Hobe, S. (2015). Evolution of the principle of permanent Sovereignty over natural resources. In *Permanent sovereignty over natural resources*. Springer.

Jamnjead, M., & Wood, M. (2009). The principle of non-intervention. *Leiden Journal of International Law, 22*(2), 345–381. https://doi.org/10.1017/S0922156509005858

Kerrest, A. (2001). Outer space: Res communis, common heritage or common province of mankind? In *Proceedings of the 10th ECSL summer COURSE on space law and policy*. University of Nice.

Kiss, A. (2017). The common heritage of mankind: Utopia or reality? *Globalization and Common Responsibilities of States, 40*(3), 89–108. https://doi.org/10.4324/9781315254135

Leiden University. (2019). *The Hague International Space Resources Governance Working Group*. https://www.universiteitleiden.nl/en/law/institute-of-public-law/institute-of-air-space-law/the-hague-space-resources-governance-working-group. Accessed 1 Sept 2019.

Lodge, M. (2017). The international seabed authority and deep seabed mining. *UN Chronicle, 54*(2), 44–46. https://doi.org/10.18356/ea0e574d-en

Marquez, P. (2017). *Testimony of Peter Marquez before the Senate subcommittee on space, science and competitiveness*. https://www.commerce.senate.gov/services/files/FA24AE95-91CB-4D6D-A54C-57544B6DAB21

Pardo, A. (1973). The future of the sea. In *Te future of the law of the sea*. Martinus Nijhoff Publishers.

Peras, R. J. J., Pulhin, J. M., Gevaña, D. T., & Inoue, M. (2021). Natural resource base as a foundation of human security. In J. M. Pulhin, M. Inoue, & R. Shaw (Eds.), *Climate change, disaster risks, and human security* (pp. 113–136). Springer. https://doi.org/10.1007/978-981-15-8852-5_6

Rosenfield, S. B. (1981). The Moon Treaty: The United States should not become a party. *Proceedings of the ASIL Annual Meeting, 74*, 162–167. https://doi.org/10.1017/S0272503700005772

Rothwell, D. R. (1990). The Antarctic Treaty System: Resource development, environmental protection or disintegration? *Arctic, 43*(3), 284–291.

Schmidt, N., & Svec, M. (2021). Breaking the deadlock in the space mining debate. *New Space* https://doi.org/10.1089/space.2021.0049

Schrijver, N. (1997). *Sovereignty over natural resources: Balancing rights and duties*. Oxford University Press.

Schrijver, N. (2015). Fifty years permanent sovereignty over natural resources. In *Permanent sovereignty over natural resources*. Springer.

Suzuki, T. (2021). Japan: Legal issues in space business in Japan – Volume 2. *Baker McKenzie*. https://insightplus.bakermckenzie.com/bm/real-estate_1/japan-legal-issues-in-space-business-in-japan-volume-2. Accessed 2 Oct 2021.

Svec, M., Bohacek, P., & Schmidt, N. (2020). Utilization of natural resources in outer space: Social license to operate as an alternative source of both legality and legitimacy. *Oil, Gas & Energy Law*, 1 available at https://.ogel.org/article.asp?key=3872.

Sybesma-Knol, N. (1977). The "common heritage of mankind", ten years later: Developments in the law of the sea. *Studia Diplomatica, 30*(6), 669–692.

The Outer Space Institute. (2020). *Vancouver recommendations on space mining*. http://www.outerspaceinstitute.ca/docs/Vancouver_Recommendations_on_Space_Mining.pdf. Accessed 28 Sept 2021.

Tronchetti, F. (2016). Title IV – Space resource exploration and utilization of the US commercial space launch competitiveness act: A legal and political assessment. *Air and Space Law, 41*(2), 143–156.

United Nations. (2017). International Space Law: United Nations Instruments. UNOOSA, available at https://doi.org/res/oosadoc/data/documents/2017/stspace/stspace61rev_2_0_html/V1605998-ENGLISH.pdf

Viikari, L. (2012). Natural resources of the Moon and legal regulation. In V. Badescu (Ed.), *Moon*. Springer. https://doi.org/10.1007/978-3-642-27969-0

Viñuales, J. E. (2011). The resource curse: A legal perspective. *Global Governance, 17*(2), 197–212.

von der Dunk, F. (2015). *The US space launch competitiveness Act of 2015* (pp. 1–9). JURIST – Academic Commentary.

White, M. V. (1982). The common heritage of mankind: An assessment the common heritage of mankind: An assessment. *Case Western Reserve Journal of International Law, 14*(3), 509–542.

World Bank. (2005). *Where is the wealth of Nations?: Measuring capital for the 21st century*. The World Bank. https://doi.org/10.1596/978-0-8213-6354-6

Zhang, W. L. (2019). Extraterritorial jurisdiction on celestial bodies. *Space Policy, 47*, 148–157. https://doi.org/10.1016/j.spacepol.2018.11.002

Peaceful Use of Lasers in Space: Challenges and Pathways Forward

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1 Introduction

The fast-paced development of breakthrough space technology is complemented by the rise of new and powerful state and non-state actors in the space industry. Meanwhile, the contemporary international space governance framework is challenged to reflect these dynamics and adapt. Further, no single actor is any longer capable of addressing complex issues themselves, especially in space, whether it is the issue of space debris, space exploration and colonisation, or planetary defence. And while a frequently quoted quip from the planetary defence community says that the dinosaurs did not have a space programme, otherwise they would still be here, it needs to be complemented by another oft-quoted claim that technological progress is not being matched by social progress. While we do have a human space programme or rather dozens of rival space programmes, we continue to manage and govern civilisational affairs, including space and technology, in dinosaur ways, according to the seventeenth-century Westphalian order, which pits conflicting geographically limited national interests against each other, as the pivotal global organising principle. We view this as a reason why technology can be a source both of human flourishing and a civilisational demise.

Since powerful new technology is required to advance human flourishing on Earth and human presence in space, it is critical to search for social conditions that mitigate threats originating from misuses of technology. The use of lasers in space, from ground-based or space-based infrastructure, is one of these areas, which carries an enormous potential to advance human flourishing on and off the Earth; however, full development and use of such powerful technology are hindered by its

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dual-use nature, ongoing rivalry and suspicion between countries, and absence of social conditions that would enable the fulfilment of laser technology potential to advance human civilisation. Such conditions need to create an effective and sustainable environment that will (a) mitigate the security concerns surrounding the use of lasers in space or, in other words, prevent its misuse, (b) legitimise the mutually beneficial use of the high-power technology, and (c) practically enable complex international scientific cooperation. These are the governance challenges that were identified at the *2019 Prague Laser SpaceApps Workshop*, which addressed not only the governance of laser use in space but also its scientific and research obstacles.

In this chapter, we first unpack the governance challenges for the peaceful use of lasers in space, in terms of these security, legitimacy, and practical aspects. In the second part of the chapter, we put forward three paths for thinking about how to address these governance challenges for the peaceful use of lasers in space, as a critical stepping stone for enabling their utilisation in a desirable and sustainable manner, in the manner of other large technical systems such as International Nuclear Fusion Research (ITER), European Organization for Nuclear Research (CERN), or even the International Space Station (ISS). The paths are based on, firstly, a networked reality of big science and technical collaboration; secondly, on context-based sources of global legitimacy; and, thirdly, on a multi-stakeholder form of governance.

2 The Potential of Lasers

The case for lasers in space spans across the areas of orbital safety, planetary defence, and space exploration. The 34,000 objects larger than 10 cm, 900,000 objects between 1 and 10 cm, and 128 million objects less than 1 cm in size on Earth's orbit, traveling at the average speed of 28,000 kph (European Space Agency, 2020a), represent a potentially lethal threat to orbiting satellites and, due to the Kessler syndrome, also to much of the 400 billion-dollar space economy. Lasers for manoeuvring and removing the small pieces of debris, a task more difficult for other active debris removal techniques, are in principle available for ground-based photon pressure systems (Esmiller et al., 2014; Grosse et al., 2018; Phipps et al., 2012; Scharring et al., 2016; Soulard et al., 2014) or space-based ablation methods (Schmitz et al., 2015; Vetrisano et al., 2015). However, despite the increased participation of the private sector, space surveillance and tracking sensors and capacities remain mainly in the control of militaries or national security apparatus, limiting collaboration on its development or use. The dual use of lasers as effective anti-satellite weapons (Dobos & Prazak, 2019) further complicates any creation of norms and rules for their use. The lack of an adequate legal framework also puts potential debris removers at risk of being liable for any damage, in the case of incomplete removal. Meanwhile, technical challenges in determining the authorship of the small pieces of debris make it impossible to attribute their emission to the culprits and hold them accountable.

For planetary defence, lasers also carry the potential to deflect dangerous asteroids by photon pressure or laser ablation (Lubin et al., 2016; Zhang et al., 2016, 2019). This can serve as a more powerful alternative to the kinetic impactor technique or to the untested use of a nuclear explosive device, which carries dramatic political, legal, and security consequences (Smetana, 2018). The other planetary defence use of lasers lays in laser-induced breakdown spectroscopy (LIBS) as a tool for remote analysis of the asteroids' internal physical but also chemical composition – a critical step for planning a deflection mission (Choi & Yoh, 2012). The UN-mandated Space Mission Planning Advisory Group recommended, as an expert body, the development of technologies for compositional analysis as well as push deflection methods, such as laser photon pressure of asteroids, in September 2019 and January 2020, respectively (SMPAG, 2020). However, there remain no international mechanisms, protocols, or decision-making bodies to deal with such a planetary threat, which accounts for the 23,000 near-Earth asteroids and 110 near-Earth comets (European Space Agency, 2020b). Yet, neither the 19-member SMPAG nor the 15-member UN Security Council arguably has the needed legitimacy, in terms of effective, inclusive, reliable, or acceptable decision-making in this area.

Space exploration can also be significantly advanced by laser technology. The Curiosity Rover has utilised its ChemCam in coordination with laser ablation to analyse Mars rocks (Wang et al., 2014). Laser-induced breakdown spectroscopy has been explored for long-distance analysis of the physical and chemical properties of celestial bodies by many (Choi & Yoh, 2012; Ferus et al., 2019; Knight et al., 2000). This can provide a critical tool for space resource utilisation, especially if usable from a satellite bus that can not only roam around asteroids but also globally cover the Moon's surface, where we continue to lack complete knowledge of the quality and quantity of the most desired elements in the Moon's regolith, water, metals, helium, or oxygen. The most exciting prospects of laser technology are for interstellar travel with large-scale laser arrays propelling nano crafts at relativistic speeds (Kulkarni et al., 2018; Phipps et al., 2018; Parkin, 2018). Yet, the governance gap preventing the fulfilment of these visions consists of financial, political, and legal barriers. The ambiguity of the Outer Space Treaty (OST) on space resource utilisation, as well as the lack of international consensus on dealing with the legal gap, is a source of investment risk (Švec et al., 2020). And with the unclarity on how to satisfy OST's Article 1 provision requiring the use and exploration of space to be done "for the benefit and in the interest of all countries", the risk of conflict over different legal interpretations persists. Questions persist over what humanity will use the limited Moon resources for (such as valuable water ice) or how it will address issues with deep civilisational impact in regard to deep space exploration. Legal and political gridlocks over space resource utilisation at the United Nations Committee on the Peaceful Uses of Outer Space (UN COPUOS) have resulted in unilateral and disputed interpretations by some and the overall weakening of the normative regime provided by the international space law.

Reacting to these dynamics, a group of state and non-state institutions (Breakthrough Initiatives, Charles University, Czech Ministry of Transport, Czech Academy of Sciences, Institute of International Relations Prague) organised the

Prague Laser SpaceApps Workshop 2019 in the Czech Republic, on 25–27 September 2019 (Institute of Physics of the Czech Academy of Sciences, 2019; McEnchroe, 2019), which resulted in the launching of the peaceful use of lasers in space initiative announced at the Scientific and Technical Subcommittee of the UN COPUOS this year (Delegation of the Czech Republic, 2020) and was further crystallised in the initiative's Declaration endorsed by Nobel laureate Gérard Mourou (*Declaration – Peaceful Use of Lasers in Space* 2020). The initiative aims to build on the 2019 conference, at which an international cohort of top laser and optics scientists from Europe, Russia, the United States, and Australia discussed the main challenges for the development of laser applications for space. The technical part of the workshop was complemented by policy discussions of politicians, government officials, and social and natural scientists on the main policy challenges in establishing an international body for the development and use of lasers in space. The policy part of the workshop concluded by outlining *security, legitimacy, and practical aspects* of governance challenges for establishing a peaceful use of lasers in space (Boháček, 2019). Firstly, we focus on the security aspects of laser use in space, concerning their dual-use nature, the establishment of a security regime, and the role of international institutions. Secondly, we explore legitimacy as a critical precondition of the sustainability of any governance, focusing on its prospects on the global level. Thirdly, we point out various practical challenges to international scientific cooperation as the enabler of the development of high-power laser technology for space.

3 Security Aspects

Many security aspects can complicate or even hinder the emergence of any type of governance regime for the peaceful use of lasers in space, whether in terms of a regulatory, legal, or security framework; however, we select three aspects that we view as the most important causes and results of its security conundrum: (a) the dual-use nature of the described laser applications; (b) an increasingly complex, multipolar, and diverse space environment characterised by space militarisation, proliferation, and innovation of space technologies and the growth of new state and non-state actors; and (c) the underlying principles of the contemporary international space regime.

3.1 Dual Use of Lasers and Their Securitisation

While many technologies can be described as dual use, they still permit some degree of civilian international scientific collaboration; however, the laser applications we discuss are different in that they can be directly usable for military means. Space debris manoeuvring technology has the potential to redirect pieces of debris to

damage or destroy satellites (Dobos & Prazak, 2019). The laser itself can also be used to blind, disrupt, and permanently or momentarily damage various sensors and instruments of satellites (Defense Intelligence Agency, 2019). This goes for both ground-based and space-based laser methods. In terms of remote, laser-induced breakdown spectroscopy, the process of ablating material with a high-energy laser also carries a military use for damaging instruments. Lastly, the use of a 200-gigawatt phased laser array of millions of lasers can not only be used to deflect dangerous asteroids or propel nanoprobes at relativistic speeds but also be easily misused. It is not necessarily that the phased array would be used directly to damage a satellite, since the convergence of the millions of single beams onto the target will be already itself a challenge, rendering the system essentially non-manoeuvrable, but the consequences of altering the trajectory of any space object could have that function. To say the least, there is plenty of direct and indirect utilisation of laser technology in the three areas we discuss for our other-than-peaceful purposes. China, Russia, France, and the United States have been frequently mentioned in media as actors either already possessing or developing both ground-based and space-based lasers with the capability to damage and disrupt space operations. Uncontrolled proliferation of dual-use laser space technologies in space, as well as on-ground without any regulatory, legal, and security governance regime, is not a desirable situation. This is especially valid if we consider the utility of laser technologies for space debris mitigation, space exploration, and planetary defence. Further, the absence of any regulations is undesirable in the current congested and contested environment in which space activity, technologies, and the number of state and non-state power interests rapidly increase.

However, security and security policy are social acts that emerge in context-dependent social environments by subjective human beings. Critical security studies, a branch of international relations theory, points out that security is always context-dependent and socially constructed by its processes, practices, and the actors involved (Booth, 2008; Buzan et al., 1998). These processes, practices, and actors remain reserved to nation-states, whether internationally, where the nation-state remains the ultimate political decision-making unit, or domestically, where areas from space to other niche technologies fall into sensitive security matters. In this sense, national interests, especially in security-sensitive areas, remain always conflicting and in the multipolar world impossible to coordinate. Any rare moment of wider alignment of different security interests, for example, in the case of a shared threat, is unlikely sustainable, as it originates from temporary time-specific needs rather than shared perception and security. This is a problem not only of security but also of science, which also falls subject to the social environment in which it emerges (Jasanoff, 2004).

3.2 More Actors, More Problems

The contemporary international dynamic, specifically its high number of capable state and non-state space actors, is in itself a significant complication to the emergence of a regime for the peaceful use of lasers in space. In the past, arms control treaties and security regimes including the space domain have successfully regulated, for many years, various weapons systems, both for normative and pragmatic reasons. Next to normativity in terms of nuclear disarmament and conflict avoidance, an important component of negotiating these treaties has always been the pragmatic strategic arguments for their emergence, whether it was lowering the spiralling costs of arms races or the strategic utility of creating a predictable and stable regime for rivalry (Wallander, 2013). And while the normative aspects, especially the cosmopolitan nature of the Outer Space Treaty, maintain their strength and appeal, the pragmatic reasons, which led the two global superpowers to adhere to such a regime with the purpose of blocking the other side from dominating space, are disappearing in the contemporary multipolar world. This is demonstrated in the ongoing disentanglement of various arms control pacts from the Iran nuclear deal, the Intermediate-Range Nuclear Forces Treaty, and the Treaty on Open Skies. Overall, they point to a more general turn away from arms control regimes as established norms of behaviour, towards grand power competition and growing reliance on deterrence as a preferred instrument of security policy (Halas, 2020). The current multipolar world is arguably less stable than the previous bipolar and unipolar constellations during and after the Cold War, respectively, in which agreement emerged on arms control pacts as well as the Outer Space Treaty, as a result of both normative and pragmatic interests.

Not only do more actors have more space capabilities, but the rate of innovation also generates new groundbreaking technologies, which not only have the potential to change the balance of power but also require governance. The combination of innovation, technology proliferation, and the growing number of actors obfuscate the alignment of interests and finding of consensus over management and problem-solving in many areas of space activity. Overall, multipolarity is making an alignment of the variety of strong national interests, and thus effective governance, overly complicated, and one can say even impossible in national security matters. We see the root of the issue in the frequent observation that the proliferation and evolution of technology have outpaced the evolution in global governance and management. The multilateral international institutions, which could deliver some sort of effective space governance during bipolarity, by meeting pragmatic and normative motivations, prove less effective, to say the least. The result is either their abandonment or growing attempts to influence them without a strong enough pushback.

In this regard, China's influence in many organisations, from the World Health Organization to the World Trade Organization, has risen significantly, with the United Nations' Office for Outer Space Affairs being used as a key platform for Beijing to frame its project of the Chinese space station and the International Lunar Research Station as open international collaborations in the interests of humankind.

Despite this, Chinese senior space officers have described space as the next South China Sea (Davis, 2018), with the Moon and Mars being like the disputed Japanese and Philippine islands that China must conquer as a duty to their predecessors, called for China to be the world-leading space power (Mai, 2017), and adhered to the first-come-first-served approach to the Moon (Whitehouse, 2002). On the other hand, the Trump administration abandoned multilateralism, substituted by the bilateralisation of international space activities through the Artemis Accords. The controversial Artemis Accords[1] are put forward as a tool of national power with which the United States plans to condition cooperation with their partners on the Moon. Further, the criticised intentional overwhelming of the International Telecommunication Union (ITU) with mega-constellation applications, which were already approved by the US Federal Communications Commission, also carries a risk of setting a precedent in circumventing international authority in space (Henry, 2019). In both cases, the weak global governance framework in space is either used as a lever by one actor, China, or enables the technologically more advanced actor, the United States, to deviate from the norms without fear of punishment. While taking different approaches to reach their goals (circumventing international organisations vs. using them to their advantage), they both apparently prioritise the *first-come-first-served* basis in Moon exploration, despite it contradicting the norms of international space governance, as epitomised by the Outer Space Treaty.

3.3 National Outlook in International Institutions

Despite the above-mentioned challenges, international organisations (IOs) are put into positions to deal with them and coordinate rival national interests. An important issue is that they lack effective authority to successfully address and solve issues. Global governance scholar Michael Zurn describes IOs' authority as either politically assigned or epistemic, originating from acknowledged expertise (Zürn, 2018); however, we argue that both sources of IOs' authority fall subject to the dominating national outlooks. The political authority of international organisations remains reflexive, meaning that it is based on demands rather than orders, as they depend on the power granted to them by nation-states, the ultimate political units. Meanwhile, epistemic authority is increasingly politically assigned but can also be removed when the epistemic authority of IOs ceases to align with the interests of the nation-states, including even their original architects, as shown by the United States' long-term approach to blocking the appellate body of the World Trade Organization, effectively paralyzing it. National outlook dominance also affects epistemic authority. Similar to the construction of security perceptions, also science remains

[1] We consider Artemis Accords as controversial due to their criticised approach in calling for a one-sided establishment of security zones on the *first-come-first-served* basis and enabling space resource utilisation without international consensus on its compliance with the OST's common benefit clause, as described in the Treaty's Article 1 as well as its non-appropriation principle.

subjective and depends on the social contexts and value frameworks in which it emerges and is employed, a complex phenomenon pivotal to the sociology of scientific studies (Rychnovská et al., 2017).

As a result, shared global security threats are not perceived outside of the national outlook, to do not only with space but also climate change and the ongoing pandemic. Speaking of climate change, an example of the irreconcilability of national interests even in the face of a global challenge is the use of the Common but Differentiated Responsibilities (CBDR) principle of the United Nations Framework Convention on Climate Change (UNFCCC) to delay emission cut-offs by some countries (Burke & Fishel, 2020) or the continuing gridlock over the Paris Agreement's Article 6 mechanisms (Michaelowa et al., 2019), which ended the COP25 negotiations last year without any agreement on processes of the Agreement's fulfilment. We see completely opposing national interest clash between those of low-lying island nations that see climate change and resulting sea-level rise as an existential threat, those of industrialised countries as fossil-dependent historical emitters responsible for the state of the climate now, and those of developing nations not wanting to relinquish their right to development. Looking at the ongoing pandemic, global health governance has seen a similar stalemate. The 2003 SARS-CoV epidemic did see nation-states accept the epistemic authority of the World Health Organization and even an enlargement of its competencies (Maffettone & Ulaş, 2019); however, since then, the increased multipolar complexity and growth of new geopolitical players have increased the difficulty of finding international consensus beyond the current authority of international organisations. The 2019 SARS-CoV-2 epidemic saw an opposite trend, with nation-states acting in defiance of international authorities to blatantly protect their own interests.

To sum up the security aspects, the dual-use nature of laser use in space makes this issue particularly affected by national security perspectives. While in the past bipolar and unipolar systems it was the pragmatic and normative reasons motivated the creation of security regimes or even arms control treaties, the contemporary multipolarity highlighted by the proliferation of space technologies among many state and non-state actors is making existing international organisations weak and ill-fitted. Without functioning global governance, the national outlook further exacerbates the governance issues and in general creates feeble conditions for the peaceful use of lasers in space. Such an environment not only risks the misuse of laser technology, which has been, for example, pointed out by the US Defense Intelligence Agency (Defense Intelligence Agency, 2019), but in its current state is also unlikely to produce an alignment enabling them to advance human flourishing.

4 Legitimacy Aspects

For a governance framework, be it in space or on the ground, to be functional and deal with the described security sensitivities, all actors need to comply with its rules and decisions. Rule acceptance is pivotal for the overall sustainability of

governance; however, imagining any type of rule or authority acceptance is difficult, not only on the global level but also in the quickly changing, increasingly complex, and informationally flooded environment of modern society.

4.1 Understanding Legitimacy

According to the literature, acceptance of authority or rules can originate from *compliance* as well as *legitimacy*. The former includes two more specific motivations for rule acceptance – namely, coercion and self-interest (Hurd, 1999; Kratochwil, 1984; Wendt, 1999). Both signal that, first, the given rule (norm) lacks a claim to normative validity (i.e. that we *ought to* abide by it) and, second, that despite following the norm, the agent fails to internalise it. Both are context-dependent and defined by, respectively, fear of punishment and cost-benefit analysis on the part of the (individual or collective) actors. However, coercing highly capable space laser actors into compliance with rules and governance principles can work only insofar as a quick and easily executable form of punishment for breaking rules is available. This would require in the first step the concrete definition of rules and in the second step adequate monitoring of noncompliant behaviour, which in some areas might be relatively simple – such as in cases of low transparency of actions, insufficient information-sharing, or overt misuse for military purposes. In other areas such as covert weaponisation; targeted corruption, of shared scientific knowledge; or simple freeriding, monitoring of noncompliance would be more difficult. Additionally, the effectiveness of coercion varies with changes in the level of technology, power, or resources among different actors and over time. The fluidity of geopolitical, technological, economic, and societal circumstances changes not only the effectiveness of coercion but also the cost-benefit analyses of each actor, constantly shifting the levels of rule acceptance. Rule acceptance in the form of mere compliance, instead of internalisation or acceptance of the validity of norms, is thus difficult to maintain for a sustainable, long-term governance regime. Therefore, *legitimacy*, as another form of rule and authority acceptance, plays a pivotal role in the peaceful use of lasers in space.

Legitimacy requires binding norms and established social structures that allow for validity claims to be accepted or rejected. It can be approached from either the *empirical* (sociological) or *normative* perspectives. The former approach takes legitimacy judgments as facts of social reality. It is not concerned with principles, procedures, processes, and rules that need to be observed in order for the claim to authority to be sanctioned: What matters is whether the claim has been accepted as such by the involved actors. Legitimacy is thus restricted to actors' beliefs as social facts (Weber, 1978). It lies at the intersection of individual experiences; structural influences of different sociocultural, historical, and belief systems (Šubrt, 2019); the personal charisma of legitimation leaders (Finnemore & Sikkink, 1998); the correspondence between the deployed narratives (Habermas, 1996); and the internal worldview of individuals. By all accounts, the sociological view of legitimacy

would point to the nation-state as the currently dominant social and political structure within which legitimacy claims are (expected to be) raised.

To the contrary, the normative view judges the authority's claim of legitimacy by procedural criteria or certain values and principles. This can take the form of rule of law, human rights, and basic civil liberties, as constitutional principles, or values associated with democratic participation, such as the freedom to influence the laws to which one is subject. An authority that satisfies these criteria is granted a degree of legitimacy, which allows it to demand rule acceptance. Worth noting at this point is that normative legitimacy allows us to move beyond the confines of the territorial nation-state and the practices of the traditional international order, because the scope of the authority – or the rules to be accepted and followed – is not fixed in advance. While the empirical (sociological) perspective is much more descriptive, in the sense that it merely focuses on whether an institution is or is not believed to be legitimate, the normative perspective is much more engaged in the reasons according to which an institution is being viewed as legitimate.

We continue here with the unpacking of the normative view of legitimacy. The scholarship of political philosophy traditionally divided normative legitimacy based on its sources. The distinction of legitimacy is between output and input legitimacy, meaning between legitimacy originating from the institution's ability to effectively solve issues and legitimacy originating from the institution's ability to reflect the demands of its citizens or subjects (Scharpf, 1999; Steffek, 2015).

4.2 Legitimacy Trade-Offs Between Effectivity and Inclusivity

The division between output and input legitimacy, or between legitimacy derived from its effectiveness and legitimacy derived from its responsiveness to its subjects, reflects the well-explored democratic dilemma between effectivity and inclusivity (Dahl, 1994). We are reminded of the trade-off between the effectivity of decision-making and its inclusiveness even more as society grows in complexity. Citizen participation remains a critical component to ensure an authority or institution acts in citizens' interests, is not misused, or does not slide into an authoritarian or technocratic system. Human subjectivity prevents actors from truly deciding on behalf of others, as even good intentions are not a source of legitimacy. The only credible measure of citizens' interests is they themselves. The dilemma arises from the growing complexity of the world. Every person cannot be an expert on every topic. This leads us to the situation when people themselves can be the only true voice of their own preferences; however, that does not mean they possess the resources, knowledge, and ability to decide in their best interest.

In the case of peaceful use of lasers in space, it is hardly imaginable to open the decision-making over development, maintenance, or use of such powerful and complex technology in critical and time-sensitive situations to all those whose interests will be affected by it and thus who should have a say in it. The long-running debate over who should be involved in inclusive democratic decision-making, whether all

those affected by a decision or only those legally subjected to a new decision, gains granularity in the area of technical and transnational topics. However, given the security sensitivity of the dual-use nature in the context of growing congestion and rivalry between various space state actors, the absence of any inclusiveness or citizen participation carries significant risks of hegemonic hijacking. Furthermore, this issue multiplies as we move from the national to the global level of governance.

4.3 Absence on the Global Level

International organisations are often viewed as legitimate institutions for dealing with transnational issues (Dellmuth & Tallberg, 2011; Ecker-Ehrhardt, 2012); however, we argue that the existing international space governance regime is not sufficiently legitimate, since it lacks effectivity in problem-solving as well as inclusivity. The first apparent lack of legitimacy in international organisations originates from their severe democratic deficits. IOs possess no meaningful democratic quality in terms of citizen participation (Archibugi, 2004; Marchetti, 2008). IOs remain separated from direct interaction with those they govern, people around the world, and thus unable to be truly responsive to their needs. There are no globally democratic institutions (e.g. a United Nations Parliamentary Assembly), or any direct citizen participation with IOs, and arguably no social prerequisites enabling the functioning of democratic principles, which are understood by some as shared values, shared identity, and shared culture.

This leads some authors to argue for emphasising output legitimacy, or legitimacy originating from effective problem-solving, over inclusivity on the transnational level (Scharpf, 1999), while others argue for decoupling transnational legitimacy from democratic participation (Sadurski, 2015). However, we view the absence of democratic participation to be one of the reasons for the faltering support of IOs, which have seen a sharp drop especially among populations negatively affected by globalisation (Bearce & Scott, 2019). The trade-offs between legitimacy generated by effectivity and legitimacy generated by inclusivity are already difficult in the complex modern world. At the global level, having a legitimate governance regime can thus seem nearly impossible, if we think in terms of the current international Westphalian world order, where only states are ultimate sources of effective problem-solving, but remain unable to act in global interests, due to their allegiance to territorial interests and constituencies. Without accepting a globally inclusive democratic decision-making process as the only solution for sufficient global input legitimacy, which is an unlikely scenario, we can instead consider the concept of a responsible cosmopolitan state.

While imperfect from the perspective of full global input legitimacy, states can reflect this normative principle and take into consideration the interest of people living in other countries. The limits of this concept are best described by Anthony Burke and his concept of a good state from a cosmic perspective, in which he recognises that while nation-states as political units ultimately defined by protecting

national interests cannot ever be purely good in themselves, they can be good actors (Burke, 2013).

5 Practical Aspects

While the previous two aspects (security and legitimacy) focused more on a governance framework enabling use, we now turn to the issue of international scientific collaboration as a prerequisite for the development of high-power laser technology for space applications outlined above. For laser use in space, this means a variety of barriers. The mentioned uses can be achieved by photon pressure or laser ablation, featured in general continuous wave or pulsed lasers, respectively. The system can be space-based or ground-based, creating a completely different set of requirements and technical challenges on beam combination, propagation, and optics. Further, support systems themselves dealing with energy production, storage, and transportation, or heat extraction, transfer, and cooling, represent other separated pools of knowledge and necessary scientific problem-solving (Boháček, 2019). However, the actual technological bottlenecks and barriers in need of research breakthroughs are shaped by the concrete practices of the scientific collaborative endeavours, which are not free of power interests.

5.1 Knowledge Is Power

Inquiry in the natural sciences based on positivist methodology with replicable empirical results cannot be viewed as objectively producing undeniable truths about the world. Knowledge can hardly be viewed as objective and value-free. Science is rather context-dependent and affected by power relations, with knowledge being power itself, in Michel Foucault's sense. From an organisational point of view, the environment, consisting of processes, rules, procedures, communication, and individual and institutional roles, affects knowledge production (Kessler & Guillaume, 2012). Science itself has many described misuses. This can include the politicisation of science, in which political objectives are repurposed as rational scientific arguments (Jasanoff, 1990; Li, 2007; Rychnovská et al., 2017). Science is in this sense used as a legitimisation tool for particular political interests, as unchallengeable facts delivering a general good (as known from the evidence-based policy approach). This can include regular political actors, who want to ensure that their home industry and constituents have a greater share of public funds and thus reframe the political discussion as a technical discussion, which is plagued by scientific eclecticism catering to their political goals.

The first question arising is who owns this relevant knowledge and how is it distributed from its point of generation. What type of information, at what point in the process, and in what format it is shared matter greatly. Information-sharing thus

determines not only the project's efficiency but also the distribution of power. What belongs in this topic is the question of not only who has access to this relevant knowledge but also who has the means to utilise it. For more capable actors, the knowledge gained can be utilised for commercialisation or new spin-off technologies, while others less developed would not benefit from it. However, commercialisation can be at odds with collaboration, information-sharing, and open access to the knowledge and data this collaborative initiative is set on. This question is similar to that of whether the sharing of data from space resource exploration can be considered as fulfilling the OST's *common benefit clause* (ensuring the benefit and interest of all countries) if many states do not have the means or capabilities to utilise them, while such data could have high commercial value for others. Therefore, ensuring that the knowledge is not only available but also equally beneficial to all involved actors is also critical. This issue is dealt with by ensuring technology and knowledge transfer as a key focus of the CERN (Nilsen & Anelli, 2016), while the United Nations Office of Outer Space Affairs capacity-building programmes ensure developing nations benefit from space (García Yárnoz et al., 2019).

5.2 Splitting Costs and Labour

International scientific cooperation enables such complex research projects thanks to not only the pooling of human resources but also the sharing of costs. Finances concern contributions by individual actors, the use of organisation's resources, their control, as well as different financial models of the organisation. However, the question of who and how much pays is a contentious one. The actor who pays a substantial part of the funds can claim a larger share in decision-making, essentially buying his way into power. Similarly, actors with greater capabilities can not only engage their value-added capacities but also benefit from generating more valuable knowledge. Weak actors can thus be destined to simple labour, generating less relevant knowledge and benefits, significantly affecting the benefits gained from participation in the form of expertise or resources. Actors are logically keen to participate in the development of high-tech elements and sensitive parts of the infrastructure, either to have more access to the valuable created knowledge or because such added value tasks have higher remuneration. But a mechanism that divides labour based on members' existing capabilities would favour stronger players. Meanwhile, should all the knowledge produced be made fully free, cheap, and easy tasks could be more attractive, generating the problem of freeriding in an environment where everyone gets everything no matter their contribution.

Further, competition as a driver is an important element of innovation. In that regard, we can think of the involvement of commercial actors as a source of an innovative drive and more resources with the motivation of profit. Yet, competition can stand at odds with collaboration and commercialisation at odds with generating a global public good, in terms of debris removal, planetary defence, or space exploration. While competition drives innovation, collaboration enables it. The middle

Table 1 A summary of the main characteristics of the three aspects

Security aspects	Legitimacy aspects	Practical aspects
The dual-use nature of lasers stigmatises their use as dangerous weapons, limiting their development and deployment for peaceful uses	Legitimacy, not compliance, to ensure sustainability and acceptance of governance regime	The sharing of knowledge and information defines the power and utility of research
The growth of actors increases the collective action problem of international organisations	Complicated legitimacy trade-offs in governance between effectivity and inclusivity	Division of costs and labour subject to freeriding or power grabs
States remain the only source of authority and effectivity, but they remain blocked by their allegiance to territorially defined and thus mutually rival interests	Global governance is characterised by weak legitimacy derived from low effectivity of problem-solving and low inclusivity in global decision-making	Competition can be at odds with collaboration

ground can be seen in the example of the CERN, where different research teams compete in finding the best solutions in the grand collaborative project (Robinson, 2019) (Table 1).

6 Pathways for Global Scientific Governance

It is apparent that the governance challenges for the peaceful use of lasers in space align with the overall contemporary problem of global governance of geographically ignorant issues in a territorially divided political and social world. We believe that space and scientific collaboration, however, has the unique ability to offer us different perspectives that extend beyond territoriality.

As a guiding approach for the paths we put forward, we begin with the meta-coordination view of legitimacy by Alan Buchanan (2013). While this view is principally concerned with legitimacy, we see it as fit for framing the following paragraphs. Instead of discussing the validity of different legitimising criteria, meta-coordination focuses on the way legitimacy criteria are defined through a meta-coordination process. In the process, an agreement is reached over what standards an institution must meet in order to be awarded the social respect needed to impose its authority and ultimately its rules. However, the meta-coordination process is for the subjected actors to partake in, not for normative deliberations or claims, and thus legitimacy, or the criteria upon which it is awarded, is much more a question of the sociological descriptive approach. The outcomes of the meta-coordination process cannot be of a prescriptive/normative nature, as no social scientist can dictate what the outcome ought to be. However, where the normative prescriptive approach to legitimacy can enter is in helping to define the "social practices of assessing legitimacy" (Buchanan, 2013, p. 130). Therefore, our role here is only to put forward

three pathways to enable the meta-coordination process over the governance regime for the peaceful use of lasers in space.

The first path builds on using big science collaboration to create a networked reality as an environment that implicitly changes structural state-centric principles that are described as the barrier to the emergence of a security regime for the peaceful use of lasers in space. The second path points out the context-based way to deal with inherent legitimacy trade-offs between effectivity and inclusivity in global and technically complex areas, such as the use of lasers in space. Lastly, we paint multi-stakeholderism as an approach that embraces the multipolarity of contemporary society and enables distinct self-interests as drivers of an autonomous, adaptive, and decentralised form of governance.

6.1 Networked Reality

In the following part, we intend to address some of the security challenges, specifically the dominance of national sovereignty, national security perceptions, and great power rivalries using the perspective of critical security studies and science and technology studies. Firstly, critical security studies (CSS) recognise the social construction of security threats, which are formed by the involved actors through securitisation processes. The Copenhagen School of CSS views this as the reason why security in a world made of nation-states, and thus national security interests, processes, and perceptions as the dominating social factors in the securitisation process, always leads to rival security perceptions, leaving security to be essentially contested (Buzan, 2008, p. 7). The Welsh School of CSS views the social world in which security is constructed as not being fixed, leaving open the scenario in which security threats can be constructed by processes, actors, and the environment beyond nation-states, security that is contested only contingently (Booth, 2008, p. 100). Therefore, since we recognise that the national outlook shapes security, science, and global governance, through national processes, contexts, actors, and environments, we also ought to recognise the possibility of changing this social reality in order to construct security, science, and global governance in a way that is not inherently conflicting and is at least somewhat mutually compatible. An agreement on the physical characteristics of laser technology and its application can provide a stepping stone for reaching an understanding of the characteristics of the social world.

While security policy remains exclusively in the hands of governments, science and technology can be in comparison viewed as much more open. Completely separating science from social reality is however unrealistic. Numerous authors have scrutinised the process of producing hard scientific assumptions and uncovered many influences on seemingly objective scientific methods (Jasanoff, 2004; Latour, 2018). However, the globalised nature of science and technology has been argued to bring some changes in processes and practices, with an impact on its politics, especially in the multi-stakeholder way in which technology forces different actors into a single space. The Global Governance of Large Technical Systems, such as the

CERN, ITRE, or ISS, has been described as creating a networked reality that, as a by-product, creates a new social reality outside of the traditional national social environments (Mayer & Acuto, 2015). This challenges otherwise automatic guiding principles, such as sovereignty and national interests, in their role as the main features of governance and politics. It is our view that the networked reality in dual-use areas, such as high-power laser use in space, can change the social context and thus reframe security from essentially contested to contingently contested. The focus on practical aspects of scientific and technical cooperation, which requires an agreement on their basic characteristics, can unlock the potential for an agreement on some basic characteristics of social cooperation as well. Further, big science collaborations, such as the CERN, ITRE, or ISS, are described by large technical systems scholar Mark Robinson as helping to break the gridlock between nations. Robinson outlines several specific paths, including the capability of shifting major power interests, empowering technical groups as the sources of legitimate authority despite dominating national interests, enabling innovative leadership and funding, and making international organisations adaptive and autonomous (Robinson, 2020). While the epistemic authority of international organisations can be subject to political influence, as we argued above, here the epistemic authority is coming directly from the technicians, scientists, and ongoing inclusive collaboration based on their produced knowledge and effectivity of their work, rather than by the mere assignment of epistemic authority.

6.2 Context-Dependent Legitimacy

Legitimacy as a result of the acceptance of the authority based on its problem-solving and participation usually carries the required trade-off between effectivity and inclusivity. Yet, in terms of security aspects, the two can be mutually beneficial and, rather than trade-offs, be considered trade-ins. Shared processes and the networked reality that enable an approximation of security perceptions, consensus, and problem-solving are both a measure of effectivity, since they enable action, but also of inclusivity, as they enable more participation. Similarly, more participants increase the diversity of opinions and increase the effectivity of problem-solving, based on the Diversity Trumps Ability Theorem (Hong & Page, 2004). To address the trade-offs, we look to the context-based approach, as proposed by international theory scholars Pietro Maffettone and Luke Ulaş (Maffettone & Ulaş, 2019). They consider the degree of interest in the topic (motivational landscape) as one of the critical factors for assessing the suitable legitimacy trade-offs between effectivity and inclusivity. Leaving the degree of inclusivity up to the motivation of actors to be involved in the decision-making also can provide a useful fix. Maffettone and Ulaş argue that by leaving decision-making of sophisticated topics open to participation, those with real interests in the topic will also be accompanied by an increased knowledge of the issue, which will prevent the lowering of the epistemic quality of the inclusive deliberative process.

However, technically complex issues remain to be faced with a trade-off between more exclusive but more expert decision-making, limited to a qualified epistemic community, and an open, diverse group of actors who can potentially improve their problem-solving but likely increase the coordination costs. Abandoning effectivity for inclusivity, however, can prove damaging to both. To address the trade-offs, we take the context-based approach. To further contextualise the question of legitimacy for our case, we make an important distinction between the peaceful development and deployment of lasers in space. While the development phase is likely to carry fewer risks of misuse or hijacking by a powerful actor, the later deployment of the powerful technology does possess these dangers. Further, the development phase is much more epistemically sophisticated and complex, requiring a high degree of qualified epistemic decision-making that cannot be widely open to the participation of anyone, unlike the mere simple case of the deployment of lasers for debris, space exploration, or planetary defence. The development phase as a scientific collaboration also carries greater promise of creating a networked reality beyond the automatic principles of national sovereignty that the deployment phase can in its later phase build upon. Therefore, dividing the governance issues between development and deployment gives us two different phases with different legitimacy needs. The development phase allows for lower inclusivity, due to its technical complexity and lower risk of misuse. The deployment phase, with less epistemic demands, allows for great inclusivity, which is also required due to the risk of malicious deployment.

6.3 Multi-stakeholder Approach

The multi-stakeholder approach responds to security, legitimacy, and practical issues we pointed out. Firstly, it tries to address the growing multipolarity, not only in terms of the more state but also of more non-state actors, and the growing complexity of transnational issues, which are not being effectively addressed by the existing international institutions – the multi-stakeholder type of governance, in which a variety of actors voluntarily come together to address issues jointly and with mechanisms beyond traditional concepts of power and in a networked self-governing manner (Stoker, 2018). Multi-stakeholderism on the global level fills the governance gap, which has traditionally been filled by national governments on the domestic level (Dryzek, 2002). Further, no single actor or international organisation has the resources, knowledge, or means in one place to solve complex issues. Even if that was the case, a single hegemonic actor cannot by default be perceived as legitimate and thus as a sustainable and stable form of authority. In this regard, a responsible cosmopolitan state would not aspire to develop, deploy, and operate a powerful laser for whatever purposes civilian orbital infrastructure require, e.g. removing orbital debris, exactly because, as a single actor, it cannot assure the rest of the international community of its civilian intentions and thus would risk other states adopting the same narrative to justify their nefarious use of such a system. Therefore, a responsible cosmopolitan state would aspire for there to be a

distributed networked multi-stakeholder governance model, because as such it can distribute the input legitimacy between scientific and technological entities and output legitimacy between other IO member states.

Moreover, the multi-stakeholder approach, although arguably increasing coordination costs, can provide benefits based on the Diversity Trumps Ability Theorem. A strong epistemic case has been made to show that when diversity increases within a group of actors, so does their problem-solving capability (Hong & Page, 2004). This also follows the two ideas that competition drives innovation while collaboration enables it.

More specifically in our case, multi-stakeholderism can bring together a variety of actors of different interests, commercial, non-profit, national, or philanthropic. This can serve the utility of providing innovative leadership and innovative funding and enable global governance to be autonomous and adaptive, which fall within three paths that big science collaborations enable to move beyond gridlock by Mark Robinson (Robinson, 2020). Specifically, commercial private actors can be very effective, innovative, and strongly motivated actors, whose selfish interests represent the motor of their effectivity. They also represent their limitation. Meanwhile, national pride and excellence provide a large-scale systemic force that can enable political, economic, and societal opportunities and possible moves, which are unavailable to other actors. Yet, the territorially limited national perspectives and national interests represent a clear boundary of national state actors. The same applies to private philanthropic endeavours, with noble motives but undeniable influences by greatly empowered individuals and their intentions. In the same way, they can serve as checks and balances between the different actors, enhancing their positive contributions and keeping under control the undesired ones. All of this needs to be triggered by a respectful authority capable of funding at least the beginning of the endeavour. Breakthrough Initiatives have invested significant resources into developing the Starshot system for relativistic space travel. But they cannot themselves build multi-stakeholder governance until national states decide to join in. Therefore, the responsible cosmopolitan state is the one that distributes power and responsibilities in the multi-stakeholder governance model. Here, we would like to recall the cyberspace governance model that is kept mainly in the hands of various non-state actors. Authoritative states can control certain parts of the network but mainly the content or routing on the DNS level; however, the architecture itself is beyond their power, proving its resilience for its civilian purpose.

While the mentioned individual motives of these different actors do shape and define the steps and moves actors take, they can also be directed and formed by their environment, specifically by the organisational setups. In this regard, Oliver Kessler and Xavier Guillaume make three observations on individuals' behaviour in international organisations (Kessler & Guillaume, 2012). Firstly, individual actors influence the processes mainly based on their organisational roles. If we enhance this further in sociological terms, the way social roles are played is a mixed product of

their individualism as well as the societal definition and expectation for that role.[2] Should we define their roles, we can make better use of their positive qualities, by putting them into an organisational framework that enables that. Secondly, while individual and societal influences have some impact on knowledge production, it is much more defined by the moves available to actors and the organisation that shapes the results. And thirdly, organisations, as well as individuals, tend to legitimise their own existence and produce knowledge that enhances their relevance (Kessler & Guillaume, 2012). Therefore, bringing in the variety of impactful and relevant actors, as a way to make new moves available for them, can provide benefits in terms of mixing in their influences, enabling a diverse combination of influencing moves, and making the networked environment more adaptive and autonomous.

Having actors live up to their own roles, which are mutually constrained, can provide a solution also to the practical challenges of financing, in two ways. Firstly, in-kind contributions defined by the participants have proven to be the most effective and functional way to finance large technical systems (Robinson, 2019). The European Space Agency (ESA) *georeturn* policy functions similarly, ensuring that around 90% of member states' contributions to the ESA budget is returned in contracts to its industrial or research subjects. Private actors can be motivated to contribute by the promise of commercialising various spin-offs from the research. Further, since many of the uses of laser technology are not marketable, as they provide non-financial public goods (debris removal, planetary defence), they can be commodified in the manner of the carbon emission market, to make them commercially attractive. The "space debris emission market" would be another source of income that would build upon the general self-interests of commercial actors.

7 Conclusion

The prospects of laser technology in space are evenly matched with the threat of their misuse. They can help us ensure safety in the Earth's orbit and lead to a proliferation of hard-to-detect satellite-blinding and damaging weapons. They can help us expand our presence onto the Moon or other celestial bodies and enable a single commercial or state actor to be empowered by game-changing weaponry, to seek their commercial or hegemonic goals. They can protect the Earth from regional, continental, or planetary destruction brought by an asteroid strike and lead us into an illegitimate authoritarian world state, if such technology is controlled by one. The use of lasers in space carries the enormous technological potential to advance human flourishing in space, but also on Earth. Yet, technological progress is

[2] Whether social roles are more affected and shaped by individuals and their subjective actions or society and its objective structure reflects the central dilemma of sociological theory between individualism and holism. Attempts to bridge conceptualisations of social roles between the two traditions are criticised for downplaying individual uniqueness as well as structural influences. For an innovative attempt to combine both perspectives in a non-exclusionary way, see Šubrt (2019).

Table 2 Three paths towards the meta-coordination process to enable peaceful use of lasers in space

Networked reality of scientific collaboration	Context-based legitimacy	Multi-stakeholder approach
Yields closer shared security perceptions by shared social reality	Trade-ins between effectivity and inclusivity, in terms of shared perceptions, inclusiveness by motivation, and diverse participation increasing effectivity	Embraces multipolarity and complexity
Moving beyond the automatic guiding principles of international cooperation based on national interests	Distinct legitimacy trade-offs between deployment and development phases	Empowers self-motivation of actors to mutually balance themselves (finance, division of labour)
Empowering technical groups as effective and legitimate sources of authority	Effectivity is prioritised in development, due to its scientific nature and lower risk of misuse	Innovative leadership provided by decentralised, autonomous, and adaptive multi-stakeholder structure
	Inclusivity in deployment, due to the risk of misuse and less complex decision-making	Innovative funding by the commodification of public goods, in-kind contributions

unmatched by social progress, leaving us with contemporary governance models that make powerful technology risky. Looking through the security, legitimacy, and practical challenges to building a sustainable governance framework to fulfil the potential of laser use in space, we put forward three paths to enable the meta-coordination process over the governance regime for the peaceful use of lasers in space, as summarised in Table 2.

The networked reality emerges out of the practicalities of scientific collaboration; its shared processes and technicalities serve as the first step towards moving beyond the traditional guiding principles of international cooperation in terms of national sovereignty and interests, which are heightened in the case of the dual-use and sensitive laser technology in space. Building upon this environment as a social prerequisite, context-based legitimacy can address the complicated legitimacy trade-offs, by distinguishing between different inclusivity and participation requirements for development and deployment phases, while identifying also legitimacy trade-ins, where effectivity and inclusivity can be mutually beneficial. And lastly, the multi-stakeholder approach embraces the complex multipolarity and enables different actors and motivations for autonomous, adaptive, and inclusive governance. All that is required is for it to be taken and implemented by a responsible cosmopolitan state.

The discussion over the framework for the meta-coordination process is not one that can be outlined in a single paper. Instead, we envision a series of international conferences dedicated to the technical and governance challenges for the peaceful use of lasers in space to provide a wealth of normative considerations, discussions, exchanges, and perspectives upon which the parameters of the meta-coordination process can take place. Each of the problematic areas, security, legitimacy, and

practical aspects, can be addressed by a dedicated working group consisting of topical experts. Just as the Treaty on the Prohibition of Nuclear Weapons grew out of the momentum created by an academic and activist-led expert initiative (Burke & Fishel, 2020), we believe the PULS initiative can also be materialised in the future in the diplomatic realm into a concrete framework.

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References

Archibugi, D. (2004). Cosmopolitan democracy and its critics: A review. *European Journal of International Relations, 10*(3), 437–473. https://doi.org/10.1177/1354066104045543

Bearce, D. H., & Scott, J. J. (2019). Popular non-support for international organizations: How extensive and what does this represent? *The Review of International Organizations, 14*, 187–216.

Boháček, P. (2019). Laser SpaceApps workshop summary report. In *Laser SpaceApps workshop*. Prague.

Booth, K. (2008). *Theory of world security*. Cambridge University Press.

Buchanan, A. (2013). *The heart of human rights*. Oxford University Press.

Burke, A. (2013). The good state, from a cosmic point of view. *International Politics, 50*, 57–76. https://doi.org/10.1057/ip.2012.28

Burke, A., & Fishel, S. (2020). A coal elimination treaty 2030: Fast tracking climate change mitigation, global health and security. *Earth System Governance, xxxx*, 100046. https://doi.org/10.1016/j.esg.2020.100046

Buzan, B. (2008). *People, States & Fear*. ECPR Press Classics.

Buzan, B., Wæver, O., de Wilde, J., & Wilde, J. D. (1998). *Security: A new framework for analysis* (National Bureau of Economic Research Working Paper Series). Lynne Rienner Publishers.

Choi, S.-J., & Yoh, J.-I. (2012). Characteristics of laser-induced breakdown spectroscopy (LIBS) at space environment for space resources exploration. *Journal of the Korean Society for Aeronautical & Space Sciences, 40*(4), 346–353. https://doi.org/10.5139/JKSAS.2012.40.4.346

Dahl, R. A. (1994). A democratic dilemma: System effectiveness versus citizen participation. *Political Science Quarterly, 109*(1), 23. https://doi.org/10.2307/2151659

Davis, M. (2018). Space: The next South China Sea. *The Strategist*. *Declaration – Peaceful Use of Lasers in Space*. (2020).

Defense Intelligence Agency. (2019, January 46). *Challenges to security in space*. Military Power Publications.

Delegation of the Czech Republic. (2020). Statement by the Czech Republic for the UN COPUOS STSC from February 6th 2020. *UN COPUOS Scientific and Technical Subcommittee 2020*. https://www.unoosa.org/documents/pdf/copuos/stsc/2020/statements/2020-02-06-PM-Item04-05-CzechiaE.pdf

Dellmuth, L. M., & Tallberg, J. (2011). The social legitimacy of international organisations: Interest representation, institutional performance, and confidence extrapolation in the United Nations. *European Union Politics, 12*(2), 241–266.

Dobos, B., & Prazak, J. (2019). To clear or to eliminate? active debris removal systems as Antisatellite Weapons. *Space Policy, 47*(xxxx), 217–223. https://doi.org/10.1016/j.spacepol.2019.01.007

Dryzek, J. S. (2002). *Deliberative democracy and beyond*. *Oxford University Press*. https://doi.org/10.1093/019925043X.001.0001

Ecker-Ehrhardt, M. (2012). Cosmopolitan politicization: How perceptions of interdependence foster citizens' expectations in international institutions. *European Journal of International Relations, 18*(3), 481–508. https://doi.org/10.1177/1354066110391823

Esmiller, B., Jacquelard, C., Eckel, H.-A., & Wnuk, E. (2014). Space debris removal by ground-based lasers: Main conclusions of the European project CLEANSPACE. *Applied Optics, 53*(31), I45. https://doi.org/10.1364/ao.53.000i45

European Space Agency. (2020a). Space Debris Office. https://www.esa.int/Safety_Security/Space_Debris/Space_debris_by_the_numbers.

European Space Agency. (2020b). Planetary defense office NEO coordination centre. http://neo.ssa.esa.int/

Ferus, M., Křivková, A., Petera, L., Laitl, V., Lenža, L., Koukal, J., et al. (2019). Simulation of meteors by TC-LIBS: Advantages, limits and challenges. In *International Meteor Organization* (pp. 1–8). Bollmannsruh.

Finnemore, M., & Sikkink, K. (1998). International norm dynamics and political change. *International Organization, 52*, 887–917.

García Yárnoz, D., Kojima, A., & Di Pippo, S. (2019). Access to Space: Capacity-building for development through experiment and payload opportunities. *Acta Astronautica, 154*(February), 227–232. https://doi.org/10.1016/j.actaastro.2018.03.034

Grosse, D., Bennet, F., Rigaut, F., D'Orgeville, C., Korkiakoski, V. A., Smith, C. H., et al. (2018). Adaptive optics tracking and pushing system for space debris manoeuvre. In D. Schmidt, L. Schreiber, & L. M. Close (Eds.), *Adaptive optics systems VI* (p. 24). SPIE. https://doi.org/10.1117/12.2313181

Habermas, J. (1996). *Between facts and norms: Contribution to a discourse theory of law and democracy*. MIT Press.

Halas, M. (2020). *A global arms control Regime on short- and medium-range missiles*. Prague.

Henry, C. (2019, October). SpaceX submits paperwork for 30,000 more Starlink satellites. *SpaceNews*.

Hong, L., & Page, S. E. (2004). Groups of diverse problem solvers can outperform groups of high-ability problem solvers. *Proceedings of the National Academy of Sciences, 101*(46), 16385–16389. https://doi.org/10.1073/pnas.0403723101

Hurd, I. (1999). Legitimacy and authority in international politics. *International Organization, 53*(2), 379–408. https://doi.org/10.1162/002081899550913

Institute of Physics of the Czech Academy of Sciences. (2019). *Prague Laser Spaceapps Workshop 2019*. https://www.fzu.cz/en/novinky/prague-laser-spaceapps-workshop-2019

Jasanoff, S. (1990). *The fifth branch: Science advisers as policy-makers*. Harvard University Press.

Jasanoff, S. (2004). *States of knowledge: The co-production of science and the social order. States of Knowledge: The co-production of science and the social order*. Routledge. https://doi.org/10.4324/9780203413845

Kessler, O., & Guillaume, X. (2012). Everyday practices of international relations: People in organizations. *Journal of International Relations and Development, 15*(1), 110–120. https://doi.org/10.1057/jird.2011.29

Knight, A., Scherbarth, N., Cremers, D., & Ferris, M. (2000). Characterization of Laser-Induced breakdown spectroscopy (LIBS) for application to space exploration. *Applied Spectroscopy, 54*(3), 331–340.

Kratochwil, F. (1984). The force of prescriptions. *International Organization, 38*(4), 685–708. https://doi.org/10.1017/S0020818300026916

Kulkarni, N., Lubin, P., & Zhang, Q. (2018). Relativistic spacecraft propelled by directed energy. *The Astronomical Journal, 155*(4), 155. https://doi.org/10.3847/1538-3881/aaafd2

Latour, B. (2018). *Down to earth: Politics in the new climatic Regime*. Polity.

Li, T. M. (2007). Practices of assemblage and community forest management. *Economy and Society, 36*(October 2014), 37–41. https://doi.org/10.1080/03085140701254308

Lubin, P., Hughes, G. B., Eskenazi, M., Kosmo, K., Johansson, I. E., Griswold, J., et al. (2016). Directed energy missions for planetary defense. *Advances in Space Research, 58*(6), 1093–1116. https://doi.org/10.1016/j.asr.2016.05.021

Maffettone, P., & Ulaş, L. (2019). Legitimacy, metacoordination and context-dependence. *International Theory, 11*(1), 81–109. https://doi.org/10.1017/S1752971918000258

Mai, C. (2017). China aims to be world-leading space power by 2045. *China Daily*.

Marchetti, R. (2008). A matter of drawing boundaries: Global democracy and international exclusion. *Review of International Studies, 34*(2), 207–224. https://doi.org/10.1017/S0260210508007997

Mayer, M., & Acuto, M. (2015). The global governance of large technical systems. *Millennium: Journal of International Studies, 43*(2), 660–683. https://doi.org/10.1177/0305829814561540

McEnchroe, T. (2019). Czech high frequency laser could help space exploration. *Radio Prague International*.

Michaelowa, A., Aglaja, E., & Muller, B. (2019). *Negotiating cooperation under Article 6 of the Paris Agreement*.

Nilsen, V., & Anelli, G. (2016). Knowledge transfer at CERN. *Technological Forecasting and Social Change, 112*, 113–120. https://doi.org/10.1016/j.techfore.2016.02.014

Parkin, K. L. G. (2018). The breakthrough Starshot system model. *Acta Astronautica, 152*, 370–384. https://doi.org/10.1016/j.actaastro.2018.08.035

Phipps, C. R., Baker, K. L., Libby, S. B., Liedahl, D. A., Olivier, S. S., Pleasance, L. D., et al. (2012). Removing orbital debris with lasers. *Advances in Space Research, 49*(9), 1283–1300.

Phipps, C. R., Bonnal, C., Masson, F., Boustie, M., Berthe, L., Schneider, M., et al. (2018). Transfers from Earth to LEO and LEO to interplanetary space using lasers. *Acta Astronautica, 146*, 92–102. https://doi.org/10.1016/j.actaastro.2018.02.018

Robinson, M. (2019). The CERN community; a mechanism for effective global collaboration? *Global Policy, 10*(1), 41–51. https://doi.org/10.1111/1758-5899.12608

Robinson, M. (2020). *Big science collaborations*. *Global Policy*. https://doi.org/10.1111/1758-5899.12861

Rychnovská, D., Pasgaard, M., & Berling, T. V. (2017). Science and security expertise: Authority, knowledge, subjectivity. *Geoforum, 84*(June), 327–331. https://doi.org/10.1016/j.geoforum.2017.06.010

Sadurski, W. (2015). Supranational public reason: On legitimacy of supranational norm-producing authorities. *Global Constitutionalism, 4*(3), 396–427. https://doi.org/10.1017/s204538171500012x

Scharpf, F. W. (1999). *Governing in Europe: Effective and democratic?* Oxford University Press.

Scharring, S., Wilken, J., & Eckel, H.-A. (2016). Laser-based removal of irregularly shaped space debris. *Optical Engineering, 56*(1), 011007. https://doi.org/10.1117/1.oe.56.1.011007

Schmitz, M., Fasoulas, S., & Utzmann, J. (2015). Performance model for space-based laser debris sweepers. *Acta Astronautica, 115*, 376–383. https://doi.org/10.1016/j.actaastro.2015.05.032

Smetana, M. (2018). Weapons of mass protection? Rogue Asteroids and the normative pitfalls of nuclear explosions in space. In N. Schmidt (Ed.), *Planetary defense – Global collaboration for saving earth from Asteroids and Comets (forthcoming)*. Springer.

SMPAG. (2020). Space mission planning advisory group. https://www.cosmos.esa.int/web/smpag/meeting-14-06-feb-2020

Soulard, R., Quinn, M. N., Tajima, T., & Mourou, G. (2014). ICAN: A novel laser architecture for space debris removal. *Acta Astronautica, 105*(1), 192–200. https://doi.org/10.1016/j.actaastro.2014.09.004

Steffek, J. (2015). The output legitimacy of international organizations and the global public interest. *International Theory, 7*(2), 263–293. https://doi.org/10.1017/S1752971915000044

Stoker, G. (2018). Governance as theory: Five propositions. *International Social Science Journal, 68*(227–228), 15–24. https://doi.org/10.1111/issj.12189

Šubrt, J. (2019). *Individualism, holism and the central dilemma of sociological theory*. EMERALD Group Publishing.

Švec, M., Bohacek, P., & Schmidt, N. (2020). Utilization of natural resources in outer space: Social license to. *Oil, Gas & Energy Law Journal (OGEL), 18*(1), 0–19.

Vetrisano, M., Thiry, N., & Vasile, M. (2015). Detumbling large space debris via laser ablation. In *IEEE Aerospace conference proceedings*, *2015-June*. https://doi.org/10.1109/AERO.2015.7119051

Wallander, C. A. (2013). *Mutually assured stability: Establishing US-Russia security relations for a new century*. Atlantic Council.

Wang, W., Li, S., Qi, H., Ayhan, B., Kwan, C., & Vance, S. (2014). Revisiting the preprocessing procedures for elemental concentration estimation based on ChemCam libs on mars rover. In *2014 6th workshop on hyperspectral image and signal processing: Evolution in remote sensing (WHISPERS)* (pp. 1–4). IEEE. https://doi.org/10.1109/WHISPERS.2014.8077520

Weber, M. (1978). *Economy and society*. University of California Press.

Wendt, A. (1999). *Social theory of international politics*. Cambridge University Press. https://doi.org/10.1017/CBO9780511612183

Whitehouse, D. (2002). China denies manned Moon mission plans. *BBC*.

Zhang, Q., Walsh, K. J., Melis, C., Hughes, G. B., & Lubin, P. M. (2016). Orbital simulations on deflecting near-earth objects by directed energy. *Publications of the Astronomical Society of the Pacific, 128*(962), 045001. https://doi.org/10.1088/1538-3873/128/962/045001

Zhang, Q., Lubin, P. M., & Hughes, G. B. (2019). Orbital deflection of comets by directed energy. *The Astronomical Journal, 157*(5), 201. https://doi.org/10.3847/1538-3881/ab13a5

Zürn, M. (2018). A theory of contested global governance, *Global Policy, 9*(1), 138–145. https://doi.org/10.1111/1758-5899.12521

Cosmopolitan Approach to the Issue of Orbital Debris

Nicol Svárovská

> We […] need new mechanisms to ensure accountability – the accountability of States to their citizens, of States to each other, of international institutions to their members and of the present generation to future generations. (Kofi Annan, *In Larger Freedom*)[1]

1 Introduction

The proliferation of discussions on climate change in recent years indicates a new sense of urgency: it has turned into an issue that concerns everyone, not only experts and scientists. The following chapter treats the issue of orbital debris as a part of a broader discussion about climate change, highlighting that however new and not established in space treaties, an environmental approach to orbital debris is logical and necessary. The rationale behind the fact that the United Nations space treaties are not concerned about environmental issues is that such issues were not the priority of spacefaring nations when concluding the treaties. None of them even mention the problem of orbital or space debris. Despite the fact that certain provisions found in the space treaties may be relevant to the environment, the focus rests on safeguarding human activities rather than the environment (Ferreira-Snyman, 2013).

This chapter proposes to elaborate on the concept of responsibility for orbital debris removal and look for analogies in climate change law, with the aim of

[1] United Nations in 2005. "A /59/2005." Human Rights 27078 (March).

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shifting focus from the material damage which was caused to a space object to *outer space pollution* as such. In treating orbital debris as an environmental issue, it follows Viikari's premise that outer space activities fall into the material scope of environmental law and suggests that a legal framework for orbital debris – especially in terms of liability and compensation – could be formed with regard to the high seas (Viikari, 2008).

Rather than focusing on parallels with aviation environment in developing a legal framework for managing orbital debris, we may recall proposals to focus on parallels with marine environment and the striking similarities between orbital debris and marine debris. Orbital debris has more in common with marine rather than aircraft debris. Aircraft debris is usually limited to one confined terrestrial area. Conversely, marine debris contaminates large area of the maritime environment by both solid objects and liquids. Marine debris is, similar to orbital debris, mobile. Uncontrollably floating debris is an issue specific to both marine and space environment. Also, space tourism will have similar characteristics to ship tourism: the focus will be on the cruise itself, not only the destination, as it is with aviation. Another parallel lies in the fact that the destination is an artificial structure; in the space environment, it is, for instance, the International Space Station (ISS), while in the marine environment, it could be a ship servicing oil rigs. Moreover, both the commercial space industry and maritime sector are driven by international competition; aviation industry, on the other hand, is protected by domestic market and international agreements (Garretson et al., 2019).

2 Orbital Debris as an Environmental Issue

Orbital debris poses an enormous problem from the perspective of sustainability of outer space.[2] The extreme velocities are responsible for the fact that even a particle that is one centimeter in diameter can incapacitate a functional satellite and even the smallest piece of debris that hits an active satellite is capable of causing a fatal

[2] "The expected lifetimes for debris depend primarily on its location: in low Earth orbits, the air drag of the upper reaches of the atmosphere will eventually cause the debris to decelerate and heat up so that it breaks up under friction, whereas in higher orbits the atmospheric drag is virtually nil. Despite the cleaning effect of the atmospheric drag, it has been calculated that if removal of LEO spacecraft at the end of their lifetime is not conducted within 25 years or so, we can expect a marked increase in the number of accidental collisions later in this century. Interestingly, it has been discovered that greenhouse gasses produced on Earth result in a decline in temperature and density of the thermosphere (the uppermost part of atmosphere, above the altitude of about 90km) and thereby reduce atmospheric drag. This in turn may allow space objects to remain in orbit longer. The positive result is that operational satellites save on fuel; the other side of the coin is that space debris becomes more persistent. It has been estimated that the density of the thermosphere may be as much as halved by the end of this century, meaning that orbital lifetimes of objects can be extended by up to 24% (depending on the altitude and prevailing solar activity). What is most alarming is that the number of on-orbit collisions would increase exponentially. […] The potential damage of even the tiniest debris particle circulating in outer space derives from the fact that

reaction. Additionally, experts on orbital debris voiced concern that debris pollution will raise to a level that a collision in the near future might trigger a chain reaction, causing small debris to tear apart large objects in a cascading event (Viikari, 2008), the so-called Kessler effect (Pelton, 2019).

If the chain reaction predicted by the Kessler syndrome theory ever began, we could imprison ourselves on Earth until we find a way to clean up the billions of pieces of orbital debris. We would lose our space infrastructure and the technology we rely on every day. The father of the concept, Dr. Donald Kessler, wrote a few years ago that not even the 25-year rule for debris removal after the end of life of spacecraft and the nonbinding, voluntary rules adopted by COPOUS are sufficient; he expressed the opinion that debris will accumulate simply due to collisions among existing debris (Pelton, 2015).

All space activities may be threatened by deterioration in the form of orbital debris contamination. Even if one takes into account the congestion of the orbit by functional space objects, the future plans of states that do not possess the resources yet to engage in space activities may be rendered meaningless. If the space environment is not preserved, developing or less developed countries will not be able to exercise their right to use it (Deva Prasad, 2019; Viikari, 2008). There is a consensus among lawyers and scientists that the international community should introduce new methods and procedures to decrease the orbital debris buildup. The question is *how*, in which framework can the issue of orbital debris be tackled. Throughout the chapter, orbital debris pollution is perceived as an environmental issue that requires a *cosmopolitan* framework, embodied in the principle of Common but Differentiated Responsibilities (CBDR).

The CBDR principle was articulated in the United Nations Framework Convention on Climate Change (UNFCCC), the first and most complex instrument of international law addressing climate change (Harris, 1999), signed at the "Rio Earth Summit" in 1992. The CBDR principle postulates that "states should be held accountable in different measure according to their respective historical and current contributions to the creation of global environmental problems and their respective capacities to address these problems" (Cullet, 1999). Taking into account the relationship between industrialization and climate change, states acknowledged that developed countries contributed to climate change significantly more than developing countries and, therefore, should bear greater responsibility for its manifestations and consequences. Built on the "polluter pays" premise, the CBDR principle takes into account the extent by which a country contributed to climate change as well as its capacity to mitigate climate change (Rajamani, 2000).

impact velocities in orbits are enormous (0.1– 0.8km/s in GEO, 6–14km/s in LEO); at best (or worst) debris is traveling about 17 times faster than a machine gun bullet" (Viikari, 2008).

3 *Ius Cosmopoliticum:* The Foundation for Global Society

The origins of cosmopolitanism lie in ancient Greece: when Diogenes Laërtius was asked where he was from, he responded that he was a citizen of the world or cosmos (*kosmou polite*). His answer reflected the source from which identity was constructed at the time: the city-state. This concept, elaborated on by the Stoics, was articulated in Hierocles' "circle model," in which an individual finds himself or herself in webs of compassion and obligation, expanding from family to community and, finally, the whole world. The Renaissance and the Enlightenment articulated cosmopolitanism as planetary awareness among the European elites; the world was perceived as unity, creating a new sense of compassion for victims of the capitalist order. Immanuel Kant envisioned a cosmopolitan world order as a federation of states promoting international trade and abolishing war; in *Perpetual Peace: A Philosophical Sketch* (1795), Kant speaks about humanity entering a universal community which means that if one violates laws in a certain part of the world, this violation is experienced everywhere (Warf, 2012). Kant establishes *ius cosmopoliticum* (cosmopolitan law) as the foundation for global society to guarantee lasting peace (Taylor, 2010).

Kant's proposal toward peace was weaved into the architecture of the League of Nations as well as the contemporary United Nations. The ideal world order which would lead to global peace was resurrected after the cold war and after the two world wars. The International Criminal Court (ICC) introduced a new version of cosmopolitanism that transcends Kant's concept of "cosmopolitan law"; it reflects the tendency of international law to weaken the postulate of state sovereignty or one's absolute subjection to the state and give people rights and responsibility under international law (Kleingeld & Brown, 2015).

Global institutions such as the United Nations or the ICC respond to threats to the collective existence of humankind. This chapter argues that just like the atomic bomb or climate change, orbital debris pollution poses a threat to *the collective existence of humanity*. The cosmopolitan thinking overcomes geographical boundaries: our world is no longer limited to our village; it extended to our city, our country, and, finally, the entire world. Being a citizen of the world stopped being a phrase. With the Internet and other technological advances, we can be anywhere. Together with Gadamer (Gadamer, 2014), we can say that the hermeneutics of our understanding expands by moving in greater and greater circles; the next circle we should extend our consciousness to is that around our planet.

This "hermeneutic cosmopolitanism" resonates with Anthony Burke's notion of security cosmopolitism. Burke applies cosmopolitanism to the field of security, ranging from threats to the survival of humankind to global peace. According to Burke, cosmopolitanism could improve and create transnational institutions and norms and therefore has the potential to respond to such threats. It offers a framework within which states could participate in solving global security problems. Security cosmopolitanism offers a reform of national as well as collective security policies. Burke understands global security as "a universal good," meaning that the

security of all human beings and states is of equal importance. This logic results from the fact that all security actors make decisions with a global impact. Security cosmopolitanism is of key importance, given the number of states which continues to be sources of insecurity. In today's world, security challenges are omnipresent: climate change, forced migration, nuclear threats, armed conflicts, arms trade, the militarization of space, increase in robotic military technology, or global terrorism (Burke, 2013a). Such concerns are deeply interconnected and no state or organization can ignore them. In the light of these developments, Burke puts forward the argument that "the globalization of insecurity in such complex interconnected forms must be acknowledged and better understood, and requires both a change in state approaches and commitments, and serious efforts to extend and improve global security governance" (Burke, 2013a, 14). In order to do so, a normative agency critically reflecting the cosmopolitan approach is needed. Equally important in this regard is to transform the ontologies and narratives of security (Burke, 2013a, 14).

"Global security governance is still overly beholden to the interests of major powers, and is vulnerable to spoiling and power-play that damages the global interest and the needs of the most vulnerable and marginalized [,]" stresses Burke, echoing the concerns of the UN Secretary-General's High-Level Panel that many believe "collective security" is set up to protect "the rich and powerful" (Burke, 2013a, 15). In this context, Burke shines a light on the problematic nature of the state-centric collective security, reflected in the structure of the United Nations Security Council and the approach of states toward issues such as transnational terrorism, nuclear weapons, and climate change. Another issue arises when the concept of security and humanitarian protection is used to pursue geopolitical interests. Despite being mistaken for cosmopolitanism, such policies are not truly cosmopolitan (Burke, 2013a, 15; Burke et al., 2016). "Globalized human existence," Burke argues, should be understood as "a networked set of interdependencies and obligations beyond all borders" (Burke, 2013a, 17). It is reflective of the view that our existence is constituted in relation to others, following Lévinas, Butler, Esposito, and Connolly. States share common experiences, such as climate change, and rely on the same global prices; they transit weapons to other countries and affect the lives of people on the other side of the globe. Burke speaks about a "common space of life and death that we have created" (Burke, 2013a, 17).

There has been a tendency lately to present the United Kingdom referendum to leave the European Union (Brexit) or Donald Trump's presidency as a paradigm shift, diverting the West from its cosmopolitan path and unapologetically prioritizing state sovereignty. However, state sovereignty has been prioritized even in international instruments that are perceived as the embodiment of cosmopolitanism. One of the many examples is Article 14 of the 1948 Universal Declaration of Human Rights: "1. Everyone has the right to seek and to enjoy in other countries asylum from persecution" – the right to *seek*, not to be *granted* asylum; the wording of the provision reflects the conscious decision of the international community to let state sovereignty overcast a cosmopolitan principle. In practice, cosmopolitan principles are not only overshadowed but flagrantly violated. With regard to the right to seek asylum, enshrined in multiple international treaties as well as customary

international law, we may recall United States' response (Pijnenburg et al., 2018) to Haitian asylum seekers in the 1980s–1990s that involved interception of Haitian boats and transportation of asylum seekers to Guantanamo Bay; Australian introduction of the Pacific Solution or Pacific Strategy (2001), involving interception of asylum seekers and their transfer to offshore processing centers on Nauru and Manus Island, a controversial offshore processing practice that Australia ended in 2008 only to revisit it in 2012; (Léonard & Kaunert, 2016); or the bilateral agreements between Italy and Libya signed from 2007 to 2009, introducing a "pushback" policy, interceptions in international waters, and returns to Libya (Office of the United Nations High Commissioner for Human Rights and United Nations Support Mission in Libya 2016).

Despite glimpses of progress on a legal level, such as the 2012 ruling of the European Court of Human Rights in *Hirsi Jamaa and Others v. Italy*, states' policies usually do not integrate and are not shifted toward cosmopolitan principles. For instance, Italy reinvented its strategy; however, not toward greater respect for human rights. What has evolved is the level of sophistication put into human rights violations, as manifested in the fact that Italy substituted the condemned "direct *refoulement*" by "*refoulement* by proxy" and outsourced interceptions and pullbacks of asylum seekers to the Libyan Coast Guard (Forensic Oceanography (Charles Heller and Lorenzo Pezzani) 2018). Sustaining the illusion of adhering to international human rights and refugee law frameworks while finding new strategies to disrespect them contradicts the cosmopolitan mind frame (Hathaway & Gammeltoft-Hansen, 2015). In a broader context, countries in the Global North have a long history of violating cosmopolitan principles while appropriating the symbolic value of remaining bound by them. This symbolic cosmopolitanism will not set us on the path of effectively dealing with global – especially environmental – issues.

4 Apocalyptic Imagination: The End of the World Through Technology

The ecological crisis, climate change – a cascade of irreversible damages – is the most alarming of all crises (Burke, 2015, 192). The atmosphere is borderless, and climate change, whose effects on our security are massive, is the result of millions of daily actions in one's life, in one's country's government, agriculture, and industry. Derrida and Esposito speak about "autoimmunization" which refers to an immune response threatening to annihilate the social body rather than protect it (Burke, 2013a, 19). Along those lines should be perceived the cascading damages predicted by the Kessler syndrome. It is time to extend the concept of cosmopolitanism to outer space, recognize the urgency of orbital debris pollution, and take collective action to safeguard the rights of both the present and future generations. Orbital debris pollution is an element of environmental degradation of and around our planet, and it deserves attention equal to any pressing environmental issue

humanity is facing. Just like marine pollution, Earth's orbit pollution is an environmental issue that manifests itself in cascading events.

The atomic bomb has similar implications; national states seeking security via nuclear threats turned into a threat to humankind as such. The nuclear threat is the ultimate autoimmunization; the deterrence logic maneuvers at the brink of preemption and therefore irremediable disaster (Burke, 2013a, 19, 2009). Günther Anders recognized the indifference of many toward the nuclear peril (Anders, 1968). Among the few who fully understood the monstrous dimensions of the danger the humanity was facing was Albert Einstein: "We do not know what may be the effects of setting loose great floods of radioactivity. There are those (Einstein), who think that the result would be the extinction of the world," wrote Claude Eatherly (1961, 84), a pilot of Enola Gay, the B-29 bomber who dropped an atomic bomb on Hiroshima, to Honorable Senator Ralph Yarborough (US Senator from Texas) in 1960. In the aftermath of the event, Anders was shocked by the lack of panic toward which he responded by the concept of "blindness to the apocalypse" (Dawsey, 2016, 150). Similarly, states and private companies are blinded by national interests or financial gains, while the public remains indifferent to the catastrophic implications of orbital debris pollution. Is it comparable, though? Can we compare orbital debris pollution or any environmental issue to the apocalypse implied in the existence of the atomic bomb?

In answering this question, we will recall Lindberg's concept of "technologies of the end of the world" (Lindberg, 2017). Just like the atomic bomb, climate change and, by extension, orbital debris pollution, perceived in this chapter as a part of environmental degradation, can be categorized as technologies of the world's end. According to Lindberg, technologies of the world's end have the potential to annihilate the Earth. Bertrand Russell calls it "universal death." With regard to climate change, the twenty-first-century philosophers have to refer to the Intergovernmental Panel on Climate Change (IPCC) Assessment Reports. Without an alarming tone, the dry prose of the Assessment Reports uncovers the impact of the rise in global temperature on the world: the polar caps melting, sea level rising, extreme weather, shortage of water and soil resources, the disappearance of species, and worsening of living conditions in the poorest regions, resulting in migration, among other issues. Along similar lines, this chapter is concerned with the dangers of orbital debris pollution and multiplication to both outer space and the Earth. Neither climate change nor nuclear war has ended the world; however, they have suffocated and annihilated certain elements of the world. Both climate change and the atomic bomb raise the question of the world's end *through technology* since they confront us with the possibility of total annihilation of the world by human beings (Lindberg, 2017).

Sciences refrain from this sort of apocalyptic imagination. Imagining the end of the world is not on their agenda; it is a matter of metaphysics. The question of the end of the world is inherent to theologies, such as the apocalypses of Judaism and Christianity, and mythologies. The modern adaptation of such apocalyptic thinking is Lars von Trier's *Melancholia*. With the atomic bomb on one hand and climate change and orbital debris on the other, we are facing a different kind of an apocalypse: it is no longer a fatal destiny imposed on the man from the outside; the end of

the world is initiated and perpetuated by man himself – through technology. Unlike the spectacle of the atomic explosion, climate change progressively suffocates the planet, and orbital debris progressively suffocates its orbit. Climate change slowly changes the world into a place that is inhospitable and ultimately impossible to live in (Lindberg, 2017). Orbital debris pollution changes the Earth's orbit into a place that becomes increasingly inhospitable and dangerous for space objects we depend on; if no collective action is taken to ameliorate the situation, it will eventually become impossible to put new space object into orbit. Both Lindberg and Burke put a great emphasis on our imagination. Whereas Lindberg underlines the necessity to imagine the consequences of our actions, the end of the world through technologies, Burke stresses that we need to imagine the solution, underlining that security cosmopolitanism is not going to happen, it has to be imagined and then created (Burke, 2013a, 20).

Lindberg calls climate change a "technological fact," even though climate change is not a system deliberately built by man. It can be regarded as a "technological fact" as it only exists because of human technological and industrial activity, as described in length by IPCC reports. Similarly, orbital debris pollution has a life of its own; despite not being deliberately created by man, it only exists due to technological and industrial activity. Contrary to the nuclear power that is concentrated in a single point, climate change reinvents the world into a network of intertwined forces rising from nature on one hand and technology on the other. Climate change conceptualizes the world as a space for all living things, not only humans. Climate change is a reaction to the technological and industrial activity of human beings; these natural processes would have never been triggered if it had not been for human activity. In return, the new natural process causes sociopolitical and technological responses that would not have come into existence without climate change (climate refugees, the "right to pollute" commerce, the carbon-neutral housing projects, etc.). Orbital debris pollution also results from the interaction between natural and technological; it is a reaction to techno-industrial human activity. Conversely, the processes triggered by orbital debris cause sociopolitical and technological responses that would not have occurred without it. What was once upon a time nature has been reconfigured into "technonature" that is equally unpredictable and ambivalent as ancient *physis*. As opposed to Hiroshima and Nagasaki which were directly experienced by human beings, climate change and orbital debris lack the immediacy of a nuclear explosion, cannot be directly experienced, and have to be mediated through sciences (Lindberg, 2017).

Claude Eatherly, who saw the atomic destruction first hand, writes:

> I saw three of the first four atom bombs set off, and I know the results of those bombs, and with the great advancement of science since then, I know, as Dr Pauling knows, that it would be the end of this people's earth. For this reason, war is a greater menace now than it was formerly. (Eatherly & Anders, 1961, 84)

In reaction to this paradigm shifting, yet personal experience, Eatherly speaks about a "guilt complex" from which he never recovered (Eatherly & Anders, 1961, 84). On the contrary, the complexity of climate change dilutes the concept of guilt,

personal responsibility, or existential crises suffered by those who participated in the Manhattan Project. The scientists who are active in IPCC deal with a phenomenon that is abstract, imperceptible, and so complex that it is impossible for one person to verify in its entirety the scientific aspects that lead to IPCC's conclusions. The origin of climate change is techno-industrial; the scientists who were contributors to climate change are not the scientists who focus on proving it exists. Correspondingly, orbital debris scientists and researchers do not bear responsibility for its creation. The phenomenon of climate change or orbital debris pollution is so complex that one is unable to understand, be responsible, and take responsibility for it. Similarly, the science describing it has to be *collective* (Lindberg, 2017). However, the twenty-first century brought a new sense of guilt. The "guilt complex" Claude Eatherly had talked about became the diagnosis of our time. It occurs in multiple forms, and one of the terms modern psychology coined to describe it is "eco-anxiety," the chronic fear of environmental damage and its consequences to future generations. In case of orbital debris, the "guilt complex" has not fully developed due to limited knowledge and awareness about the issue among the public. As witnessed with the atomic bomb or climate change, humankind starts feeling guilty when it is too late, i.e., when the destruction manifests and plays before our eyes.

5 Cosmopolitan Responsibility

The environmental guilt of the twenty-first century is collective. It is only logical that the responsibility for climate change and orbital debris pollution be collective as well. An individualistic approach, driven by national or commercial interests, is not sustainable from a long-term perspective. The only sustainable solution is built on *cosmopolitanism* in the original sense of the Greek *kosmou polite*, a citizen of the world or the cosmos, a citizen who is aware of the interconnectedness of today's world and understands the global implications of individual actions. The ultimate example is the invention of the atomic bomb, an action which has forever changed our world and ourselves; every person on this planet is impacted by this invention that will never go anywhere. Humankind is stuck with it until the end of time. The atomic bomb and other inventions responsible for fuelling climate change and orbital debris pollution are the embodiment of Friedrich Nietzsche's concept of "eternal return" (Nietzsche, 1882) that is put into historical context by Milan Kundera:

> Putting it negatively, the myth of eternal return states that a life which disappears once and for all, which does not return, is like a shadow, without weight, dead in advance, and whether it was horrible, beautiful, or sublime, its horror, sublimity, and beauty mean nothing. We need take no more note of it than of a war between two African kingdoms in the fourteenth century, a war that altered nothing in the destiny of the world, even if a hundred thousand blacks perished in excruciating torment. Will the war between two African kingdoms in the fourteenth century itself be altered if it recurs again and again, in eternal return? It will become a solid mass, permanently protuberant, its inanity irreparable. […] [T]he idea of eternal return implies a perspective from which things appear other than as we know

> them: they appear without the mitigating circumstance of their transitory nature. […] In the world of eternal return the weight of unbearable responsibility lies heavy on every move we make. (Kundera, 2009, 19–21)

Kundera captured the essence of Nietzsche's concept of eternal return which lies in "unbearable responsibility" for one's actions. Both Lindberg and Burke grasped the suffocating burden and impact one single action can have on the entire world and beyond. Whereas Lindberg focuses on the issue of responsibility and interconnectedness from the perspective of time, Burke puts greater emphasis on the perspective of space. While both perspectives are inseparable, the historical perspective reflects the concept of *inter*generational equity, and the contextual perspective reflects the concept of *intra*generational equity. The invention of the atomic bomb, the rise of technologies, and actions contributing to climate change, including orbital debris pollution, have to be assessed from a cosmopolitan perspective, taking into account both intergenerational and intragenerational equity, the rights of current, as well as future generations. The impact of technologies of the end of the world is not only far-ranging but eternal, in Nietzsche's sense of the word. The atomic bomb will eternally return, we can say with Hegel, in its potentiality or actuality as the technologies of the end of the world cannot be un-invented.

Together with Burke, we shall underline the need to create a global society system, enabling universal human security, and the importance of states and security actors to behave responsibly with regard to future generations and sustainability of the global ecosystem. Burke's cosmopolitanism acknowledges that pursuing universal values and global ends is determined by the transformation of states and international law, by reconfiguration of power and cooperation for tackling global issues (Burke, 2013b). The atomic bomb and climate change are just two instances of the way our collective decisions determine the potential of future generations' security. To this end, Burke speaks about a "global categorical imperative," refining Kant's categorical imperative as follows: "act as if both the principles and consequences of your action will become global, across space and through time, and act only in ways that will bring a more secure life for all human beings closer" (Burke, 2013a, 22–23). In other words, governments, international organizations, and other international actors must act as if their actions have a global impact (as they are likely to). The global categorical imperative puts actions into a perspective of their global consequences and causalities. It asks the security actors to look into and take responsibility for the future. The global categorical imperative demands us to assess pain, fear, and radicalization – resulting from insecurity, violence, and conflict – against their future multiplications and mutations. The proliferation of ideas, doctrines, and weapons constitutes the long-term security concern (Burke, 2013a, 23).

6 Conclusion

Throughout the chapter, orbital debris pollution is treated as an environmental issue that requires a *cosmopolitan* framework, embodied in the principle of Common but Differentiated Responsibilities (CBDR). The concept of cosmopolitanism is articulated with regard to technologies of the end of the world (Lindberg), defined as technologies with the potential to annihilate certain elements of the Earth and its orbit. This chapter argues that just like the atomic bomb or climate change, orbital debris pollution manifests as a global challenge, affecting the collective existence of humanity.

As mentioned above, Einstein understood the immense responsibility the invention of the atomic bomb bears to humankind, and Anders could not grasp the indifference of the public toward this global issue that deeply concerned every individual on this planet. The cosmopolitan approach attaches new sensitivity to universal or global issues toward which one learned to be desensitized; furthermore, it encourages every individual and every state to reclaim their responsibility and engage with such issues. No matter the nationality, race, religion, political opinion, or membership of a particular social group of the scientists who invented a technology with a potentially global impact, the invention at stake concerns humanity as a whole, and its impact stretches across space and time and concerns all the living as well as the unborn.

In this regard, the CBDR principle is the embodiment of cosmopolitanism as it stretches responsibility across space and time. Developing a legal regime for debris mitigation (Pelton, 2015, 69–81) – a regime that would follow the Kyoto Protocol and the CBDR principle (Gopalakrishnan & Prasad, 2013, 11) – would expand the concept of sustainability from Earth to outer space while shifting the issue of orbital debris into a cosmopolitan direction. The CBDR principle was crafted to tackle global environmental problems and, therefore, is perfectly applicable to the current orbital debris pollution, which is an environmental problem on a global scale. States that only recently initiated their space activities or plan to do so face environmental degradation for which they bare no responsibility but whose consequences they have to deal with. These negative consequences posit an obstacle to future space missions. A way forward in the context of space debris pollution, which would achieve equity, would be for states responsible for having created the space debris pollution over the years to work toward cleaning it up. This solution is in accordance with the perspective expressed in COPUOS – "mitigation of existing debris should take into consideration the principle of [CBDR]"[3] – while the future debris creation should be avoided by adopting orbital debris mitigation measures (Stubbe, 2010, 5–10).

To conclude, the author wishes to highlight that Kant's concept of *ius cosmopoliticum* influenced Hersch Lauterpacht (Koskenniemi, 1997, 219) who crafted the concept "crimes *against humanity*." Looking through the optics of Lauterpacht's

[3] UN doc. A/AC.105/891, para. 27.

concept and seeing cosmopolitanism in its essence – and the essence of cosmopolitanism is *humanity* – a cosmopolitan approach manifests as an approach *toward humanity*. As such, it cannot be discredited as idealistic or impractical. "Humanity" is not an ideal; it is one of the fundamental principles of far-too-realistic and far-too-practical international humanitarian law (IHL) and one of the seven principles of the International Committee of the Red Cross (ICRC), the guardian of that body of law, as well as the *Geneva Conventions*. Expressed, among other provisions, in common Article 3 to *Geneva Conventions I–IV*, the principle of humanity anticipates the suffering and destruction of an armed conflict only to alleviate unnecessary suffering and destruction. In other words, the destruction has to be first *imagined.* When Dr. Kessler introduced a scenario of destruction caused by the accumulation of orbital debris, it triggered our imagination; such triggering of our imagination serves as an impetus to act before the destruction manifests. It is no coincidence that imagination is of crucial importance to both Lindberg and Burke and those who had a front-row seat in the nuclear destruction of the last century: Einstein, Anders, and Eatherly. Ultimately, the human capacity to imagine lays the foundation for a cosmopolitan approach toward any global issue, including the issue of orbital debris.

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References

Anders, G. (1968). Die Antiquiertheit des Menschen: über die Seele im Zeitalter der zweiten industriellen Revolution, Beck.

Burke, A. (2009). Nuclear reason: At the limits of strategy. *International Relations, 23*(4), 506–529. https://doi.org/10.1177/0047117809348697

Burke, A. (2013a). Security cosmopolitanism. *Critical Studies on Security, 1*(1), 13–28. https://doi.org/10.1080/21624887.2013.790194

Burke, A. (2013b). The good state, from a cosmic point of view. *International Politics, 50*(1), 57–76. https://doi.org/10.1057/ip.2012.28

Burke, A. (2015). Security cosmopolitanism: The next phase. *Critical Studies on Security, 3*(2), 190–212. https://doi.org/10.1080/21624887.2015.1065109

Burke, A., Lee-Koo, K., & McDonald, M. (2016). An ethics of global security. *Journal of Global Security Studies, 1*(1), 64–79. https://doi.org/10.1093/jogss/ogv004

Cullet, P. (1999). Differential treatment in international law: Towards a new paradigm of inter-state relations. *European Journal of International Law, 10*, 549–582.

Dawsey, J. (2016). *After Hiroshima: Günther Anders and the history of anti-nuclear critique* (pp. 140–164). Manchester University Press.

Deva Prasad, M. (2019). Relevance of the sustainable development concept for international space law: An analysis. *Space Policy, 47*, 166–174. https://doi.org/10.1016/j.spacepol.2018.12.001

Eatherly, C., & Anders, G. (1961). *Burning Conscience: The case of the Hiroshima pilot*. Preface by Bertrand Russell. New York: Monthly Review Press.

Ferreira-Snyman, A. (2013). The environmental responsibility of states for space debris and the implications for developing countries in Africa. *The Comparative and International Law Journal of Southern Africa, 46*(1), 19–51.

Forensic Oceanography Mare Clausum: Italy and the EU's undeclared operation to stem migration across the Mediterranean: A report by Forensic Oceanography (Charles Heller and Lorenzo Pezzani), affiliated to the Forensic Architecture agency, Goldsmiths, University of London, May 2018. Available at: http://www.forensicarchitecture.org/wp-content/uploads/2018/05/2018-05-07-FO-Mare-Clausum-full-EN.pdf#http://www.forensicarchitecture.org/wp-content/uploads/2018/05/2018-05-07-FO-Mare-Clausum-full-EN.pdf

Gadamer, H.-G. (2014). The problem of historical consciousness. *Graduate Faculty Philosophy Journal, 5(1)*, 8–52.

Garretson, P., Anzaldúa, A. B., & Davidson, H. (2019). Catalyzing space debris removal, salvage, and use. *The Space Review*. December 9, 2019. Available at: https://www.thespacereview.com/article/3847/1.

Gopalakrishnan, V., & Prasad, S. (2013). Space debris remediation- common but differentiated responsibility, *13*(E7.4.8).

Harris, P. G. (1999). Common but differentiated responsibility: The Kyoto Protocol and United States policy. *New York University Environmental Law Journal, 27*, 27–48.

Hathaway, & Gammeltoft-Hansen. (2015). Non-refoulement in a world of cooperative deterrence. *Columbia Journal of Transnational Law, 53*(2), 235–284.

Kleingeld, P., & Brown, E. (2015). Cosmopolitanism. In *The stanford encyclopedia of philosophy*.

Koskenniemi, M. (1997). Lauterpacht: The Victorian Tradition in International Law. *European Journal of International Law, 8*(2), 215–263.

Kundera, M. (2009). *The unbearable lightness of being*. Harper Perennial Modern Classics.

Léonard, S., & Kaunert, C. (2016). The extra-territorial processing of asylum claims. *Forced Migration Review, 51*, 48–50.

Lindberg, S. (2017). Technologies of the End of the World. In M. S. C. Schuback & S. Lindberg (Eds.), *The end of the world: Contemporary philosophy and art* (Future perfect: Images of the time to come in philosophy, politics and cultural studies) (pp. 3–20). Rowman & Littlefield International.

Nietzsche, F. (1882). *Die fröhliche Wissenschaft*.

Pelton, J. N. (2015). *SPRINGER BRIEFS IN SPACE DEVELOPMENT New Solutions for the Space Debris Problem*. S. I. Publishing.

Pelton, J. N. (2019). A path forward to better space security: Finding new solutions to space debris, space situational awareness and space traffic management. *Journal of Space Safety Engineering, 6*(2), 92–100. https://doi.org/10.1016/j.jsse.2019.04.005

Pijnenburg, A., Gammeltoft-Hansen, T., & Rijken, C. (2018). Controlling migration through international cooperation. *European Journal of Migration and Law, 20*(4), 365–371.

Rajamani, L. (2000). The principle of common but differentiated responsibility and the balance of commitments under the climate regime. *Review of European Community & International Environmental Law, 9*, 120–131.

Stubbe, P. (2010). Common but differentiated responsibilities for space debris – New impetus for a legal appraisal of outer space pollution. *European Space Policy Institute, 31*, 1–12.

Taylor, R. S. (2010). Kant's political religion: The transparency of perpetual peace and the highest good. *Review of Politics, 72*(1), 1–24. https://doi.org/10.1017/S0034670509990945

UNHCR and UNSMIL (2016). "Detained and dehumanised: Report on human rights abuses against migrants in Libya". Office of the United Nations High Commissioner for Human Rights and United Nations Support Mission in Libya, 13 December 2016. Available at : http://www.ohchr.org/Documents/Countries/LY/DetainedAndDehumanised_en.pdf

Viikari, L. (2008). *The environmental element in space law. Studies in space law/ 3*. Martinus Nijhoff Publishers. https://doi.org/10.1017/CBO9781107415324.004

Warf, B. (2012). Cosmopolitanism and space. *Geographical Review, 102*(3). https://doi.org/10.1111/j.1931-0846.2012.00151.x

Part IV
Technology Readiness

Technology Readiness and Small States' Contributions to Planetary Defense

Petr Fatka, Petr Pravec, and Jiří Borovička

1 Asteroid Observation and Planetary Defense

In this section, we define interplanetary matter and its categorization and distribution across the Solar System. We discuss the risk of impacts posed by near-Earth objects and their possible consequences. We give a short visit to each of the most commonly used observation methods and discuss their usefulness and difficulties. The most promising proposed deflection methods are discussed with special attention paid to the upcoming space mission AIDA. Possible contributions by small states are illustrated by the example of the research of interplanetary matter in the Czech Republic.

1.1 What Is Interplanetary Matter

It is commonly known that our Solar System consists of the Sun and the eight major planets,[1] which together represent >99% of the total mass of the system. However, these massive objects are vastly outnumbered by smaller bodies, namely, asteroids (rocky bodies larger than 1 meter), meteoroids (rocky bodies smaller than 1 meter), and comets (volatile-rich[2] bodies), which are collectively called interplanetary

[1] Pluto was reclassified as a dwarf planet by the International Astronomical Union (IAU) in 2006.

[2] Chemical elements or compounds that sublimate at low temperatures (e.g., water, carbon dioxide)

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matter.[3] As of mid-2021, there are almost 1.1 million known asteroids and more than 3700 known comets, which is still a small fraction of their estimated population.

Interplanetary matter is material left over from the formation of the planets, which occurred about 4.5 billion years ago. Interplanetary matter is scattered across the entire Solar System, though there are some preferable regions where certain types of objects can be found in higher numbers. Almost 90% of all known asteroids orbit the Sun at average distances of between 2 and 3.2 astronomical unit[4] (au) in a region between the orbits of Mars and Jupiter, usually referred to as the main belt of asteroids. This belt is dynamically stable (asteroids may stay there for a very long time, even since their formation) except for several narrow regions that are affected by orbital resonances[5] caused by the gravitational attraction of the major planets, especially Jupiter. These resonances play a significant role in the dynamical evolution and distribution of small bodies in the Solar System. Beyond the orbit of Neptune (more than 30 au from the Sun), the Kuiper belt spreads out to approximately 50 au. This region is orders of magnitude larger than the main belt, and it is populated by objects that are mostly composed of a mixture of dust and ice (frozen volatiles) – comets and dwarf planets[6] (e.g., Pluto). While the Kuiper belt is dynamically stable, it borders (and mixes with) the so-called scattered disc (which stretches to up to several hundred au), and its objects experience close encounters with Neptune that alter their orbits. The scattered disc is believed to be the source of short periodic comets. For the sake of completeness, let us mention the Oort cloud, which is a cloud of icy objects spanning from a few thousand to a few hundred thousand au from the Sun, and it is the source of long periodic comets.

A main belt asteroid that drifts into a strong resonance (due to, for example, another resonance or a nongravitational force altering its orbit) may undergo a major orbital change, which can eventually result in its escape from the Solar System or a collision with the Sun or a planet. The majority of the near-Earth object (NEO) population comes from the main belt, and it is constantly supplied from it. A celestial object is classified as an NEO if the distance of the closest point of its orbit to the Sun (called the perihelion) is less than 1.3 au and the distance of its farthest point from the Sun (called the aphelion) is more than 0.983 au, which means that an NEO may get relatively close to the Earth's orbit. As of mid-2021, almost 26,000 NEOs (which represent 2.4% of all known asteroids) are known, with the largest NEO being (1036) Ganymed,[7] whose mean diameter is about 38 km (Mainzer et al., 2011). About 8% of NEOs have the minimum orbit intersection distance with Earth $\leq$0.05 au (about 7.5 million km), and they are about 140 m or larger in size; they are

[3] For completeness, we note that the definition of interplanetary matter includes dwarf planets and interplanetary dust as well.

[4] 1 astronomical unit equals 149,597,870.7 km (exactly).

[5] For example, an asteroid completes three full orbits around the Sun, while Jupiter completes one, resulting in a 3:1 resonance between the two bodies. This is similar to repeatedly pushing someone on a swing when they are closest to us – 1:1 resonance.

[6] Currently known dwarf planets in the Kuiper belt are Pluto, Haumea, and Makemake.

[7] Not to be confused with Jupiter's largest moon Ganymede

classified as *potentially hazardous objects* (PHOs). Special attention is paid and observing priority is given to PHOs. As of mid-2021, no known PHO has an alarmingly high probability of impacting the Earth. Currently, the highest impact probability is 0.012% for asteroid (29075) 1950 DA with its possible impact predicted to happen in the year 2880.[8]

In August 2020, the known near-Earth asteroid (NEA) population included 898 asteroids with estimated diameters ≥1 km, which represents about 96% of the estimated population of near-Earth asteroids with diameters ≥1 km (Harris & Chodas, 2021). Asteroids of these sizes pose a serious threat to life on Earth, and an impact of such a large asteroid would probably result in long-term climate damage on a global scale (Stuart & Binzel, 2004). The exact consequences of such an impact depend on several factors, such as its relative velocity[9] to the Earth, impact angle, the chemical composition of the impactor, its porosity, and the location of the impact. Statistically, an impact of a 1-km asteroid on Earth happens on average about every 500,000 years (Collins et al., 2005; Paine & Peiser, 2004; Stuart & Binzel, 2004). The current goal of surveys aimed at finding NEOs (e.g., *Catalina Sky Survey*, *The Panoramic Survey Telescope and Rapid Response System*) is to catalog at least 90% of all NEAs larger than 140 m. The latest population estimate of NEAs larger than 140 m is about 19,000 (Harris & Chodas, 2021), while only nearly 50% of them have been found by August 2020. A 140-m large object poses a threat on a continental scale, and such objects collide with the Earth on average once every 5000–10,000 years (Collins et al., 2005; Paine & Peiser, 2004). It has been estimated that there are about 310,000 NEAs with sizes ≥40 m (with about 5% of them already discovered) and they strike Earth every few hundred years on average. There are hundreds of millions of even smaller objects that hit Earth's atmosphere on a daily basis, but most of them burn up completely before they reach the ground or they drop meteorites harmlessly; these phenomena are called meteors or fireballs (if they are very bright). Up to the present, four small asteroids were found on their impact trajectories in advance before they hit, in fact, several hours before they caused fireballs in the Earth's atmosphere.

One of the recently documented impact events of a relatively large object happened in Russia in 1908 (known as the Tunguska event), when a ~50 m object (unclear whether an asteroid or a comet) exploded at an altitude of 5–10 km above ground and uprooted trees in a 26 km radius. A more recent and much better documented event happened again in Russia in 2013 (known as the Chelyabinsk meteor), where a ~20-m object struck Earth and shattered windows in 6 nearby cities, causing about 1500 injuries. Since 1994, seven impacts of asteroids or comets were observed on Jupiter, and hundreds of smaller impacts were detected on the Moon. It is clear that collisions in the Solar System (including Earth) are not rare. Despite the

[8] According to the *Sentry* monitoring program run by the *Center for NEO Studies*

[9] One of the reasons why long periodic comets pose a nonnegligible threat despite their small number, low density, and weaker structure is that their impact velocity is typically several times higher than in the case of an NEO orbiting in an orbit similar to Earth's.

smaller probability of impact by a larger object, we can say that nowadays we have means to detect and deflect them for the first time in history.

1.2 Methods of Observations

Techniques for observing interplanetary matter can be generally split into two (in some cases overlapping) groups. Asteroid surveys are primarily aimed at searching for new objects and their orbit determinations. The surveys typically use dedicated telescopes and instruments purposely built and optimized for their specific task (e.g., they have large fields of view so that they can survey large sky areas in a short time). Large surveys have all their observation time dedicated to their task, and it is not possible to request any observation time for individual targets. The first large surveys aimed at NEOs were *Spacewatch*, *Lincoln Near-Earth Asteroid Research* (LINEAR), and *Near-Earth Asteroid Tracking* (NEAT). Since 2005, the majority of new NEOs discovered every year was done by the *Catalina Sky Survey* (CSS), which is a system of three telescopes (with primary mirror diameters of 1.5 m, 1 m, and 0.68 m), and it was later joined by *The Panoramic Survey Telescope and Rapid Response System* (Pan-STARRS) consisting of two 1.8-m telescopes. For the last decade, these two surveys are responsible for about 90% of the yearly NEO discoveries. The cost of running a survey is relatively high and is, therefore, the domain of countries/organizations with a budget that allows the dedication of a telescope or telescopes to such a large project for many years. All of the NEO surveys listed above are funded by the USA.

The other observational strategy is aimed at the characterization of individual objects (which have already been found by the surveys). Since the survey telescopes have fixed observing schedules and they are neither suited nor equipped for further object characterization (e.g., spectroscopic observations), follow-up observations with other telescopes are needed to reduce the initial orbital uncertainty and to provide estimates of physical properties for individual NEOs. The most common observation methods are listed and briefly discussed below.

1.2.1 Astrometry

When an object is discovered (e.g., by a survey), its initially determined orbit is very uncertain and allows for a prediction of future positions of the object for only up to a couple of days.[10] Therefore, it is crucial to perform follow-up observations and measure positions of the object at multiple times (extending the observed arc of its orbit); otherwise, the object may become lost. About 18% of NEAs discovered

[10] For example, an NEO in an orbit similar to Earth travels (very roughly) a billion kilometers during one orbit around the Sun, and we are attempting to predict their position from a few observation windows during which the object has only completed a very small fraction of its orbit.

between 2013 and 2016 (i.e., more than 900 asteroids) have been lost (Vereš et al., 2018). An orbit is typically precisely determined when the time between the first and the last observation is at least several hundred days (with measurements in between). It is important to get a good estimate of the orbit before the object seemingly approaches the Sun in the sky and becomes unobservable for several months, so it can be recovered after. Precise orbit estimations are necessary to predict potential future collisions with Earth with as early a warning time as possible. It is also needed for other purposes, such as planning space missions, or to better understand the evolution of the Solar System in general.

With the high rate of new NEO discoveries performed by the surveys, it is essential that other telescopes (sometimes even amateur astronomers) help to determine their orbits and prevent their losses. This is a good opportunity even for telescopes with tight observation schedules as astrometric measurements are not very demanding in terms of telescope time and only a few images of a given target per night are usually sufficient for its orbit improvement. This is a good example of how less financially demanding observational infrastructures of small states can contribute to the NEO observational effort, confirming orbits of discovered NEOs, which is crucial for planetary defense efforts.

1.2.2 Time-Resolved Photometry

The apparent brightness of an asteroid (which is the amount of sunlight reflected from the asteroid and then measured by an observer) varies in time for several reasons. There are present geometric effects (such as the changing distance of the asteroid from the Sun and the observer or changing phase angle[11]) that cause relatively slow brightness changes, and they can usually be easily corrected for. This allows us to study the brightness variations caused by physical properties of the studied object, such as its shape, rotation, and varying surface reflectance (albedo) on different parts of the object (due to, for example, a young crater or cometary activity). Among other reasons, an estimation of the shape and precise measurement of its rotation is needed for planning space missions to specific NEOs. Another reason causing brightness variations of an asteroid is the presence of a gravitationally bound companion (a satellite), which can be discovered by photometric observations of mutual events (eclipses or occultations) between the two components of the binary asteroid system.

Time-resolved photometry observations are more demanding in terms of telescope time than astrometric observations, and they also require sophisticated processing routines.[12] However, they are an opportunity for telescopes of (almost) any

[11] A phase angle is an angle between the Sun, the observer, and the object.

[12] As an example of data processing complexities, we note that an asteroid's brightness is usually measured relatively with respect to several nearby reference stars in the same image. However, asteroids are moving, and therefore typically different sets of stars are used on different nights (or even more than one set of reference stars during a single night in the case of a fast-moving NEO).

size, provided a team operating the telescope masters the observational and processing techniques, for NEAs during their close approaches to Earth. Large surveys are not capable of gathering precise photometric data for detailed brightness variation studies. Only about 25,000 asteroids (as of mid-2021 according to the Asteroid Lightcurve Database[13]) of all kinds have estimated rotational periods, and only a few hundred asteroids with their own orbiting satellites have been identified, many of them by our team at the Ondřejov Observatory using the 0.65-m telescope from Ondřejov (Czech Republic) and the 1.54-m Danish telescope located at the La Silla station of the European Southern Observatory in Chile (within our collaboration with the Danish colleagues from the Copenhagen University). Photometric observations are a good opportunity for any state or organization to contribute to the NEO characterization, and they can allow individual teams to get expertise in some specific field, e.g., estimating the NEO's rotational state, its shape, detection of non-gravitational effects, or search for asteroids with satellites and their characterization.

1.2.3 Spectroscopy and Colorimetry

Different materials interact differently with electromagnetic radiation (e.g., visible light); therefore, it is possible to study the properties of the surface material of asteroids and comets because of this interaction. Comparing the measured properties with laboratory results (e.g., with terrestrial materials, found meteorites, or samples collected by space missions), we can estimate the surface composition of a distant object without visiting it with spacecraft. Reflected radiation (typically measured in the visible or near-infrared part of the spectrum) from an asteroid is split by wavelength, and the radiation intensity is measured for each wavelength.[14] After the measured spectrum is evaluated and the studied object is taxonomically categorized, values of other properties common for a given taxonomic group, such as albedo, can be inferred.

The light flux from asteroids and comets is typically low, and after its decomposition by wavelength, its light flux density is even much more reduced. Therefore, it is necessary to use relatively large telescopes to measure the spectrum of an NEO. If no suitable telescope for spectroscopic observations of a given NEO is available, it is also possible to photometrically measure the object in several filters transparent at different wavelengths (colors). That way we can obtain a low-resolution spectrum of the object that allows us to assess a likely taxonomic class of the NEO. We note that colorimetry is "poor man's" spectroscopy and many spectral features (e.g., absorption bands) cannot be recognized with it, but it still remains a valuable (and

Methods for combining observations taken on different nights (e.g., absolute brightness calibration) are required.

[13] Accessible at https://sbn.psi.edu/pds/resource/lc.html

[14] To be exact, the spectrum is divided into bins with widths up to several dozens of nanometers to boost the measured intensities.

affordable) tool for a basic taxonomic classification upon which object's albedo and size can be estimated.

Any spectral data for NEOs (or, in fact, any asteroid or comet) are very useful and highly valued by anyone modeling basically anything concerning real asteroids. For example, their albedo (which is an essential parameter directly linked to, for example, asteroid size) can be assumed/constrained upon their taxonomic classification from measured spectra. For example, refurbishing an old telescope and equipping it with a modern spectrometer might be an effective way to collect these important spectral data. Colorimetry is even more accessible, with only a set of standard filters needed.

1.2.4 Radar Observations

Radar observations of asteroids and comets principally differ from other NEO observations in that the reflected electromagnetic radiation does not originate from the Sun, but it is emitted by a transmitter, which is part of the radar. This has the benefit that we know exactly the characteristics of the transmitted electromagnetic wave (e.g., the timing of the transmission, its frequency modulation and polarization), and by comparing it with the reflected signal, we know how it was modified by reflection from the asteroid's surface. The main disadvantage is the limited range; the intensity of the received echo from a studied object decreases with the fourth power of its distance from the radar. Even with its strong transmitters (with power up to 1 MW) and 305-m-diameter dish, it requires a relatively close encounter of an NEO with Earth to be observable with the *Arecibo Telescope*, which was the largest radar with its own powerful transmitters ever built. (Unfortunately, in December 2020, it collapsed due to its age and local weather conditions.) Currently, the most powerful operational radar for interplanetary observations is the *Goldstone Solar System Radar* with a 70-m dish and 500-kW transmitter.

The use of radars for the study of interplanetary matter belongs among the most hardware-demanding observations. However, it can provide a unique set of information, such as the object's size and shape (with a spatial resolution as small as a few tens of meters), its precise position (with higher accuracy than optical astrometry measurements), rotation rate, and a direct imaging of possible companions.

1.2.5 Thermal Observations

In addition to reflecting solar radiation, all objects emit their own thermal radiation. Due to the low temperature of asteroids and comets (typically below 0 degrees Celsius), their thermal radiation is emitted mainly in the infrared part of the spectra. This makes it a challenging task to perform ground-based observations due to its strong absorption in the atmosphere, mainly due to water vapor, carbon dioxide, and ozone. Therefore, infrared telescopes are built at high-altitude sites with very low humidity and a less amount of atmosphere above, such as the *Visible and Infrared*

Survey Telescope for Astronomy (VISTA), a 4.1-m telescope in Chile; the *United Kingdom Infra-Red Telescope* (UKIRT), a 3.8-m telescope built in Hawaii; and NASA's *Infrared Telescope Facility* (IRTF), a 3-m telescope also located in Hawaii. The difficulty of infrared observations from Earth's surface led to the development of airborne observatories consisting of a plane carrying a telescope capable of observation during flight (e.g., the *Kuiper Airborne Observatory* and *Stratospheric Observatory for Infrared Astronomy*). The ultimate solution was to send an infrared telescope to space (e.g., *Spitzer Space Telescope*, *Herschel Space Observatory*, or *Wide-field Infrared Survey Explorer*). The planned infrared telescopes include the 6.5-m *James Webb Space Telescope* and the 0.5-m *Near-Earth Object Surveillance Mission* telescope that will be focused on the discovery and characterization of NEOs and is expected to launch in 2025.

Obtaining observations over a wide part of the infrared spectrum puts several demands on the instruments used (e.g., adequate cooling of the whole system to eliminate self-contamination) and the telescope location (to minimize absorption by Earth's atmosphere). Using a synergy between visible and infrared photometry measurements (and with the application of a physical model), we can determine asteroid sizes and their surface thermal parameters, most interesting of them being albedo, which are the fundamental asteroid physical properties that are usually difficult to estimate by other means.

1.2.6 Polarimetric Observations

Light reflected from the surface of an asteroid or a comet may change its polarization characteristics. This change depends on the surface material properties and the illumination and viewing geometry of the object. By observing an object at several different phase angles, a dependency of the degree of polarization on the phase angle can be obtained, which allows us to derive some surface properties, such as material roughness, porosity, and its albedo. By observing active comets, we might get information about the size, shape, and orientation of dust particles around them. Polarimetric observations are similar to the photometric ones, and they are doable by anyone with at least a 1-m sized telescope, with only a polarizing filter needed. The disadvantage of using a polarizing filter is that the amount of light going through onto the detector is significantly reduced and using a larger telescope may be needed for fainter objects.

1.2.7 In Situ Observations

A special type of observation of asteroids and comets is visiting them by a spacecraft. As of mid-2021, a total of 24 interplanetary objects of the Solar System were visited by human-made spacecraft.[15] Most of these visits were only flybys during the spacecraft's journey to the primary target of its given mission, but they are still a highly valuable source of information. From detailed images obtained during a close flyby, we can precisely estimate many of the object's properties, e.g., its size, shape (at least for the illuminated part of the body), surface features (e.g., craters, ridges, jet sources), surface albedo distribution, and the presence of companions (satellites). In 8 of the 24 cases, the spacecraft did match the velocity of the interplanetary object and "parked" itself in an orbit around the body, doing a "rendezvous" mission. Unlike during a flyby, which is always short (typically lasting minutes), the spacecraft on a "rendezvous" mission has much more time for measurements. It can explore the whole surface of the body from a much smaller distance, revealing many more surface details. In addition to the most common measurements (such as spectroscopy and polarimetry), another type of measurement is possible – gravitational. A detailed measurement of the gravitational field around a visited object provides an insight into the mass distribution and its properties[16] (e.g., bulk density or porosity). Six of the eight objects orbited by a spacecraft were also explored on the surface by a lander or by the spacecraft itself. That made it possible to perform an even more detailed study of their surface (and in some cases even subsurface) material. Finally, one of the most challenging tasks is a sample return to Earth. The Japanese spacecraft *Hayabusa* and *Hayabusa2* are the only missions that have already managed to return samples from an asteroid surface (and subsurface in the case of *Hayabusa2*) to Earth,[17] specifically, in 2010 from the asteroid *Itokawa* and in 2020 from the asteroid *Ryugu*. NASA's spacecraft OSIRIS-REx[18] collected samples from the asteroid *Bennu* in October 2020, and it is expected to deliver them to Earth in September 2023.[19] These samples allow us to perform studies of asteroid surface materials to the finest particles, and they help to restrict physical and evolutionary models created from macroscopic/distant observations. The obvious disadvantage of space missions is the limited number of objects that can be

[15] An overview can be found at https://en.wikipedia.org/wiki/List_of_minor_planets_and_comets_visited_by_spacecraft

[16] For example, a combination of ground-based measurements together with measurements made by the *Hayabusa* spacecraft of the elongated asteroid *Itokawa* suggests that the bulk density of one end of the asteroid is about 2.85 g/cm^3, while the other part and the central body exhibit an average bulk density of only about 1.75 g/cm^3 (Lowry et al., 2014).

[17] In 2006, the spacecraft *Stardust* (NASA) delivered a sample of dust particles collected in the coma of comet *81P/Wild*. These samples were collected during a flyby with the closest distance of 240 km from the comet.

[18] OSIRIS-REx stands for *Origins, Spectral Interpretation, Resource Identification, Security, Regolith Explorer*.

[19] According to the official update from May 10, 2021 (Johnson et al., 2021)

visited during a single mission and the high cost of these missions. Regarding ESA missions, any institute or company from a member state can participate in the selection procedure for, for example, instrument development or assembly.

1.2.8 Meteorite Analysis

Meteorites are samples of asteroids delivered cheaply to the Earth by nature. Laboratory analyses are used to study details of mineralogical, chemical, and isotopic composition of meteorites as well as their physical properties such as density, porosity, and structure. The basic classification can distinguish at least 30 types of stony meteorites, 15 types of metallic (iron-nickel) meteorites, and 4 types of stony-iron meteorites (Weisberg et al., 2006). Though some meteorites come from the Moon and Mars and it is possible that some of the least processed meteorite types (rich in carbon) originated in comets, the diversity of meteorite types is evidence for the diversity of asteroids. Some meteorite types have been linked to asteroid taxonomic classes by reflectance spectroscopy, but for many types, the link remains uncertain (DeMeo et al., 2015).

Meteorite analyses are performed in special laboratories. Each developed country has facilities for basic analyses and meteorite classification and also institutions (e.g., museums) to curate meteorites. More demanding analyses can be done in only a few laboratories worldwide, which have special equipment and the necessary expertise.

Although the meteorite collections are rich, they do not provide full information about asteroid properties. Meteorites are delivered by meteoroids and small (meter-sized) asteroids, but they represent their most resistant parts that survived the high-velocity (~11–30 km/s) passage through the Earth's atmosphere. Typically, more than 90% of the mass is lost in the atmosphere, and the rest is often split into a number of fragments. The structure of the original body could be quite different from that of the surviving fragments. Moreover, some types of asteroidal material can be too weak to deliver any meteorites at all (e.g., Borovička et al., 2017). Finally, the meteorite-asteroid link could be enhanced if the pre-encounter meteorite orbits were known. Then the source regions of different meteorites in the asteroid belt could be evaluated. But the orbit of the vast majority of meteorites is unknown. Nevertheless, the gaps between meteorite and asteroid studies can be partly bridged by meteor observations.

1.2.9 Observations and Characterization of Meteors

Meteors are luminous phenomena caused by the ablation of solid objects during their high-velocity penetration through a planetary atmosphere. On Earth, they usually occur at heights between 20 and 120 km and can be observed from the ground even by the naked eye. The detection is also possible by acoustic and radar techniques. Most precise data are obtained by photographic or video cameras (Koten

et al., 2019). The optical observation of meteors is cheap and easy since almost any commercial camera can be used. Obtaining scientific results relevant for asteroid studies, nevertheless, needs systematic and precise work. Meteor trajectories and pre-encounter heliocentric orbits can only be computed if the meteor was observed from at least two sites. The cameras further provide meteor light curves (brightness as a function of time), deceleration as a function of height, morphologies (shape of the radiating volume), and spectra.

To study meteoroids larger than several centimeters, meteors brighter than all other objects in the sky except the Sun and the Moon, called fireballs, must be observed. Since fireballs are rare, fireball camera networks covering a larger geographic area than is possible from just two sites are used. One of their aims is to calculate the location of meteorites after a meteorite dropping a fireball was observed and to provide the corresponding meteorite orbit. In addition, the behavior of the meteoroid in the atmosphere, especially its fragmentation, which can be revealed from the fireball data, provides information about the structure and mechanical strength of the original body. This information is also obtained if the meteorite was not recovered or when no meteorite was produced because of the low strength or small size of the meteoroid. Note that the number of instrumentally observed falls of recovered meteorites is still relatively low, less than 40 (Meier, 2017). The meteoroid chemical composition can be studied from fireball spectra, though with lower precision than a meteorite laboratory analysis can provide. Meteor observations therefore provide data about all types of asteroidal and cometary material encountering the Earth (Borovička et al., 2019). In fact, it is one of few tools to study the internal structure of asteroids (on the centimeter to meter scale), which is relevant for both asteroid deflection efforts and the evaluation of the consequences of asteroid impacts.

1.3 Planetary Defense

In order to provide any chance of defense against a threat posed by an incoming asteroid or comet, it is necessary to identify the threat as soon as possible and to have a plan and technology for eliminating the threat. The public is becoming more and more aware of the possibility of impacts on Earth, and a lot of effort is being put into the threat identification. The vast majority of the largest NEOs have been already found by sky surveys (especially by LINEAR, NEAT, and CSS), and none of them is on a collision course with Earth within this or the next few centuries.[20] The current goal for the surveys (set by NASA) is to identify at least 90% of the NEOs with sizes of 140 m or larger. Currently (as of mid-2021), we know nearly 50% of the estimated population of near-Earth asteroids of these sizes (discovered

[20] As mentioned in Sect. 4.1.1, the currently highest-impact probability is 0.012% for asteroid (29075) 1950 DA with the possible impact in the year 2880.

mainly by CSS and Pan-STARRS). Then the upcoming ground-based *Vera C. Rubin Observatory* with an 8.4-m survey telescope (formerly known as the *Large Synoptic Survey Telescope*) and the upcoming space-based *Near-Earth Object Surveillance Mission* (formerly known as the *Near-Earth Object Camera*) with a 0.5-m infrared telescope are expected to significantly boost the discovery rate of NEOs. The risk of an impact in the next 100 years of any known NEO is daily computed with the latest data by the *Center for Near-Earth Object Studies*, and the results are publicly available on their webpage.[21]

When a potential collision of an NEO with Earth is identified, the further characterization of the possible impactor is necessary so that we can plan how to best eliminate the threat. The main physical property determining the eventual scale of destruction is the mass of the impactor, which can be either estimated remotely from its estimated or measured size and estimated or assumed bulk density or determined from in situ measurements performed by a rendezvous mission with a space probe. If the incoming impactor is not very big and its impact would cause only localized destruction on Earth, it might be enough to simply evacuate the area on Earth's surface that is predicted to be affected by the impact. Obtaining detailed knowledge of the potential impactor's physical properties, such as its size, shape, composition, rotational state, presence of a satellite, or its activity, may play an important role for planning the best deflection strategy. For instance, if there is material escaping from the body's surface (as seen on the asteroid *Bennu* by the OSIRIS-REx spacecraft), it might hamper the use of deflection missions requiring a long stay close to the asteroid's surface (e.g., the gravity tractor deflecting method – see below). Estimating many of these properties by remote observations usually requires a long observational run and favorable observing conditions, such as a close encounter of the potential impactor to Earth (which enables the use of radar measurements, among other observational techniques). However, we cannot fully rely on obtaining a warning of a potential impact a long time (decades) in advance, and we must also have a plan for the possibility that an incoming impactor is discovered relatively shortly (a few years or less) before the potential impact. We give a brief overview of the currently most available deflection missions below, (for more information, see, for example, Schmidt, 2019).

1.4 Kinetic Impactor

The most technologically ready method of deflecting an incoming object is a high-velocity collision of a massive spacecraft with the object. The momentum of the fast-moving spacecraft is transferred to the dangerous object, resulting in a small change of its heliocentric orbit that leads to avoiding the potential future collision with Earth. The effectiveness of this method depends on several factors, such as the

[21] https://cneos.jpl.nasa.gov/sentry/

mass ratio between the spacecraft and the object, the impact velocity, the location of the impact on the object (an impact directed toward the center of the mass of the body will be much more effective than a tangential one), or the direction of the impact with respect to the object's velocity vector – an impact directed along or against its current velocity vector is most effective and produces the largest change in the object's orbital period. In addition to the momentum transferred to the object by the spacecraft projectile, significant additional momentum may be added by the ejected mass of the object itself during the crater formation. This effect of momentum transfer enhancement may be up to several times greater than the "kick" by the projectile spacecraft itself.

In 2005, the *Deep Impact* spacecraft successfully delivered a 372-kg projectile that struck the comet 9P/Tempel at a speed of 10.2 km/s and created a 150-m-wide crater ("Tempel 1 Impact Site", 2011), demonstrating the technological readiness of performing a high-velocity impact onto a small body. Another major step is the joint project of NASA and ESA called *Asteroid Impact and Deflection Assessment* to the asteroid (65803) Didymos and its satellite Dimorphos. The main goal of NASA's *Double Asteroid Redirection Test* (DART) mission is to perform a deliberate high-velocity impact of the 500-kg spacecraft at about 7 km/s ("DART Mission", 2021) onto Dimorphos (which is about 160 m wide), which will produce a change of its orbit around Didymos. Shortly before the impact, a small CubeSat[22] will separate from the main spacecraft, and it will record the impact and released ejecta and will send the gathered data back to Earth. However, due to the high velocity, it will only fly by Didymos and Dimorphos in a short time (minutes) so it will not measure the change of the Dimorphos orbit which will require a longer set of measurements. The change of the orbital period of Dimorphos is predicted to be large enough to be measurable by ground-based observations. DART will be launched during the window beginning in November 2021, and it is scheduled to collide with Dimorphos in late September or early October 2022. Both Didymos and Dimorphos will be thoroughly studied by the ESA's *Hera* mission[23] in 2026 or later, which is planned to launch in 2024. Hera will park itself in an orbit around the Didymos-Dimorphos system, and its main goals will be a detailed study of the formed crater after the DART impact and, most importantly, a precise measurement of the mass of Dimorphos, which is essential for the DART impact efficiency evaluation.

In order for the DART spacecraft to successfully hit Dimorphos, it is essential to know the orbital parameters of Dimorphos, allowing us to make an accurate prediction of its position. As said above, the maximum efficiency for the orbit change will be achieved by an impact directed along or against the current velocity vector of the target. The worst-case scenario would be if Dimorphos was hidden behind Didymos (as seen from the approaching spacecraft), making it impossible for DART to hit. Our team here at Ondřejov Observatory, Astronomical Institute of Czech Academy

[22] A 6-unit CubeSat named *Light Italian CubeSat for Imaging of Asteroids* (LICIA)

[23] Not to be confused with NASA's ground-based *Human Exploration Research Analog* (HERA) mission

of Sciences, contributes significantly to the goal within the DART/Hera Working Group 2 “Remote Observations” with analyzing and modeling Didymos photometric data, determining the orbit of Dimorphos around Didymos, and predicting its position at the time of the DART impact. Then, after the DART impact, we will use new photometric measurements (taken by a large consortium of telescopes spread around the world) and determine the new orbit period of Dimorphos, changed by the DART impact, with high accuracy, which is an essential result to evaluate the efficiency of the impact and the magnitude of the momentum transfer enhancement.

1.5 Nuclear Explosion

A more radical approach than the kinetic impactor is the use of a nuclear explosion. The most effective results are achieved by a detonation above the asteroid’s surface, depending mainly on the target’s size, composition, and structural integrity (Simonenko et al., 1994; Solem, 1995, 1999). This presents a serious challenge regarding the timing of the ignition since a high-velocity approach to the target is more likely. Once the explosion takes place, a massive amount of energy is released, the surface material gets instantly vaporized, and its escape produces a thrust propelling the targeted body in the opposite direction. To achieve an even stronger effect, comparable with a subsurface detonation, a combination of a kinetic impactor and nuclear explosion was proposed (Barbee et al., 2015; Wie, 2013). In this scenario, the leading spacecraft will act as a kinetic impactor hitting the object at high velocity (10–30 km/s). In a small fraction of second, the following spacecraft equipped with a nuclear cargo would fly into the previously created crater and would detonate upon impact resulting in a theoretically much higher amount of mass ejected from the threatening object (meaning a stronger kick). This method might be hypothetically effective against large objects, but without knowing the object’s internal structure, it could result in its disruption, which would be an unwanted outcome.

1.6 Gravity Tractor

A gravity tractor is a non-collisional approach to deflect an asteroid proposed by Lu and Love (2005). It is based on the fact that the gravitational attraction between a spacecraft and a nearby object is mutual. A spacecraft hovering at an altitude above the surface of the deflected object (i.e., not orbiting around it) slowly pulls the object toward it, resulting in a gradual change of its heliocentric orbit. In principle, this allows for fine and controlled orbital adjustments in an optimal direction for efficient deflection, whereas the exact outcome of the kinetic impactor or the nuclear explosion missions is somewhat less predictable. This, of course, means that it is necessary to match the velocity of the object by a (heavy) spacecraft, which is

achieved by a longer travel time than in the case of a direct hit. This method is useful when we know about the asteroid's collision with Earth decades in advance. Increasing our knowledge about the interplanetary matter in the Solar System will likely make this method the most used in the centuries to come because humanity will not need to act "at the last minute" given the knowledge we will have. In this regard, we can imagine dozens of gravity tractors placed through the Solar System, which can become a global continuous effort without the need for a specific mission to deflect just the one asteroid threatening Earth at a given time.

1.7 Induced Ablation

Another potential method for changing the orbit of an asteroid or a comet is by localized heating of the surface material to achieve its ablation (producing a weak thrust) by a focused beam of light. The source of the light beam can be either a powerful laser (or an array of several lasers) or a focused sunlight (e.g., by a set of large mirrors). The usability of this method is limited by the rotational state of the targeted object (e.g., a fast rotation puts a significant constraint on the length of the exposure). Similarly, as with the gravity tractor method, adjustments of the deflection are possible during the process allowing steering the object in a preferable direction. The application of this method is not yet possible with current technologies, but it may be ready in the future. More discussion of this method is provided in Sect. 5.2 of this book.

A brief summary of the usability of the methods outlined above follows. Currently the only applicable method for an asteroid deflection is the kinetic impactor. Space missions DART and Hera are set to test the technological readiness of the method and its efficiency. Even a small orbital change of a potential Earth impactor may be sufficient to avoid the impact if it is applied a long time in advance. A deflection by a nuclear explosion is theoretically capable of a faster orbital change of the potential impactor, and the technology allowing a nuclear explosion in space could be ready within several years if it is given a priority. The biggest issue with this method is the question of weaponizing the sky with extremely strong nuclear warheads capable of striking any place on Earth. The gravity tractor method is capable of steering a dangerous object in a controlled fashion, but decades of steering may be needed to achieve a requested orbital change. One of the potential issues is equipping a heavy spacecraft with enough propellant so it is capable of very frequent maneuvers in order to stay in the best guiding position for the potential Earth impactor. Inducing surface ablation on a NEO is the most challenging method of its deflection requiring development of new technologies and solving many issues, such as providing enough energy to repeatedly heat up parts of the surface to achieve material ablation.

2 Potential Contribution of Small Countries: The Case of Czechia

The opportunity to contribute to our knowledge of the Solar System is open for everyone, including professional research teams from small states and even decentralized communities of enthusiasts. With the focus on planetary defense against a threat posed by asteroids and comets, a contribution with follow-up astrometric observations of NEOs is one of the least demanding but important tasks. The *Minor Planet Center* provides a daily updated list of newly discovered NEOs with their ephemerides, and it updates their heliocentric orbits with newly submitted astrometric measurements on a daily basis, which can include any observatory willing to contribute, provided a certain level of accuracy of its measurements is achieved. This approach helps to quickly reveal potentially hazardous objects. High-precision astrometric observations of asteroids and comets are the main task of the Kleť Observatory (Czech Republic). Their measurements help to improve orbital estimation of asteroids and comets, including NEOs. Furthermore, over a thousand new asteroids were discovered at Kleť despite its limited technical capabilities compared to huge multimillion dollar surveys. Measurements from Kleť Observatory also help to refine the risk of impacts identified by automatic collision monitoring systems (SENTRY or CLOMON); about 200 potential impactors were observed during 2002–2018 (Ticha et al., 2019).

A characterization of asteroids and comets is another important task. This is the primary focus of the Asteroid research team of the Interplanetary Matter Department of *the Astronomical Institute of Czech Academy of Sciences* at Ondřejov Observatory. Mastering their observational techniques and the development of custom data processing tools together with fine and careful hardware tuning are the cornerstones of the success and international respect earned by the team. Among the research topics of the Asteroid research group, the main one is the photometric observations of asteroids and their physical characterization. For the task, they utilize the 0.65-m telescope at Ondřejov and the 1.54-m Danish telescope on the La Silla station of the European Southern Observatory in Chile (the latter in collaboration with their colleagues at the Copenhagen University in Denmark). Among the asteroid physical parameters they determine, the most important ones are asteroid absolute magnitudes, their rotational states, and the presence of satellites. They have determined rotational periods and states for hundreds of NEAs, and they have discovered or characterized tens of NEA binary or multiple systems. One of the most important principal findings obtained by the Asteroid team, also thanks to their rich and fruitful collaboration with other astronomical observatories in the world, has been the description and confirmation of a physical process that is responsible for gentle breakups of asteroids – the rotational fission process (Pravec et al., 2010). Being recognized as experts in the field of asteroid photometry and the derivation of their physical parameters, they have been invited to collaborate or to contribute with target observations and characterization on a few new space mission projects, such as the DART and Hera missions, where they have a principal role in the DART/Hera Working Group 2 “Remote Observations” (see the *Kinetic Impactor* part of the

previous section), or the prepared NASA *Janus* space mission that plans to visit two near-Earth asteroids with satellites.[24] The Asteroid research team at Ondřejov collaborates closely with researchers at the *Astronomical Institute of Charles University* in Prague. The collaboration is very fruitful, especially due to a synergy between the two teams, who use different but complementary research methods and techniques, which leads to unique results. One example is their collaborative study of PHA (99942) Apophis that led to its shape and rotational state determination, revealing its excited, non-principal axis rotation[25] (Pravec et al., 2014) and constraining a magnitude of its heliocentric orbit change due to the Yarkovsky effect[26] (David Vokrouhlický et al., 2015), which was essential for the evaluation of the probability of impact of the asteroid with Earth later in this century. Another example of a close collaboration between the two teams is the detailed study of PHA (3200) Phaethon, which is believed to be the largest (primary) body of a cluster consisting of Phaethon and two other, smaller near-Earth asteroids (Hanuš et al., 2016, 2018), and it has been also identified as the source of the Geminid meteoroid stream, which strikes Earth in December every year. The parent body of these three asteroids most likely underwent rotational fission due to the nongravitational thermal effect called YORP,[27] demonstrating how new NEOs can be formed. An understanding of these processes is needed for obtaining a good estimate of the NEO population, its properties, and evolution. Several detections of these nongravitational evolutionary forces acting on NEOs were obtained by the researchers from the Astronomical Institute of Charles University and the Czech Academy of Sciences (a few examples are Ďurech et al., 2008; Scheirich et al., 2021; Vokrouhlický et al., 2008).

Another example of a small country contribution for the characterization of our cosmic environment is the fireball network which has been operated by the Meteor Physics group of the Interplanetary Matter Department of the Astronomical Institute of Czech Academy of Sciences for almost 60 years. Systematic photographic double-station observations of meteors started at the Ondřejov Observatory and another neighboring site back in 1951. Although the program was focused on fainter meteors, a very bright fireball was photographed on April 7, 1959. An innovative analysis of the data allowed Z. Ceplecha (1929–2009) to conclude that multiple meteorite fragments reached the ground and to calculate their fall area. Four pieces were actually found, and the meteorites, named Příbram, became the first meteorites in history, whose orbit was precisely determined (Ceplecha, 1961). The link between meteorites and the asteroid belt was firmly established.

[24] Janus is scheduled to be launched in August 2022, and it is planned to fly by the binary asteroids (175706) 1996 FG3 and (35107) 1991 VH in 2026.

[25] The orientation of the rotational axis of a non-principal axis rotator is not fixed in space, but it precesses around the angular momentum vector.

[26] The Yarkovsky effect is a thermal effect that slowly changes an asteroid's orbit. It is partially responsible for the long-term uncertainty of predictions of asteroid positions (e.g., estimating the probability of a collision with Earth).

[27] The YORP (Yarkovsky-O'Keefe-Radzievskii-Paddack) effect spins up or down asteroid rotation. The spin up may eventually lead to a rotational fission and split of the affected body into two (or more) fragments, increasing the number of asteroids.

With the aim of observing other similar events more often, Ceplecha and his collaborators established the first fireball network in the world in 1963. Initially covering the former Czechoslovakia, and later extended to Western Germany and partly also to other countries (Austria, Switzerland, Belgium, the Netherlands), the network became known as the European Fireball Network (EN). The success of Příbram and the foundation of the EN inspired the establishment of the Prairie Network (PN) in the USA, which was in operation in 1963–1975, and the Meteorite Observation and Recovery Project (MORP) in Canada, working in 1971–1985 (see Borovička et al., 2015 and references therein). Each of the two North American networks yielded one recovered meteorite, but their funding was stopped after somewhat more than a decade of operation despite providing good data. The funding of the EN also became minuscule in Germany over the years, but in the small Czech Republic, the fireball network was recognized as one of the key national astronomical programs and continued to be funded by the Academy of Sciences (and, of course, the funding was supplemented by grants). The program has been aimed not only at meteorite recovery but also at the characterization of the physical and chemical properties of various populations of meteoroids. Fireball spectroscopy was part of the observations from the beginning. Z. Ceplecha became a leading international expert in the field and was invited to help with the analysis of important events such as the Peekskill meteorite fall in the USA in 1992, where causal camera records were available (Brown et al., 1994). Peekskill then became the fourth meteorite with a known orbit. In fact, Ceplecha and his successors P. Spurný and J. Borovička analyzed or participated in the analysis of nearly half of all instrumentally observed meteorite falls to date worldwide. Among them was the damaging Chelyabinsk meteorite fall in Russia in 2013 (Borovička et al., 2013). The EN itself yielded the heterogeneous Benešov meteorite, which fell in 1991 but was only recovered in 2011 (Spurný et al., 2014); the Neuschwanstein meteorite, which fell in 2002 and had a very similar orbit to Příbram (Spurný et al., 2003); and several others. In 2005, P. Spurný, together with P. Bland from the UK, established the Desert Fireball Network (DFN) in Australia (Bland et al., 2012), which yielded two meteorites in its initial stage when Czech fireball cameras were used. Later on, DFN became directed from Australia and was expanded. Nowadays, various fireball networks are being established in various countries, continuing the scientific field invented in the Czech Republic. Nevertheless, the modernized Czech part of the EN can still be considered to be the leading project in fireball characterization, not because of its size but because of the complexity of the data and of the analyses it provides.

3 Conclusions

The fact that asteroids and comets pose a threat to life on Earth does not surprise anyone anymore. This could be due to the large impact responsible for the mass extinction of the dinosaurs taught in schools or maybe due to the more recent smaller impacts, such as the Tunguska event or the very recent Chelyabinsk meteorite fall.

A significant effort is being put into the possible identification of threats by a thorough search of the night sky by surveys (with more of them under construction), by the precise positional measurements of NEOs, and by evaluating a possible collision with Earth in the future. The usability of suitable deflection methods is dependent on the physical characteristics, which are typically derived by focused teams from various countries around the globe.

As we showed in the example of research of small Solar System bodies in the Czech Republic above, even research teams from small countries can contribute significantly to the global effort of planetary defense against impacts of asteroids and comets. This may serve as an inspiration for scientists from other small countries to find their own ways for fruitful research in the field, taking advantage of their best experience and specialization and considering specific conditions for scientific research in their countries.

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References

Barbee, B. W., Wie, B., Steiner, M., & Getzandanner, K. (2015). Conceptual design of a flight validation mission for a Hypervelocity Asteroid Intercept Vehicle. *Acta Astronautica, 106*, 139–159. https://doi.org/10.1016/j.actaastro.2014.10.043

Bland, P. A., Spurný, P., Bevan, A. W. R., Howard, K. T., Towner, M. C., Benedix, G. K., et al. (2012). The Australian Desert Fireball Network: A new era for planetary science. *Australian Journal of Earth Sciences, 59*(2), 177–187. https://doi.org/10.1080/08120099.2011.595428

Borovička, J., Spurný, P., Brown, P., Wiegert, P., Kalenda, P., Clark, D., & Shrbený, L. (2013). The trajectory, structure and origin of the Chelyabinsk asteroidal impactor. *Nature, 503*(7475), 235–237. https://doi.org/10.1038/nature12671

Borovička, J., Spurný, P., & Brown, P. (2015). Small near-Earth asteroids as a source of meteorites. In P. Michel, F. E. DeMeo, & W. F. Bottke (Eds.), *Asteroids IV*. University of Arizona Press. https://doi.org/10.2458/azu_uapress_9780816532131-ch014

Borovička, J., Spurný, P., Grigore, V. I., & Svoreň, J. (2017). The January 7, 2015, superbolide over Romania and structural diversity of meter-sized asteroids. *Planetary and Space Science, 143*, 147–158. https://doi.org/10.1016/j.pss.2017.02.006

Borovička, J., Macke, R. J., Campbell-Brown, M. D., Levasseur-Regourd, A.-C., Rietmeijer, F. J. M., & Kohout, T. (2019). Physical and chemical properties of meteoroids. In G. O. Ryabova, D. J. Asher, & M. D. Campbell-Brown (Eds.), *Meteoroids: Sources of meteors on earth and beyond* (2019th ed., pp. 37–62). Cambridge University Press.

Brown, P., Ceplecha, Z., Hawkes, R. L., Wetherill, G., Beech, M., & Mossman, K. (1994). The orbit and atmospheric trajectory of the Peekskill meteorite from video records. *Nature, 367*(6464), 624–626. https://doi.org/10.1038/367624a0

Ceplecha, Z. (1961). Multiple fall of Přibram meteorites photographed. 1. Double-station photographs of the fireball and their relations to the found meteorites. *Bulletin of the Astronomical Institute of Czechoslovakia, 1961*(12), 21.

Collins, G. S., Melosh, H. J., & Marcus, R. A. (2005). Earth impact effects program: A web-based computer program for calculating the regional environmental consequences of a meteoroid impact on Earth. *Meteoritics & Planetary Science, 40*(6), 817–840. https://doi.org/10.1111/j.1945-5100.2005.tb00157.x

DeMeo, F. E., Alexander, C. M. O., Walsh, K. J., Chapman, C. R., & Binzel, R. P. (2015). The compositional structure of the asteroid belt. In P. Michel, F. E. DeMeo, & W. F. Bottke (Eds.), *Asteroids IV*. University of Arizona Press. https://doi.org/10.2458/azu_uapress_9780816532131-ch002

Double Asteroid Redirection Test (DART) Mission. (2021, June 4). *nasa.gov*. https://www.nasa.gov/planetarydefense/dart

Ďurech, J., Vokrouhlický, D., Kaasalainen, M., Higgins, D., Krugly, Y. N., Gaftonyuk, N. M., et al. (2008). Detection of the YORP effect in asteroid (1620) Geographos. *Astronomy & Astrophysics, 489*(2), L25–L28. https://doi.org/10.1051/0004-6361:200810672

Hanuš, J., Delbo, M., Vokrouhlický, D., Pravec, P., Emery, J. P., Alí-Lagoa, V., et al. (2016). Near-Earth asteroid (3200) Phaethon: Characterization of its orbit, spin state, and thermophysical parameters. *Astronomy & Astrophysics, 592*, A34. https://doi.org/10.1051/0004-6361/201628666

Hanuš, J., Vokrouhlický, D., Delbo, M., Farnocchia, D., Polishook, D., Pravec, P., et al. (2018). (3200) Phaethon: Bulk density from Yarkovsky drift detection. *Astronomy & Astrophysics, 620*, L8. https://doi.org/10.1051/0004-6361/201834228

Harris, A. W., & Chodas, P. W. (2021). The population of near-earth asteroids revisited and updated. *Icarus, 365*, 114452. https://doi.org/10.1016/j.icarus.2021.114452

Johnson, A., Fox, K., Gran, R., & Potter, S. (2021, April 10). NASA's OSIRIS-REx spacecraft heads for Earth with asteroid sample. *nasa.gov*. https://www.nasa.gov/press-release/nasa-s-osiris-rex-spacecraft-heads-for-earth-with-asteroid-sample

Koten, P., Rendtel, J., Shrbený, L., Gural, P., Borovička, J., & Kozak, P. (2019). Meteors and meteor showers as observed by optical techniques. In G. O. Ryabova, D. J. Asher, & M. D. Campbell-Brown (Eds.), *Meteoroids: Sources of meteors on earth and beyond* (2019th ed., pp. 90–115). Cambridge University Press.

Lowry, S. C., Weissman, P. R., Duddy, S. R., Rozitis, B., Fitzsimmons, A., Green, S. F., et al. (2014). The internal structure of asteroid (25143) Itokawa as revealed by detection of YORP spin-up. *Astronomy & Astrophysics, 562*, A48. https://doi.org/10.1051/0004-6361/201322602

Lu, E. T., & Love, S. G. (2005). Gravitational tractor for towing asteroids. *Nature, 438*(7065), 177–178. https://doi.org/10.1038/438177a

Mainzer, A., Grav, T., Bauer, J., Masiero, J., McMillan, R. S., Cutri, R. M., et al. (2011). Neowise observations of near-Earth objects: Preliminary results. *The Astrophysical Journal, 743*(2), 156. https://doi.org/10.1088/0004-637X/743/2/156

Meier, M. M. M. (2017). Meteoriteorbits.info – Tracking all known meteorites with photographic orbits. In *Lunar and planetary science XLVIII* (Vol. 2017). Presented at the 48th Lunar and Planetary Science Conference, The Woodlands, Texas, Lunar and Planetary Science XLVIII. https://www.meteoriteorbits.info/

Paine, M., & Peiser, B. (2004). The Frequency and Consequences of Cosmic Impacts Since the Demise of the Dinosaurs. In *Bioastronomy 2002: Life among the stars* (Vol. 2004, p. 289). Presented at the 213th Symposium of the International Astronomical Union.

Pravec, P., Vokrouhlický, D., Polishook, D., Scheeres, D. J., Harris, A. W., Galád, A., et al. (2010). Formation of asteroid pairs by rotational fission. *Nature, 466*(7310), 1085–1088. https://doi.org/10.1038/nature09315

Pravec, P., Scheirich, P., Ďurech, J., Pollock, J., Kušnirák, P., Hornoch, K., et al. (2014). The tumbling spin state of (99942) Apophis. *Icarus, 233*, 48–60. https://doi.org/10.1016/j.icarus.2014.01.026

Scheirich, P., Pravec, P., Kušnirák, P., Hornoch, K., McMahon, J., Scheeres, D. J., et al. (2021). A satellite orbit drift in binary near-Earth asteroids (66391) 1999 KW4 and (88710) 2001 SL9 – Indication of the BYORP effect. *Icarus, 360*, 114321. https://doi.org/10.1016/j.icarus.2021.114321

Schmidt, N. (Ed.). (2019). *Planetary defense: Global collaboration for defending earth from asteroids and comets* (1st ed.). Springer International Publishing: Imprint: Springer. https://doi.org/10.1007/978-3-030-01000-3

Simonenko, V. A., Nogin, V. N., Petrov, D. V., Shubin, O. N., & Solem, J. C. (1994). Defending the earth against impacts from large comets and asteroids. In T. Gehrels, M. S. Matthews, & A. Schumann (Eds.), *Hazards due to comets and asteroids* (Vol. 1994, p. 929). University of Arizona Press.

Solem, J. C. (1995). Interception and disruption. In *Planetary defense workshop* (Vol. 1995). Presented at the Planetary defense workshop, Livermore, USA.

Solem, J. C. (1999). Comet and asteroid hazards: Threat and mitigation. *Science of Tsunami Hazards, 17*(3), 141–154.

Spurný, P., Oberst, J., & Heinlein, D. (2003). Photographic observations of Neuschwanstein, a second meteorite from the orbit of the Příbram chondrite. *Nature, 423*(6936), 151–153. https://doi.org/10.1038/nature01592

Spurný, P., Haloda, J., Borovička, J., Shrbený, L., & Halodová, P. (2014). Reanalysis of the Benešov bolide and recovery of polymict breccia meteorites – Old mystery solved after 20 years. *Astronomy & Astrophysics, 570*, A39. https://doi.org/10.1051/0004-6361/201424308

Stuart, J. S., & Binzel, R. P. (2004). Bias-corrected population, size distribution, and impact hazard for the near-Earth objects. *Icarus, 170*(2), 295–311. https://doi.org/10.1016/j.icarus.2004.03.018

Tempel 1 Impact Site. (2011, February 18). *nasa.gov*. https://www.nasa.gov/mission_pages/stardust/multimedia/Schultz4.html

Ticha, J., Tichy, M., & Honkova, M. (2019). Klet observatory preparedness and plans for planetary defence. In *Presented at the 1st NEO and debris detection conference*. ESA Space Safety Programme Office.

Vereš, P., Payne, M. J., Holman, M. J., Farnocchia, D., Williams, G. V., Keys, S., & Boardman, I. (2018). Unconfirmed near-Earth objects. *The Astronomical Journal, 156*(1), 5. https://doi.org/10.3847/1538-3881/aac37d

Vokrouhlický, D., Chesley, S. R., & Matson, R. D. (2008). Orbital identification for asteroid 152563 (1992 BF) through the Yarkovsky effect. *The Astronomical Journal, 135*(6), 2336–2340. https://doi.org/10.1088/0004-6256/135/6/2336

Vokrouhlický, D., Farnocchia, D., Čapek, D., Chesley, S. R., Pravec, P., Scheirich, P., & Müller, T. G. (2015). The Yarkovsky effect for 99942 Apophis. *Icarus, 252*, 277–283. https://doi.org/10.1016/j.icarus.2015.01.011

Weisberg, M. K., McCoy, T. J., & Krot, A. N. (2006). Systematics and evaluation of meteorite classification. In D. S. Lauretta & H. Y. McSween Jr. (Eds.), *Meteorites and the early solar system II* (2006th ed., pp. 19–52). University of Arizona Press.

Wie, B. (2013, February 11). *An innovative solution to NASA's NEO impact threat mitigation grand challenge and flight validation mission architecture development*. nasa.gov.

Asteroid Prospecting and Space Mining

Martin Ferus, Jano Žabka, Nikola Schmidt, and Alan Heays

1 Introduction

Asteroids are not only of scientific interest but will probably become a source of valuable ore for space industry in the future or a replacement for resources lacking on Earth. Key questions related to this ambition are as follows: What is currently known about the feasibility of asteroid prospecting? What strategy should be adopted for economic mining in the future? Is this idea still only a subject for academic discussion, or are we ready to take the first real steps? Determining the composition of asteroids is one specific issue and currently very difficult. Remote observations from Earth provide insufficient detail, and the cost of spacecraft flybys or probe landings is very high. An interesting alternative method for asteroidal compositional analysis that is advantageous with respect to mission duration, economy, and technical feasibility is the systematic spectroscopic study of meteors of asteroidal origin with a CubeSat satellite swarm. Another promising method for inferring asteroidal properties is by high-resolution mass spectrometry of interplanetary dust particles. The basic technologies needed to support these schemes require further development, as do the necessary data analysis algorithms, calibrating standards, and methods for computing the solar system source region of observed meteors.

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2 Prospecting for Natural Resources in Interplanetary Space

2.1 Why We Need Reliable Techniques for Broad Prospecting

We are in an era of unprecedented opportunity for proposing spacecraft exploration to nearly any known solar system object, and multiple missions to asteroids and comets have been executed or are in preparation. In spite of the wealth of new knowledge returned by recent spacecraft, we are still limited to a grab-bag sample of the solar system. To design a proper asteroid mining strategy, a better and broader knowledge is required of geochemistry occurring in interplanetary space and the highly dynamic accretion processes that occurred within the primordial solar nebula leading to the present-day distribution of metals and rare elements. In short, we have to explore celestial bodies as completely as is technologically and economically possible, the new knowledge obtained needs to be properly shared across humanity according to the principles of the Outer Space Treaty, and business interests must be incentivized to provide new sources of funding for material prospecting. Finding the sensitive balance of technical and economic means is a developing field of inquiry even as the gates to solar system mining are being opened by the new technology and knowledge.

The characterization of a large representative sample of asteroids, comets, and other solar system bodies via individual targeted space missions and landers is not yet an option. Much of what is now known about the composition of asteroids and comets has been gleaned from remote telescopic observations and the analysis of meteorites, micrometeorites, and interplanetary dust particles (Maturilli et al., 2016). This data shows an enormous diversity of chemical and physical properties arising not only from the complicated process distributing matter within the evolving solar system but potentially also based on recent results (Namouni & Morais, 2020), as well from bodies captured from interstellar space. A broad characterization of solar system material is important for the fundamental exploration of its chemical and physical evolution and may provide information on other challenging grand questions of contemporary science, for instance, the origin and building blocks of life. There are also crucial applications of this fundamental research that are possibly less satisfying to our desire for knowledge but important for the sustainable development of our technological civilization in its space age.

Mining natural resources on asteroids has been a subject of academic discussion for more than 70 years (Preston-Thomas, 1952; O'Leary & Oleary, 1977). In principle, there are two groups of products to be extracted from asteroids: those that are valuable for space industry and those important to Earth (Elvis, 2013). The former are, for instance, industrial metals like iron, nickel, and cobalt (Fe, Ni, Co) and water, which are low cost on Earth but of significant value in space because of the expense of lifting them into the orbit. The latter consists of materials that could be extracted from an asteroid and then returned to Earth for less than the cost of producing it locally. Increasingly, policies supporting natural preservation may make certain materials expensive on Earth, and policy-makers will be especially tempted

to support high-tech industries while preserving the Earth's environment once space mining becomes feasible. This is an ideal currently unavailable to policy-makers as industrial activity usually goes against nature preservation, and the scarcity of computer chips in 2020 and 2021 is a good case in point. Space-mined materials of value on Earth include metals such as ruthenium, rhodium, palladium, osmium, iridium, and platinum (Ru, Rh, Pd, Os, Ir, Pt), other precious metals such as gold and maybe silver (Au, Ag), and possibly also rare lanthanide and actinide elements such as europium, indium, dysprosium, neodymium, terbium, and yttrium (Eu, In, Dy, Nd, Tb, Y) (McLeod & Krekeler, 2017). Most of these metals are essential for state-of-the-art and future electronic industrial and high-tech applications.

For space mining to contribute toward preventing the possible classical catastrophe of resource exhaustion, it is important to consider the economic and logistical advantages of particular asteroid targets, those with a large abundance of ore and which are in energetically favorable orbits for transportation to Earth or to space bases (O'Leary & Oleary, 1977; Sonter, 1997; Elvis, 2012). A bottleneck in such plans is the need for a detailed mineral characterization of these bodies. Establishing whether some resource is potentially profitable, and thus qualifies as ore, depends on many factors. The fundamental demands on prospecting missions will be a balance between the accuracy and breadth of data, related to technological requirements of onboard instruments, mission feasibility, time requirements, and cost. We know of more than 523,000 asteroids (Cellino, 2019), and deciding which of them may be a potentially "treasure chest" rich in rare elements is a difficult task. It is obvious that a series of individual spacecraft missions or landers to a statistically significant number of asteroids will not satisfy practical economic and mission duration criteria (Elvis, 2014). Then, the problem is to design a prospecting scheme including as many asteroids as feasible (Elvis, 2013).

2.2 Remote Prospecting

The cheapest technology for asteroid characterization is remote prospecting with large ground-based telescopes. Astronomers can rapidly observe a large number of asteroids. Despite limitations on the information gained, remote prospecting is a crucial pathfinder for any further investigation and thus should be considered as the first step before investing in other methods.

For example, the fundamental characteristic of an asteroid's diameter is generally uncertain by a factor of two when deduced from ground-based observations. Then, corresponding volumes are uncertain by an order of magnitude (Elvis, 2013). For prospecting asteroids, photometric and spectral observations can be generally done. Photometry provides information in the optical range (400–900 nm, mainly reflection of sunlight), and spectroscopy extends measurements to the near infrared (800–2500 nm) and thermal infrared (350–10,000 nm, mainly thermal emission from the object itself). However, these ranges are limited by absorption by molecules in the atmosphere and a background of atmospheric thermal radiation, so any

complete measurements will require current or newly deployed space telescopes (Elvis, 2013). Although the spectral response of an asteroid varies because of its color, texture, crystal structure, specific gravity, and other physical and optical properties, it is possible to tentatively identify its overall mineralogy remotely (Ramasamy et al., 1993). Even limited spectra evaluated with the help of detailed modeling may provide important information (Reddy et al., 2015), but a direct link between metallicity and spectral characteristics is still missing for the purposes of a wide systematic survey. Remotely recorded spectra cannot provide a direct elemental composition of a particular body or assess the occurrence of minor ores. For instance, most spectroscopy is sensitive to silicates rather than to potentially valuable elements (Elvis, 2013). A high radar reflectivity can indicate enstatite and FeNi alloys on the asteroid surface but, as demonstrated for the asteroid 216-Kleopatra (Ostro et al., 2000), without any direct information on the specific trace element composition. This is potentially an important screening method, because iron-rich objects are very likely to contain precious metals (Kargel, 1994), but such analyses are not always completely convincing (Shepard et al., 2010), because, for example, information obtained from remote observations is also obscured by space weathering which differentiates surface mineralogy from the bulk of a particular asteroid (Elvis, 2013). In this regard, remote prospecting can be useful to the design phase of space missions that will conduct remote prospecting or spacecraft flyby missions for observations from Earth. Remote prospecting is crucial for gathering an overall picture of the solar system despite inherent uncertainties, because it is impossible to build and operate a multitude of spacecrafts, and will remain so for the foreseeable future.

2.3 Proximity Prospecting

Proximity prospecting by spacecraft during asteroids flybys provides far more detailed information than remote observations. Any spacecraft sent to main-belt asteroids requires significant energy and a round-trip journey time of a decade or more with current technology. Such a long timescale disfavors the profitability of a prospecting venture, and for mining, it means that we have to precisely know how long we intend to mine which object and for what cost. Therefore, prospecting with a large number of spacecraft, like APIES (Asteroid Population Investigation and Exploration Swarm) suggested in 2006 (D'Arrigo & Santandrea, 2006), can be a comfortable strategy for the future. This requires an estimate of mission feasibility and the number of objects which can be reached. The swarm strategy will likely be used in the future, especially because any miniaturization of the spacecraft lowers its cost and a swarm strategy significantly increases the benefit of the mission. The proposed Starshot mission by Breakthrough Initiatives consisting of tiny 1-gram satellites for the exploration Proxima Centauri system is an example of a mission that only makes sense with a swarm design. Asteroid mining will not be exempted from this swarm paradigm, despite that the instruments needed for prospecting will

probably never fit on a 1-gram spacecraft. If prospecting spacecrafts are mass-produced comparably to the Starlink mega-constellation, the price will also be significantly lowered. Therefore, a proximity swarm strategy is probably the next most meaningful approach for prospecting after remote observations.

Another option is to focus on near-Earth objects (NEOs) with trajectories approaching or crossing Earth's orbit. Dust from small NEOs and comets enter the atmosphere and burn up as meteors on a daily basis. Larger pieces can reach the surface as meteorites. Proximity prospecting is only meaningful when the right instruments are used. For instance, spectral data provided by infrared spectrometers, as demonstrated by the Galileo flyby of the 951 Gaspra and 243 Ida asteroids (Chapman, 1994), can improve upon ground-based observations, while the surface elemental composition can be measured by X-ray spectroscopy similar to the exploration of asteroid 433 Eros by NEAR Shoemaker spacecraft at a cost of $227 million USD. However, this analysis is limited to basic elements such as Mg, Si, Al, S, Ca, and Fe. Gamma ray and neutron detectors have been employed for chemical analysis by the DAWN spacecraft on 4 Vesta and 1 Ceres (Prettyman et al., 2004), with a projected cost of $373 million increased to a final $446 million USD. This mission obtained epochal results; however, elemental analysis was limited to H, Fe, Mg, and Si abundances (Lawrence et al., 2013). In light of the cost of such missions, it is probably beyond the capabilities of small states; however, if such a mission is shared by a consortium of small states and private actors willing to fund fundamental science with the expectation of mining asteroids in the future, even small states might be able to trigger comparable missions.

To support these possibilities, it is critical that small states cooperate on the development of CubeSat missions capable of delivering meaningful knowledge. The mass production of spacecraft only lowers their price, as does miniaturization, although costs usually go up when specific instruments must be tailor-made. Since even low-volume mass production can significantly lower costs, international cooperation on spacecraft development, or having multiple spacecraft shares in one launch, can bring these missions into the hands of small states ambitious to fulfill the responsibilities of a cosmopolitan state by contributing to the knowledge of humanity.

2.4 Local Characterization

A local characterization of the promising sites of asteroids that have been visited by spacecraft is the ultimate option for finding proof of whether enough viable mining targets are present but will very likely only be executed for a limited number of targets. For the first time, the NEAR Shoemaker spacecraft landed on the surface of 433 Eros in 2001 (Veverka et al., 2001). Five years later, Hayabusa touched down on 25,143 Itokawa and returned a milligram sample of the regolith for analysis in Earth laboratories (Ebihara et al., 2015). The ongoing mission OSIRIS-Rex reached asteroid 101,955 Bennu in 2016. The probe should also land on the asteroid surface

and return a sample to Earth. The onboard Regolith X-Ray Imaging Spectrometer (REXIS) should also provide information about the surface elemental composition (Allen et al., 2013), and thermal emission together with visible and infrared spectrometers provides estimates of the mineralogy of the surface. Another recent mission was successful in touchdown and sample return. The Hayabusa2 spacecraft landed on asteroid 162,173 Ryugu in 2019. This satellite is equipped with a reflectance spectrometer in order to characterize surface rocks and minerals (Kitazato et al., 2019). In situ examination of an asteroid, or sample return missions, provides the most precise data but still only provides a narrow view and is limited by their high cost. This strategy can be broadly applied in the case of a particularly large swarm of spacecraft, with thousands of cheap fully autonomous landers.

In summary, depending on the development of future technologies, almost everything is possible. Major obstructions are mainly the physical limitations of methods employed in prospecting and their cost. It is obvious that easier ways – such as remote observation of asteroid surfaces by ground-based instruments – are very limited by the low amount of useful information they provide to prospectors. In contrast, a swarm of hundreds or more nanosatellites, proximity prospectors, and landers sent to a significant number of asteroids seems to be an idea complicated only by its very high cost. However, as sketched above, if international cooperation is successfully established, a swarm is a great strategy for sharing the development and mass production costs among multiple actors. This is not an obstacle of technical feasibility but requires smooth international governance.

2.5 Satellite Spectroscopy of Meteors

It might have been assumed that meteor science has reached full maturity, and arguments have even arisen that the discipline is in decline (Silber et al., 2018). In reality, research continues into fascinating new topics, and there remains a wide range of unanswered questions on the many detailed physical and chemical processes involved and their consequences for atmospheric entry, impacts, meteor plasma, meteoroid bodies, and meteorites. As examples, recent studies focus on meteor-generated shock waves (Silber et al., 2018), explosive events (Tabetah & Melosh, 2018), the formation of molecular species in meteor plasma (Berezhnoy et al., 2018; Borovička & Berezhnoy, 2016), simulation of meteor dynamics (Oppenheim & Dimant, 2015), novel approaches in meteor spectroscopy (Madiedo et al., 2014; Ferus et al., 2018; Vojacek et al., 2015), impact of meteors and meteorites on the evolution of the early Earth (Rotelli et al., 2016; Kuwahara & Sugita, 2015; Zahnle et al., 2019; Ferus et al., 2017) and Mars (Navarro-González et al., 2019), exploration of meteors suspected to be created by extrasolar matter (Afanasiev et al., 2007; Siraj & Loeb, 2019), fingerprints of meteors and asteroid impact in exoplanetary atmospheres (Rimmer et al., 2019), etc. This field also has an impact on future cosmic and engineering applications, such as planetary defense and the determination of the catastrophic consequences of an impact (Collins et al., 2005), or to

prospecting for natural resources on celestial bodies – particularly on asteroids (O'Leary & Oleary, 1977; Sonter, 1997; Elvis, 2012; Mueller & van Susante, n.d.).

Investigations published over 30 years show that meteor spectra provide information about the elemental composition of descending bodies (Madiedo et al., 2013, 2014; Trigo-Rodriguez et al., 2003, 2004, 2005; Borovička & Betlem, 1997; Ferus et al., 2018, 2020; Spurny et al., 1990). When meteoroids enter the Earth's atmosphere with velocities between 11.2 and 72.5 km s^{-1} (the mean value being ≈50 km s^{-1} (Dyrud et al., 2004)), they immediately begin to interact with the upper atmosphere at altitudes typically between 80 and 125 km (Baggley, 1980). Collisions with atmospheric molecules lead to rapid surface heating due to the high kinetic energy, consequent ablation of material, high-velocity expansion of vapors, and finally disintegration or even explosion (Tabetah & Melosh, 2017, 2018). This happens in most cases, and the meteoroid is therefore completely obliterated in the atmosphere. Conversely, if a piece of meteorite is discovered, usually in a desert or snow fields such as the Great Plains of the USA and deserts of Australia, Northwest Africa, Sahara, Oman, and Antarctica, there is a fundamental problem of how to link this specific meteorite to a particular meteor event with known trajectory. Therefore, the parent body (i.e., primary matter of an asteroid or a comet nucleus) cannot be identified. In over 1000 known cases of observed falls, precise orbital trajectory calculations exist only for 32 of them (year 2020 (Gounelle et al., 2006; Gritsevich, 2008; "List of meteorites with a complete 'lineage'", 2020)). This is, of course, not enough data for any statistical evaluation of metal resources or rare element abundances in the solar system.

It is more feasible to observe meteor in flight and perform an in-depth analyses of the qualitative and quantitative elemental composition from the emission spectra, thereby generating a statistical characterization of meteoroids and their parent bodies – asteroids and comets on NEO trajectories. If a trajectory is recorded from at least two locations, we can calculate the region of interplanetary space from which the meteoroid originates and correlate this with its spectrally analyzed composition (Siraj & Loeb, 2019). Recent studies show the feasibility of spectral analysis in determining the elements in meteoroid bodies and discuss spectral classification schemes for meteors and their association with particular petrologic type (Ferus et al., 2019; Drouard et al., 2018; Křivková et al., 2021). However, ground-based spectral studies are limited by molecular absorption (particularly oxygen and ozone) (Kaltenegger et al., 2020), aerosols, molecular scattering (Yan et al., 2014), or even clouds, which are able to block broad UV and IR spectral ranges important to complete analysis of meteor plasma composition (Ferus et al., 2018, 2019; Jenniskens, 2007; Milley et al., 2007; Vojacek et al., 2015).

Observing meteors with satellites is not only a novel idea but also a very hot topic in contemporary meteor science and is strongly connected to the scientific topics mentioned above. Meteors in Earth's atmosphere are recorded by satellites from time to time, and extraterrestrial impacts or meteor events have been observed on the Moon (Mohon, 2017), Mars (Brown et al., 2014), and Jupiter (Levy, 1998). Although meteor spectra are occasionally recorded from the orbit, a systematic satellite spectral survey of meteors has never been conducted. An example is the

analysis of bright bolides based on data provided by a network of military satellites in 1994 (McCord et al., 1995). In 2000, Jenniskens et al. published photographic documentation of the 1997 Leonid meteor shower provided by wide-angle camera onboard the Midcourse Space Experiment (MSX) satellite telescope (Jenniskens et al., 2000). Three years later, the same team published the first complex analysis of a meteor spectrum recorded during the 1999 Leonid outburst (Carbary et al., 2003). In 2008, Nuth et al. published a concept of the Near Earth Object Chemical Analysis Mission (NEOCAM) intended for observation of meteors in the spectral range 125–300 nm (Nuth et al., 2008). However, this mission has not been realized. Ten years ago, Oberst et al. introduced a camera designed for observing faint events such as lightning discharges or meteors in planetary atmospheres (Oberst et al., 2011). In 2014, the group of Rambaux et al. (2014) proposed a mission later named Meteorix. They have designed a 3 U nanosatellite concept equipped with UV spectrometer and ViS camera intended for the detection of meteors and reentering space debris (Chen et al., 2020). A parallel mission called S-CUBE has been suggested by Ishimaru et al. (2014). Recently, Petri et al. introduced another satellite mission intended for the space-based determination of meteor trajectories using stereoscopic camera (Petri et al., 2019). The only running project focused on meteor spectroscopy from space is currently operated on the ISS. The camera equipped with a diffraction grating for detection of major elements (Fe, Ca, Mg, and Na) is mounted inside the Window Observational Research Facility (WORF) and provides observation in the range 304–700 nm (Kramer, 2020).

It can be expected that future satellite observation of meteors will be used for sporadic bolides (for which the trajectory must be calculated, because the parent body or source region in the solar system is generally unknown). Such spectral data recorded in the UV, ViS, and NIR ranges will be not burdened of absorption by atmospheric molecules and aerosols. The spectra of meteors can be analyzed and their precise elemental composition determined. First of all, information about elemental composition of meteoroids will serve for verifying the emission spectroscopy technique applicability in statistically significant prospection of natural resources on solar system bodies. The results can motivate the future design of a fleet of cube satellites for spectral and video survey of meteors from the orbit, and their connection to networks is intended for more advanced and systematic prospection. Depending on the development of laser technologies, the emission spectral data can be also used for remote ablation of surfaces by high-power lasers or kinetic impactors.

2.6 Mass Spectrometry for Dust Analysis

It is known that comets and asteroids release small particles from their surfaces. In the case of comets, the creation of a dust and ion tail is well known to occur by the ejection of material from their porous, low-strength nuclei. The process is triggered when a heat wave generated by insolation near perihelion penetrates the nucleus

(Prialnik & Sierks, 2017). In the case of asteroids, material can be released by collisions with interplanetary particles ranging in diameter from microscopic sizes to relatively large objects. Another option is that the asteroid is so called active, and it ejects particles to space by sublimating ice, rotational instability, thermal fractures, phyllosilicate dehydration, or electrostatic repulsion. This is the case for 101,955 Bennu. However, many such asteroids can, in fact, be active, with Bennu initially assumed to be inactive based on telescope observations, and its ejecta were only revealed by the arrival of OSIRIS-Rex in 2018/2019 (Lauretta et al., 2019). Ejected dust particles are affected by several forces, gravity of the Sun and planets, radiation pressure, Poynting-Robertson drag, and the solar wind. However, according to computer simulations, grains from main-belt asteroids differ significantly in their orbital characteristics from grains that evolve from comets, and they nearly always retain orbital characteristics indicative of their origins (Jackson & Zook, 1992). This means that the chemical analysis of dust can provide a characterization of their parent bodies in a similar way to the observation of meteors. We expect that the elemental abundance of interplanetary dust will be locally variable, because it must be affected by bodies releasing particles on particular trajectories in the solar system. Calculating the specific source of dust with high concentrations of natural resources detected by mass spectrometry during flyby mission is another strategy for identifying objects or regions interesting for space mining.

A big advantage of this technique is that mass spectrometry is a classical analytical technique widely employed for in situ analysis onboard spacecraft and landers. It is used to analyze objects in the solar system, to determine the proportion of neutral and ionized (positively or negatively charged) molecules occurring in their atmospheres. The atmosphere of Saturn's moon Titan was analyzed during the Cassini-Huygens mission, its Ion and Neutral Mass Spectrometer (Waite et al., 2005, 2007; Fulchignoni et al., 2005), where hydrocarbon ions $C_xH_y^+$ were discovered and nitrogen-containing ions $C_xH_yN_z^+$ were found with m/z values up to the instrument's upper mass limit of $m/z = 100$. Moreover, the Cassini plasma spectrometer (CAPS) proved the evidence of heavy ions that are both positively charged (up to $m/z = 350$) and negatively charged (up to $m/z = 4000$). Unfortunately, the mass ranges and resolutions of these analyzers did not allow the exact determination of the individual components of this interesting atmosphere. Analyzers with a similar construction (quadrupole) and parameters (mass range in the range of $m/z = 1$–350, resolution max. 1000 for a mass/charge ratio of $m/z = 100$) were used in the study of the atmospheres of Venus (Niemann et al., 1980), Jupiter (Niemann et al., 1992), and Mars (Niemann et al., 1998) and most recently by the Mars exploration spacecraft MAVEN (Mahaffy et al., 2015).

Another application of mass spectrometry is the analysis of space dust, micrometeorites, and particles released from larger objects. The analyzed ions formed in the plasma are created by impacting particles on a surface (CDA instrument on the Cassini-Huygens mission (Srama et al., 2004)). A second method captures particles on a surface and subsequently ionizes them with Cs^+ (secondary ion mass spectrometry) and was used to study comet 67P/Churyumov-Gerasimenko (Cometary Secondary Ion Mass Analyzer onboard Rosetta mission (Hilchenbach et al., 2016)).

COSIMA based on the principle of time-of-flight (TOF) measurement had a mass range of m/z = 1–350 with a resolution of 1500 at m/z = 100. These parameters are currently the best ever used in an online analysis of extraterrestrial particles in space. However, this is insufficient for application to prospecting: an m/z of 150 only takes into account the combinations of atoms C, N, O, and H; then there exists 29 possible distinct molecular compositions contributing for a resolution of 1500 at m/z = 100 (TOF COSIMA) but only one possible composition when studied with a resolution of 50,000 at $m/100$ (laboratory prototype of high-resolution mass spectrometry instrument – CosmOrbitrap (81)). On this basis, methods for determining composition are more accurate, especially when analyzing extraterrestrial samples. A prototype space analyzer based on this principle is currently also being developed at the J. Heyrovsky Institute of Physical Chemistry in close collaboration with CNES and ESA.

Regarding the wide range of advantages of mass spectrometry, its application to asteroid exploration has recently become a hot topic. For instance, the CubeSat asteroid Prospection Explorer (APEX) has been selected to accompany the ESA Hera Mission (intended launch 2023). The CubeSat is intended to be equipped with a low-mass low-power ion and neutral time-of-flight mass spectrometer called Asteroid Composition Analyzer (ACA) (Wahlund et al., 2019). Primary science goals include the detection of neutrals and ions sputtered from the asteroid surfaces. The spectrometer is intended to cover the range of 1–100 amu for the basic elements covering Mg, Fe, Si, Al, Ni, C, N, O, S, H, and He. A limitation of this design is that precious metals such as Au, Pt, Ir, Os, Pd, Rh, and Ru cannot be detected by this technique.

It is expected that high-resolution mass spectrometry has great potential for being employed in the interplanetary chemical analysis. However, its technical detection limit for precious metals (Ru, Rh, Pd, Os, Ir, Pt) and rare elements (Eu, In, Dy, Nd, Tb, Y) important to space mining must be demonstrated. So far, such instruments exist only in the laboratory, and their miniaturization and development are crucial for applying this promising technique to prospecting for space resources.

3 Implications for the Cosmopolitan Responsible State Concept

Space mining is, from a technical perspective, available to small countries as well. A country's size does not prevent the existence of a critical technological, scientific, or industrial background. Small countries can produce critical knowledge from asteroid prospecting later shared among the international community, which would be considered as a contribution to the benefit of humankind. Sharing the cost of a space mission implies sharing knowledge about the critical technologies necessary for mining. Finally, small spacecrafts might be cheap and more easily mass-produced than sophisticated spacecrafts. If a small state is capable to develop some

of the critical technologies, mainly for prospecting, then it can ask the international community for financial support or industrial capacities for mass production. Finally, some critical technologies can be produced by small states that will be implemented in broader projects. Mass-produced spacecrafts will require significantly different navigation techniques; therefore, artificial intelligence at a certain level of autonomy will be necessary. Small countries with their less powerful industrial capacities usually develop specific ingenuities leading to unconventional solutions. In this regard, the fact that a country is small definitely does not exclude it from the space mining business. Rather the opposite should become a narrative of its foreign policy because it is usually small countries who can cross difficult borders between superpowers. Finally, as we have shown in this chapter, mining is not just about mining but also acquiring the requisite knowledge. Prospecting is crucial, and without it, we will not move forward to actual mining of asteroids. That said and taking into consideration the plethora of options we identified here, small countries can become part of this business today.

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References

Afanasiev, V. L., Kalenichenko, V. V., & Karachentsev, I. D. (2007). *Detection of an intergalactic meteor particle with the 6-m telescope*. https://doi.org/10.1134/s1990341307040013

Allen, B., Grindlay, J., Hong, J., Binzel, R. P., Masterson, R., Inamdar, N. K., et al. (2013). The REgolith X-Ray Imaging Spectrometer (REXIS) for OSIRIS-REx: Identifying regional elemental enrichment on asteroids. *Optical Modeling and Performance Predictions VI*. https://doi.org/10.1117/12.2041715

Baggley, W. (1980). Meteors and atmospheres. In I. Halliday & B. McINtosh (Eds.), *Solid particles in the solar system* (pp. 85–100). IAU.

Berezhnoy, A. A., Borovička, J., Santos, J., Rivas-Silva, J. F., Sandoval, L., Stolyarov, A. V., & Palma, A. (2018). The CaO orange system in meteor spectra. *Planetary and Space Science, 151*, 27–32. https://doi.org/10.1016/J.PSS.2017.10.007

Borovička, J., & Berezhnoy, A. A. (2016). Radiation of molecules in Benešov bolide spectra. *Icarus, 278*, 248–265.

Borovička, J., & Betlem, H. (1997). Spectral analysis of two Perseid meteors. *Planetary and Space Science, 45*(5), 563–575. https://doi.org/10.1016/S0032-0633(97)00024-X

Brown, D., Webster, G., Zubritsky, E. A., & Jones, N. N. (2014). Mars spacecraft reveal comet flyby effects on Martian atmosphere. *NASA Press Release*, 14–311.

Carbary, J. F., Morrison, D., Romick, G. J., & Yee, J.-H. (2003). Leonid meteor spectrum from 110 to 860 nm. *Icarus, 161*(2), 223–234. https://doi.org/10.1016/S0019-1035(02)00064-7

Cellino, A. (2019). Asteroids. In *Reference module in Earth systems and environmental sciences*. Elsevier. https://doi.org/10.1016/B978-0-12-409548-9.11842-1

Chapman, C. R. (1994). The Galileo encounters with Gaspra and Ida. In A. Milani, M. di Martino, & A. Cellino (Eds.), *Asteroids, comets, meteors 1993* (Vol. 160, p. 357).

Chen, H., Rambaux, N., & Vaubaillon, J. (2020). Accuracy of meteor positioning from space- and ground-based observations. *A&A, 642*, L11. https://doi.org/10.1051/0004-6361/202039014

Collins, G. S., Melosh, H. J., & Marcus, R. A. (2005). Earth impact effects program: A web-based computer program for calculating the regional environmental consequences of a meteoroid impact on Earth. *Meteoritics & Planetary Science, 40*(6), 817–840. https://impact.ese.ic.ac.uk/ImpactEarth/I

D'Arrigo, P., & Santandrea, S. (2006). The APIES mission to explore the asteroid belt. *Advances in Space Research, 38*(9), 2060–2067. https://doi.org/10.1016/j.asr.2006.09.017

Drouard, A., Vernazza, P., Loehle, S., Gattacceca, J., Vaubaillon, J., Zanda, B., et al. (2018). Probing the use of spectroscopy to determine the meteoritic analogues of meteors. *Earth and Planetary Astrophysics, 613*, A54. https://doi.org/10.1051/0004-6361/201732225

Dyrud, L. P., Denney, K., Close, S., Oppenheim, M., Chau, J., & Ray, L. (2004). Meteor velocity determination with plasma physics. *Atmospheric Chemistry and Physics, 4*(3), 817–824. https://doi.org/10.5194/acp-4-817-2004

Ebihara, M., Shirai, N., Sekimoto, S., Nakamura, T., Tsuchiyama, A., Matsuno, J., et al. (2015). Chemical and mineralogical compositions of two grains recovered from asteroid Itokawa. *Meteoritics & Planetary Science, 50*(2), 243–254. https://doi.org/10.1111/maps.12418

Elvis, M. (2012). Let's mine asteroids – For science and profit. *Nature, 485*, 549.

Elvis, M. (2013). Prospecting asteroid resources. In V. Badescu (Ed.), *Asteroids: Prospective energy and material resources* (pp. 81–129). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-39244-3_4

Elvis, M. (2014). How many ore-bearing asteroids? *Planetary and Space Science, 91*, 20–26. https://doi.org/10.1016/j.pss.2013.11.008

Ferus, M., Pietrucci, F., Saitta, A. M., Knížek, A., Kubelik, P., Ivanek, O., et al. (2017). Formation of nucleobases in a Miller–Urey reducing atmosphere. *Proceedings of the National Academy of Sciences, 114*(17), 4306–4311. https://doi.org/10.1073/pnas.1700010114

Ferus, M., Koukal, J., Lenža, L., Srba, J., Kubelík, P., Laitl, V., et al. (2018). Calibration-free quantitative elemental analysis of meteor plasma using reference laser-induced breakdown spectroscopy of meteorite samples. *Astronomy and Astrophysics, 610*, A73. https://doi.org/10.1051/0004-6361/201629950

Ferus, M., Kubelík, P., Petera, L., Lenža, L., Koukal, J., Křivková, A., et al. (2019). Main spectral features of meteors studied using a terawatt-class high-power laser. *Astronomy & Astrophysics, 630*, A127. https://doi.org/10.1051/0004-6361/201935816

Ferus, M., Petera, L., Koukal, J., Lenža, L., Drtinová, B., Haloda, J., et al. (2020). Elemental composition, mineralogy and orbital parameters of the Porangaba meteorite. *Icarus, 341*, 113670. https://doi.org/10.1016/J.ICARUS.2020.113670

Fulchignoni, M., Ferri, F., Angrilli, F., Ball, A. J., Bar-Nun, A., Barucci, M. A., et al. (2005). In situ measurements of the physical characteristics of Titan's environment. *Nature, 438*(7069), 785–791. https://doi.org/10.1038/nature04314

Gounelle, M., Spurny, P., & Bland, P. A. (2006). The orbit and atmospheric trajectory of the Orgueil meteorite from historical records. *Meteoritics & Planetary Science, 41*(1), 135–150. https://doi.org/10.1111/j.1945-5100.2006.tb00198.x

Gritsevich, M. I. (2008). The Pribram, Lost City, Innisfree, and Neuschwanstein falls: An analysis of the atmospheric trajectories. *Solar System Research, 42*(5), 372–390. https://doi.org/10.1134/S003809460805002X

Hilchenbach, M., Kissel, J., Langevin, Y., Briois, C., von Hoerner, H., Koch, A., et al. (2016). Comet 67P/Churyumov-Gerasimenko: Close-up on dust particle fragments. *apjl, 816*(2), L32. https://doi.org/10.3847/2041-8205/816/2/L32

Ishimaru, R., Sakamoto, Y., Kobayashi, M., Fujita, S., Gonai, T., Senshu, H., et al. (2014). CubeSat mission for UV-visible observations of meteors from space: S-CUBE (S3: Shootingstar Sensing Satellite). *45th lunar and planetary science conference*, *Contributi*, 1846.

Jackson, A. A., & Zook, H. A. (1992). Orbital evolution of dust particles from comets and asteroids. *Icarus, 97*(1), 70–84. https://doi.org/10.1016/0019-1035(92)90057-E

Jenniskens, P. (2007). Quantitative meteor spectroscopy: Elemental abundances. *Advances in Space Research, 39*(4), 491–512. https://doi.org/10.1016/j.asr.2007.03.040

Jenniskens, P., Nugent, D., Tedesco, E., & Murthy, J. (2000). 1997 Leonid shower from space. In J. Peter, F. Rietmeijer, N. Brosch, & M. Fonda (Eds.), *Leonid storm research* (pp. 305–312). Springer Netherlands. https://doi.org/10.1007/978-94-017-2071-7_23

Kaltenegger, L., Lin, Z., & Madden, J. (2020). High-resolution transmission spectra of Earth through geological time. *The Astrophysical Journal, 892*(1), L17. https://doi.org/10.3847/2041-8213/ab789f

Kargel, J. S. (1994). Metalliferous asteroids as potential sources of precious metals. *Journal of Geophysical Research, Planets, 99*(E10), 21129–21141. https://doi.org/10.1029/94JE02141

Kitazato, K., Milliken, R. E., Iwata, T., Abe, M., Ohtake, M., Matsuura, S., et al. (2019). The surface composition of asteroid 162173 Ryugu from Hayabusa2 near-infrared spectroscopy. *Science*. https://doi.org/10.1126/science.aav7432

Kramer, H. J. (2020). ISS utilization: Meteor (meteor composition determination) camera. *ISS: Meteor*. https://directory.eoportal.org/web/eoportal/satellite-missions/i/iss-meteor

Křivková, A., Petera, L., Laitl, V., Kubelík, P., Chatzitheodoridis, E., Lenža, L., et al. (2021). Application of a dielectric breakdown induced by high power lasers for a laboratory simulation of meteor plasma. *Experimental Astronomy*. https://doi.org/10.1007/s10686-020-09688-3

Kuwahara, H., & Sugita, S. (2015). The molecular composition of impact-generated atmospheres on terrestrial planets during the post-accretion stage. *Icarus, 257*, 290–301. https://doi.org/10.1016/j.icarus.2015.05.007

Lauretta, D. S., Hergenrother, C. W., Chesley, S. R., Leonard, J. M., Pelgrift, J. Y., Adam, C. D., et al. (2019). Episodes of particle ejection from the surface of the active asteroid (101955) Bennu. *Science, 366*(6470). https://doi.org/10.1126/science.aay3544

Lawrence, D. J., Peplowski, P. N., Prettyman, T. H., Feldman, W. C., Bazell, D., Mittlefehldt, D. W., et al. (2013). Constraints on Vesta's elemental composition: Fast neutron measurements by Dawn's gamma ray and neutron detector. *Meteoritics & Planetary Science, 48*(11), 2271–2288. https://doi.org/10.1111/maps.12187

Levy, D. H. (1998). The collision of comet shoemaker-Levy 9 with Jupiter. *Space Science Reviews, 85*(3), 523–545. https://doi.org/10.1023/A:1005079807445

List of meteorites with a complete "lineage." (2020).

Madiedo, J. M., Trigo-Rodríguez, J. M., Lyytinen, E., Dergham, J., Pujols, P., Ortiz, J. L., & Cabrera, J. (2013). On the activity of the γ-Ursae Minorids meteoroid stream in 2010 and 2011. *Monthly Notices of the Royal Astronomical Society, 431*(2), 1678–1685. https://doi.org/10.1093/mnras/stt288

Madiedo, J. M., Ortiz, J. L., Trigo-Rodríguez, J. M., Dergham, J., Castro-Tirado, A. J., Cabrera-Caño, J., & Pujols, P. (2014). Analysis of bright Taurid fireballs and their ability to produce meteorites. *Icarus, 231*, 356–364. https://doi.org/10.1016/j.icarus.2013.12.025

Mahaffy, P. R., Benna, M., King, T., Harpold, D. N., Arvey, R., Barciniak, M., et al. (2015). The neutral gas and ion mass spectrometer on the Mars atmosphere and volatile evolution mission. *Space Science Reviews, 195*(1), 49–73. https://doi.org/10.1007/s11214-014-0091-1

Maturilli, A., Helbert, J., Ferrari, S., Davidsson, B., & D'Amore, M. (2016). Characterization of asteroid analogues by means of emission and reflectance spectroscopy in the 1- to 100 um spectral range. *Earth, Planets and Space, 68*(1), 113. https://doi.org/10.1186/s40623-016-0489-y

McCord, T. B., Morris, J., Persing, D., Tagliaferri, E., Jacobs, C., Spalding, R., et al. (1995). Detection of a meteoroid entry into the Earth's atmosphere on February 1, 1994. *Journal of Geophysical Research, Planets, 100*(E2), 3245–3249. https://doi.org/10.1029/94JE02802

McLeod, C., & Krekeler, M. (2017). Sources of extraterrestrial rare Earth elements: To the moon and beyond. *Resources, 6*(3), 40. https://doi.org/10.3390/resources6030040

Milley, E. P., Hawkes, R. L., & Ehrman, J. M. (2007). Meteor luminosity simulation through laser ablation of meteorites. *Monthly Notices of the Royal Astronomical Society, 382*(1), L67–L71. https://doi.org/10.1111/j.1745-3933.2007.00390.x

Mohon, L. (2017). About lunar impact monitoring. *National Aeronautics and Space Administration*. https://www.nasa.gov/centers/marshall/news/lunar/overview.html

Mueller, R. P., & van Susante, P. J. (n.d.). A review of extra-terrestrial mining robot concepts. In *Earth and space 2012* (pp. 295–314). https://doi.org/10.1061/9780784412190.034

Namouni, F., & Morais, M. H. M. (2020). An interstellar origin for high-inclination Centaurs. *Monthly Notices of the Royal Astronomical Society, 494*(2), 2191–2199. https://doi.org/10.1093/mnras/staa712

Navarro-González, R., Navarro, K. F., Coll, P., McKay, C. P., Stern, J. C., Sutter, B., et al. (2019). Abiotic input of fixed nitrogen by bolide impacts to gale crater during the Hesperian: Insights from the Mars science laboratory. *Journal of Geophysical Research, Planets, 124*(1), 94–113. https://doi.org/10.1029/2018JE005852

Niemann, H. B., Booth, J. R., Cooley, J. E., Hartle, R. E., Kasprzak, W. T., Spencer, N. W., et al. (1980). Pioneer Venus orbiter neutral gas mass spectrometer experiment. *IEEE Transactions on Geoscience and Remote Sensing, 18*, 60–65. https://doi.org/10.1109/TGRS.1980.350282

Niemann, H. B., Harpold, D. N., Atreya, S. K., Carignan, G. R., Hunten, D. M., & Owen, T. C. (1992). Galileo probe mass spectrometer experiment. *Space Science Reviews, 60*(1), 111–142. https://doi.org/10.1007/BF00216852

Niemann, H. B., Harpold, D. N., Feng, S., Kasprzak, W. T., Way, S. H., Atreya, S. K., et al. (1998). The Planet-B neutral gas mass spectrometer. *Earth, Planets and Space, 50*(9), 785–792. https://doi.org/10.1186/BF03352170

Nuth, J., Lowrance, J. L., & Carruthers, G. (2008). NEOCAM: The near Earth object chemical analysis mission. *Earth, Moon, and Planets, 102*, 495–504.

O'Leary, B., & Oleary, B. (1977). Mining the Apollo and Amor asteroids. *Science, 197*(4301), 363 LP–363366. https://doi.org/10.1126/science.197.4301.363-a

Oberst, J., Flohrer, J., Elgner, S., Maue, T., Margonis, A., Schrödter, R., et al. (2011). The Smart Panoramic Optical Sensor Head (SPOSH) – A camera for observations of transient luminous events on planetary night sides. *Planetary and Space Science, 59*(1), 1–9. https://doi.org/10.1016/j.pss.2010.09.016

Oppenheim, M. M., & Dimant, Y. S. (2015). First 3-D simulations of meteor plasma dynamics and turbulence. *Geophysical Research Letters, 42*(3), 681–687. https://doi.org/10.1002/2014GL062411

Ostro, S. J., Hudson, R. S., Nolan, M. C., Margot, J.-L., Scheeres, D. J., Campbell, D. B., et al. (2000). Radar observations of asteroid 216 Kleopatra. *Science, 288*(5467), 836–839. https://doi.org/10.1126/science.288.5467.836

Petri, J., Schmidt, A., Zink, J., & Klinker, S. (2019). Design and test of a COTS based imaging system for stereoscopic meteor observations. In *IAA symposium* (pp. 1–1).

Preston-Thomas, H. (1952). Interorbital transport techniques. *Journal of the British Interplanetary Society, 11*(2), 173–193.

Prettyman, T. H., Feldman, W. C., Barraclough, B. L., Capria, M. T., Coradini, A., Enemark, D. C., et al. (2004). Mapping the elemental composition of Ceres and Vesta: Dawn's gamma ray and neutron detector. In C. A. Nardell, P. G. Lucey, J.-H. Yee, & J. B. Garvin (Eds.), *Instruments, science, and methods for geospace and planetary remote sensing* (Vol. 5660, pp. 107–116). SPIE. https://doi.org/10.1117/12.578551

Prialnik, D., & Sierks, H. (2017). A mechanism for comet surface collapse as observed by Rosetta on 67P/Churyumov-Gerasimenko. *Monthly Notices of the Royal Astronomical Society, 469*(Suppl_2), S217–S221. https://doi.org/10.1093/mnras/stx1577

Ramasamy, S. M., Venkatasubrmanian, V., & Anbazhagan, S. (1993). Reflectance spectra of minerals and their discrimination using Thematic Mapper, IRS and SPOT multispectral data. *International Journal of Remote Sensing, 14*(16), 2935–2970. https://doi.org/10.1080/01431169308904412

Rambaux, N., Galayko, D., Mariscal, J.-F., Breton, M.-A., Vaubaillon, J., Birlan, M., et al. (2014). Detection of spectral UV of meteor from a nanosatellite. In *Proceedings of the IMC, Giron* (pp. 1–3).

Reddy, V., Dunn, T. L., Thomas, C. A., Moskovitz, N. A., & Burbine, T. H. (2015). Mineralogy and surface composition of asteroids. In *Asteroids IV* (pp. 43–63). https://doi.org/10.2458/azu_uapress_9780816532131-ch003

Rimmer, P. B. B., Ferus, M., Waldmann, I. P. P., Knížek, A., Kalvaitis, D., Ivanek, O., et al. (2019). Identifiable acetylene features predicted for young Earth-like exoplanets with reducing atmospheres undergoing heavy bombardment. *The Astrophysical Journal, 888*(1), 21. https://doi.org/10.3847/1538-4357/ab55e8

Rotelli, L., Trigo-Rodriguez, J. M., Moyano-Cambero, C. E., Carota, E., Botta, L., Di Mauro, E., & Saladino, R. (2016). The key role of meteorites in the formation of relevant prebiotic molecules in a formamide/water environment. *Scientific Reports, 6*. https://doi.org/10.1038/srep38888

Shepard, M. K., Clark, B. E., Ockert-Bell, M., Nolan, M. C., Howell, E. S., Magri, C., et al. (2010). A radar survey of M- and X-class asteroids II. Summary and synthesis. *Icarus, 208*(1), 221–237. https://doi.org/10.1016/j.icarus.2010.01.017

Silber, E. A., Boslough, M., Hocking, W. K., Gritsevich, M., & Whitaker, R. W. (2018). Physics of meteor generated shock waves in the Earth's atmosphere – A review. *Advances in Space Research*. https://doi.org/10.1016/j.asr.2018.05.010

Siraj, A., & Loeb, A. (2019). *Discovery of a meteor of interstellar origin*.

Sonter, M. J. (1997). The technical and economic feasibility of mining the near-Earth asteroids. *Acta Astronautica, 41*(4), 637–647. https://doi.org/10.1016/S0094-5765(98)00087-3

Spurny, P., Ceplecha, Z., & Borovicka, J. (1990). Earth-grazing fireball: Czechoslovakia, Poland, October 13, 1990, 03h27m16s UT. WGN. *Journal of the International Meteor Organization, 19*(1), 13.

Srama, R., Ahrens, T. J., Altobelli, N., Auer, S., Bradley, J. G., Burton, M., et al. (2004). The Cassini cosmic dust analyzer. *Space Science Reviews, 114*(1), 465–518. https://doi.org/10.1007/s11214-004-1435-z

Tabetah, M. E., & Melosh, H. J. (2017). The role of air penetration in the break-up of entering meteoroids. *Lunar and planetary science: 48th lunar and planetary science conference*, Contribution No. 1964, 1267.

Tabetah, M. E., & Melosh, H. J. (2018). Air penetration enhances fragmentation of entering meteoroids. *Meteoritics & Planetary Science, 53*(3), 493–504. https://doi.org/10.1111/maps.13034

Trigo-Rodriguez, J. M., Llorca, J., Borovicka, J., & Fabregat, J. (2003). Chemical abundances determined from meteor spectra: I. Ratios of the main chemical elements. *Meteoritics & Planetary Science, 38*(8), 1283–1294.

Trigo-Rodriguez, J. M., Llorca, J., & Fabregat, J. (2004). Chemical abundances determined from meteor spectra – II. Evidence for enlarged sodium abundances in meteoroids. *Monthly Notices of the Royal Astronomical Society, 348*(3), 802–810. https://doi.org/10.1111/j.1365-2966.2004.07389.x

Trigo-Rodríguez, J. M., Llorca, J., Borovička, J., & Fabregat, J. (2005). Spectroscopy of a geminid fireball: Its similarity to cometary meteoroids and the nature of its parent body. In R. Hawkes, I. Mann, & P. Brown (Eds.), *Modern meteor science an interdisciplinary view* (pp. 375–387). Springer Netherlands. https://doi.org/10.1007/1-4020-5075-5_36

Veverka, J., Farquhar, B., Robinson, M., Thomas, P., Murchie, S., Harch, A., et al. (2001). The landing of the NEAR-Shoemaker spacecraft on asteroid 433 Eros. *Nature, 413*(6854), 390–393. https://doi.org/10.1038/35096507

Vojacek, V., Borovicka, J., Koten, P., Spurny, P., & Stork, R. (2015). Catalogue of representative meteor spectra. *Astronomy & Astrophysics, 580*. https://doi.org/10.1051/0004-6361/201425047

Wahlund, J.-E., Andrews, D., & Pentila, A. (2019). Asteroid Prospection Explorer (APEX) cubesat for the ESA Hera Mission. In *EPSC-DPS Joint Meeting, Vol. 13* (pp. 1–2). Geneva.

Waite, J. H., Niemann, H., Yelle, R. V., Kasprzak, W. T., Cravens, T. E., Luhmann, J. G., et al. (2005). Ion neutral mass spectrometer results from the first flyby of titan. *Science, 308*(5724), 982–986. https://doi.org/10.1126/science.1110652

Waite, J. H., Young, D. T., Cravens, T. E., Coates, A. J., Crary, F. J., Magee, B., & Westlake, J. (2007). The process of tholin formation in Titan's upper atmosphere. *Science, 316*(5826), 870–875. https://doi.org/10.1126/science.1139727

Yan, F., Fosbury, R. A. E., Petr-Gotzens, M. G., Zhao, G., Wang, W., Wang, L., et al. (2014). High-resolution transmission spectrum of the Earth's atmosphere-seeing Earth as an exoplanet using a lunar eclipse. *International Journal of Astrobiology, 14*(2), 255–266. https://doi.org/10.1017/s1473550414000172

Zahnle, K., Lupu, R., & Catling, D. (2019). *Creation and evolution of impact-generated reduced atmospheres of early Earth*.

High-Energy Systems Today and Tomorrow

Miroslav Krůs and Nikola Schmidt

1 Introduction

Since the invention of the laser (*light amplification by stimulated emission of radiation*) in 1960 by Theodore Maiman, they have become standard tools in various applications both in fundamental and applied research, industry (LIDAR, laser scanners), and medicine (eye surgery, cosmetic surgery). Lasers can be divided into four main groups: solid-state (including fiber) lasers, semiconductor (diode) lasers, gas lasers (including chemical and excimer), and dye lasers. However, lasers that can be scaled up to high power and considered as possible candidates for the space applications discussed in this volume come from three main groups: solid-state lasers, fiber lasers, and laser diodes (and marginally also CO_2 lasers). As expected, different laser systems, either in continuous-wave operation or in pulsed operation, are useful for different applications. The four applications discussed in this book, deflecting asteroids, orbital debris ranging or removal, asteroid (space) mining, and propulsion systems for solar system or interstellar travel, require different approaches.

In the following text, we aim to provide the general knowledge necessary for answering a simple question: How far advanced are the lasers needed to address these applications? Are they a subject of ongoing research or already available on the commercial market? As this book has a theme of the cosmopolitan responsible state, we do not focus on the capacities of a particular state as the available laser

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technology is affordable to any sized nation; however, we will focus on the opportunities for small- or medium-size states to participate in ongoing laser research or analyze whether a certain technology is or is not a security threat based on the power or energy of its beam.

2 Key Laser Parameters

The key parameters of laser systems with respect to space applications are average power and beam quality; these are crucial because enough power is required to induce the desired effect, e.g., asteroid surface ablation, or to push nanoprobes, and beam quality affects focusability and transportability. Other parameters mentioned below are more or less related to these two, except for wall-plug efficiency that expresses the overall efficiency of the laser system:

- *Average power*: The energy emitted during a certain time period (usually 1 s), i.e., for continuous lasers, this straightforwardly represents the energy emitted per 1 s; for pulsed lasers, this represents the average energy carried by a certain number of pulses released during 1 s (e.g., a nanosecond laser system delivering 1 J in a pulse with kHz repetition rate – peak power, 1 GW = 1 J/1 ns; average power, 1 kW = 1 J × 1000 Hz).
- *Peak power*: The energy emitted during one pulse duration, e.g., a nanosecond laser system delivering 1 J in a pulse carries a peak power of 1 GW (for continuous lasers, this corresponds to an average power).
- *Repetition rate*: The frequency of individual pulses, i.e., when 1000 pulses is emitted during 1 s, the repetition rate is equal to 1 kHz.
- *Laser phase*: Laser light can be approximated as a periodic wave in time; if the phase shift of two waves is 0 or 180 degrees, then these two waves may be combined into one wave with double the amplitude; if the phase shift of two waves is 90 or 270 degrees, then overlapping waves will destructively interfere, and the signal vanishes (this effect is important when combining many laser beams in order to avoid destructive interference that diminishes the laser power and intensity at the focus).
- *Beam quality*: A measure of how tightly the laser beam can (i.e., to reach the focal spot radius limited by diffraction). Usually, it is also related to the laser beam wave front identifiable as a surface associated with a propagating wave passing through all points with constant phase.
- *Wall-plug efficiency*: The total efficiency of a laser system and defined as the ratio between the laser light power and the initial electrical power.

3 What Kind of Lasers Do We Have?

3.1 Flashlamp-Pumped Solid-State Lasers

The first lasers developed were based on a flashlamp pumping scheme, in which energy produced by flashlamps is absorbed by a glass or crystal lasing medium. As the flashlamps produce a broad spectrum of light, the majority of absorbed energy is transferred to heat and increases the temperature of the lasing medium; only a small fraction of pump energy is utilized by the lasing process.

Up to 1972, the progress in high-power high-energy lasers was driven mainly by the needs of inertial confinement fusion research (Nuckolls et al., 1972). High-power lasers of this era in the USA were based on Nd:glass technology (lasing at a wavelength of 1053 nm) at the Lawrence Livermore National Laboratory (LLNL), gaseous CO_2 lasers (10.6 μm wavelength) at Los Alamos National Laboratory, or KrF excimer laser (241 nm wavelength) at the Naval Research Laboratory. Major laser development at LLNL beginning in 1974 validated the Nd:glass technology (glass doped with neodymium ions) lasers for use in very high-power facilities. This development started with one- or two-beam laser systems such as the Janus laser (one beam 10 J), long path laser, Cyclops laser (one beam), and Argus laser (two beams). These were starting points for multiple-beam facilities such as the Shiva laser that had 20 beams based on Nd:glass technology and an energy of 10.2 kJ. The development of the Omega laser (Okishev & Seka, 1999) started in the late 1970s in the Laboratory for Laser Energetics; this Nd:glass laser delivered 2 kJ of energy from 24 beams converted to the third harmonics and after a 1995 upgrade delivers 30 kJ from 60 beams in up to 8 shots per day (a duty time of 1.5 h). In LLNL, work on a 100 kJ laser system, NOVA, started in 1984 (10 beam system, 10 kJ per beam, 74 cm diameter, maximum 6 shots per day).

Development of the laser systems was more or less a prerequisite for constructing the most energetic laser system build to date – the National Ignition Facility (Le Pape et al., 2018; Van Arsdall et al., 1999). Its construction started in 1997 and it was final commissioned in 2009. The NIF laser is also based on Nd:glass technology and delivers 4 MJ of energy at its fundamental wavelength of 1053 nm (or 1.2 MJ at the third harmonic, 351 nm) with 192 laser beams pumped by 7680 flashlamps powered by a capacitor bank storing 422 MJ of energy (total wall-plug efficiency around 1%). The NIF laser delivers one shot per 4–5 h due to the long time necessary for cooling the flashlamps and (glass) amplifier slabs. The NIF laser mainly operates to demonstrate the fusion reaction gain of inertial confinement and high-energy density hydrodynamical studies.

3.2 Diode-Pumped Solid-State Lasers

Further progress in high-energy solid-state lasers occurred with the development of high-power laser diode arrays, where individual diodes are arranged into strips or stacks and used for active laser medium pumping. In principle, laser diodes emit monochromatic light that can be matched to the active medium absorption spectrum by tuning the laser diode elemental composition, diode structure, and temperature. This leads to a higher-efficiency laser system and less heat generation than flashlamps. Furthermore, diode-pumped lasers show higher long-term energy stability and higher repetition rates when compared with flashlamp-pumped laser systems. Nowadays, only a multi-slab laser architecture is capable of delivering pulse energies around 100 J at a 10 Hz repetition rate. Such a high processing speed is possible because the amplifier medium is divided into longitudinally separated thin stacked slabs of laser glass or crystal. This geometry is very efficient at removing the heat generated by active medium pumping because it permits a coolant (often helium gas due to its high thermal capacity and suitable refractive index) to flow between slabs and absorb the heat from their surface.

The first laser to deliver more than 60 J and a 10 Hz repetition rate was developed within the LLNL Mercury project; this system uses a Yb:S-FAP (ytterbium-doped strontium fluorapatite) crystalline gain medium operated at room temperature (Bayramian et al., 2008). Recently, the HAPLS (Haefner et al., 2017) project (also developed in LLNL and based on Mercury technology) has been used for pumping the Ti:sapphire PW laser system at ELI Beamlines in the Czech Republic and demonstrated nearly 100 J pulses at a repetition rate of 3.3 Hz when using Nd:glass as the gain medium. In 2020, the Bivoj/DiPOLE (Banerjee et al., 2016, p. 41; Mason et al., 2017) laser system (developed at the Central Laser Facility in the UK) became available at the HiLASE facility in the Czech Republic. It operates at 145 J at 10 Hz; the gain media of this laser system are Yb:YAG (ytterbium-doped yttrium aluminum garnet) ceramics cooled by helium gas at cryogenic temperature (−133 °C).

There exist many diode-pumped laser systems delivering laser pulses with energies up to 10 J and repetition rates of 10 Hz (Liu et al., 2017, p. 25; Yasuhara et al., 2008). All laser systems mentioned above generate nanosecond-duration laser pulses. Nowadays, 100 J-class nanosecond laser systems (Nd:glass medium, 250 J per pulse, 0.1 Hz repetition rate, or Nd:YAG medium, 75 J per pulse, at 10 Hz repetition rate) using active mirror disk amplifiers are commercially available.[1]

All the lasers discussed above are scalable to higher energies and powers, primarily for the purposes of inertial confinement fusion research. With pulse energy increased to kJ levels, these laser systems will meet the requirements for deorbiting space debris. And scaling their power to levels comparable with the NIF will make them good candidates for deflecting small-scale asteroids in collision trajectories.

[1] www.amplitude-laser.com

3.3 Fiber Lasers

Fiber lasers are a special type of the solid-state laser where the medium is fabricated into a fiber rather than a rod, slab, or disk. Laser light is emitted due to a dopant in the central core of the fiber and is pumped by laser diodes. A key feature of fiber lasers is their large surface-to-volume ratio that permits relatively easy heat dissipation.

Fiber lasers belong to the family of scalable high-power high-energy lasers being considered for various applications, such as space debris removal (Quinn et al., 2015; Soulard et al., 2014). Efficient debris removal requires an average laser power of about 100 kW (Schall, 1998). Current generation single-emitter fiber lasers typically deliver energies at the mJ level, so several thousand fibers must be combined to reach several Joules of output energy. This can be done by means of the coherent beam combining technique (Brignon, 2013; Fan, 2005), which adjusts the phase of light generated by individual fiber amplifiers. This is usually done by splitting the seed signal generated in a common fiber oscillator and matching pumping and fiber parameters (e.g., their length and diameter). The principle of coherent beam combination requires dividing a single source into a large number, N, of independent single-channel beams that are each equipped with a dedicated amplifier. The output of a system consisting of N amplified channels is precisely and coherently combined into a single beam carrying the summed power of the single channels. For efficient recombination, individual beam phases have to be matched very precisely (Antier et al., 2014), and the main challenge when scaling to a high power is the coherent adjustment of thousands of beams. The main advantage of fiber lasers when compared with solid-state lasers is their good thermal management and effective heat removal from the amplifiers. Fiber lasers demonstrate a high beam quality and high wall-plug efficiency (about 40%). The means of coherent beam combining to produce high-energy, scalable laser systems is nowadays under intensive research and development, with several groups demonstrating high-quality beams from the combination of 7–64 fiber amplifiers (Bourderionnet et al., 2011; Fsaifes et al., 2020; Heilmann et al., 2018; Le Dortz et al., 2017). The maximum power reached so far is 4 kW, generated from eight coupled fiber laser amplifiers (Yu et al., 2011). Fiber lasers are currently considered the best candidates for future space applications.

3.4 Laser Diodes

Although solid-state and fiber lasers exhibit good beam quality, their efficiency is limited by the active medium pumping scheme and efficiency of the laser diode pump array. Another path to high-power, high-energy laser beams is the direct use of laser diodes. These exhibit the best wall-plug efficiency (nowadays above 60%) and very high average power at very low cost (up to 1.5 kW (Thoss & Crump, 2019)), but the overall beam quality is very poor. This is the main reason why laser

diodes are only used to pump lasers of higher beam quality. The low beam quality of diode lasers is a consequence of their highly elongated emitting region consisting of a linear array of individual laser emitters. These arrays are usually based on incoherent beam combination. Nevertheless, the spectral combination of several laser diodes with slightly different wavelengths has led to kW-class laser systems, and the coherent combination of diode lasers is demonstrated for large arrays of relatively low-power diodes (Creedon et al., 2012). Furthermore, laser diode arrays are more stable than individually mounted diodes because they are subject to approximately similar temperature fluctuations averaged over the entire array. Laser diode arrays are also scalable to high-power systems. On the other hand, the power of a laser diode array is significantly less than compared with the same number of individually mounted laser diodes. For several decades, there has been a huge effort to improve laser diode beam quality, and several techniques have been adopted including beam shaping with two mirrors (Clarkson & Hanna, 1996), beam shaping by prism groups (Wang, 2001), or the introduction of an external cavity (Gao et al., 2004). These techniques improve the slow axis (less divergent direction), while the fast axis, usually perpendicular to the diode array direction, usually exhibits a good beam quality and can be collimated by the use of microcylindrical lens. These possibilities present an opportunity for new high-power continuous-wave lasers with high wall-plug efficiency that, moreover, can be directly coupled to photovoltaic cells that also reach relatively high efficiency. Such a device is suitable for both ground-based and space-borne applications.

4 Increasing Laser Efficiency

In this section, we introduce a few solutions for improving the laser efficiency: pulse shaping, pulse trains, and adaptive optics. These improvements are successfully tested and lead to increased efficiency in many applications: LIBS (laser-induced breakdown spectroscopy); inertial fusion confinement; X-ray laser generation; laser drilling, percussion introduction; etc.

4.1 Efficient Heat Dissipation

We will mention in the beginning the weak point of each laser that must be overcome to meet future applications in space. The main issue for space-based high-power lasers is the need for efficient heat dissipation; this is not the issue for the ground-based lasers due to the presence of Earth's atmosphere and large amount of water usable as heat exchangers. As mentioned above, laser efficiency is limited to several tens of percents; the remaining energy is transformed to heat which must be removed from the system or otherwise may cause a further decrease in efficiency or even damage the system. The highest-power laser diodes reach 800 kW (Fulkerson

et al., 2015; Haefner et al., 2017) and are utilized for pumping the HAPLS laser located at ELI Beamlines. Assuming 50% efficiency, 800 kW of power is converted to heat that must, in space, be removed by radiation from surface panels. The average radiation efficiency of such panels is 200 W/m^2, and an area as large as 4000 m^2 is then needed, roughly corresponding to 6 football fields. However, this number accounts only for the pump diodes, and the solid-state HAPLS laser being pumped also has imperfect efficiency, leading to extra heat generation and proportionally larger radiator panels.

From the viewpoint of cooling, fiber lasers are more efficient because of their favorable surface area-to-volume ratio (i.e., very long, very thin fibers), but for the same laser power, the heat produced is similar to the above example. Fiber lasers can also withstand and be operated at temperatures up to several hundreds of °C (much higher than for solid-state lasers) (Guan et al., 2008; Joly & Taira, 2011; Lai et al., 2006) without significant degradation of the laser beam quality or a significant efficiency decrease.

4.2 Laser Beam Wave Front Corrections

The performance of a laser system can also be improved by implementing adaptive optics within the laser amplification chain. These manipulate the laser wave front, mainly using deformable mirrors to achieve wave front control and optical aberration correction. Adaptive optics were first introduced in 1953 by H. W. Babcock (1953) to correct atmospheric seeing. Since that time, many systems have been developed and are in operation in the service of astronomy, to correct atmospheric turbulences and in high-power laser systems to correct aberrations arising inside the amplification chain. The use of adaptive optics is crucial for space-based systems and mainly in ground-based laser systems. The conventional deformable mirrors used for wave front correction contain a certain number of piezo-bimorphs or piezo-actuators, but the current technology is only capable of compensating for small wave front errors, while larger corrections can to some extent be made with segmented active mirror (Smithson, 1987).

The wave front correction is especially important for coherently combined fiber lasers composed of several distant independent fibers; the individual focusing collimators must be precisely adjusted for proper performance. This can be done by manipulating inside the collimator by transverse displacement of the fiber and the tip and tilt of the fiber endcap (the technique is called adaptive fiber-optic collimation (AFOC)) (Vorontsov et al., 2009). This leads to proper beam combination at the focus and to the constructive interference of individual beams.

4.3 Laser Pulse Burst Generation

Additional opportunities exist for upgrading solid-state lasers. For example, there is an effort to increase their repetition rate from 10 Hz to kHz, thereby increasing the delivered power a thousand fold. This is partially successful owing to the development of lasers emitting a burst of pulses, mainly for specific crystal Nd:YAG lasers. This is achieved either by pulsed switching the oscillator Q-switch with fast-switching Pockels cells (up to 15 times). The resultant pulse train is generated during within a 100 μs flashlamp pulse. Such a long pulse allows for repumping the active medium in preparation to be switched again by a Q-switch Pockels cell (Den Hartog et al., 2010) in a technique where the same light is reused, multiplying the delivered power. The second method for pulse train generation is the slicing of a long pulse generated by the laser diode (1064 nm) with an acousto-optic modulator. Such a pulse train is then amplified in a Nd:YAG amplification chain (a 10 ms burst consists of 100 pulses) (He et al., 2019). Such a pulse train can improve the performance of laser drilling and the sensitivity of LIBS measurements, which are a candidate for mineral prospection on asteroids. The requirements of a multi-pulse laser system are less demanding than for a single-pulse system when the total energy is the same.

4.4 Laser Pulse Shaping

Another technique for improving overall laser performance is laser pulse shaping. This is mostly adopted for Nd:glass lasers used in inertial confinement fusion research. Pulse shaping is usually performed by means of electro-optic modulation where the desired electric waveform is applied. The NIF laser at LLNL uses a train of 140 Gaussian pulses of 300 ps duration delayed by 200 ps and with various amplitudes corresponding to the desired laser pulse shape (Brunton et al., 2012); the ELI Beamlines L4-Aton laser pulse is shaped with 150 ps steps (Jourdain et al., 2021).

5 Meeting the Requirements of Space Applications

Laser systems used in space applications can be divided into two main groups: space-based or ground-based. The former can be designed for maximum absorption efficiency of a material or for maximum momentum transfer because the absorption of ultraviolet laser radiation is almost 100% in the absence of strong absorption by Earth's atmosphere. Ultraviolet wavelengths can be generated efficiently by conversion to higher harmonic frequencies in the case of Nd:YAG lasers or by excimer KrF or ArF lasers. For ground-based lasers, the requirement of transmission through

Earth's atmosphere, and for eye-safe operation in the presence of significant atmospheric scattering and backscattering, requires the laser wavelength to be around 2 or 4 μm, which is a very challenging region for either solid-state lasers or fiber and diode lasers. Another option is to use a CO_2 laser operating around 10 μm, with this wavelength being minimally absorbed in the atmosphere. All systems require techniques for cooling their amplifiers, and this is a crucial issue in space where there is no medium for effective heat transfer. Instead, the head must be radiated, which is significantly less effective than conduction and provides fewer opportunities for high-repetition systems. Ground-based lasers, on the other hand, require adaptive optic systems in order to focus the laser properly on the target while the beam is deflected in the atmosphere.

5.1 Planetary Defense

High-power laser systems are being considered for deflecting asteroids on collision trajectories with Earth. Such a system will be aboard a spacecraft orbiting the asteroid, and its average power is mainly determined by the required intensity hitting the asteroid surface. The maximum thrust experienced by the asteroid due to the laser occurs for an intensity triggering surface material evaporation, i.e., before plasma formation. This intensity must reach a value around 10 MW/m^2 and determines the laser power demanded. For example, 20 or 60 kW lasers would need to irradiate an Apophis-sized asteroid (325 m in diameter) for 16 or 9 years (Lubin, 2016), respectively, to deflect such a body from a collision trajectory by 1 Earth diameter. If there is insufficient time for such a mission, the laser power must be proportionately increased, and for deflection of an Apophis-sized asteroid within a year, a PW-class (average power 10^{15} W) laser will be required. Such a system would probably be able to completely evaporate such an asteroid within 1 year and cost hundreds of millions of USD.

High-power lasers can be also used for mineral prospecting or, possibly, mining on asteroids. The prospection scheme consists of two phases, laser drilling followed by collection of an emission signal or released material, and is analogous to LIBS. In this case, the laser intentionally drills a relatively large hole or crater, whereas conventional LIBS is minimally invasive. In order to get a large enough signal from LIBS, the amount of ablated material has to be proportionately high. A laser pulse with an energy 1 J and GW-level peak power ablates, on average, a few tens of micrograms. In order to accumulate a high-quality signal and penetrate to sufficient depth of the asteroid surface, the laser system shall possess energy on the order of a gigajoule (GJ) and reach a peak power of 1000 PW. Similar numbers hold for mineral mining, where in order to ablate 1 kg of material, one laser pulse has to carry an energy of 1 GJ. In contrast to other applications presented here, mineral prospection does not require a high repetition rate.

5.2 Debris Deorbiting

High-power laser radiation may represent the most effective and feasible means to remove space debris with dimensions in the range 1–10 cm. The laser power or energy (pulsed rather than continuous) is given by the absorption efficiency of laser radiation and ablation rate. For example, 15 kJ of energy has to be absorbed for the complete vaporization of 1 gram of aluminum by a laser pulse; the rate of ablation for aluminum and carbon is 80 μg/J and 10 μg/J, respectively. In general, the required laser energy in a laser pulse is 10–200 kJ depending on debris altitude, but the required repetition rate of such a laser is modest, around 1 Hz. The Mt. Stromlo laser-ranging site in Australia already announced that they possess a laser and all other general requirements, including working adaptive optics, to deorbit debris, and we expect other similar sites will follow suit. Laser deorbiting is certainly arriving at the present time.

5.3 Nanoprobe Propulsion

There are several proposed concepts for using lasers to propel spacecraft. One well-known case is an experiment performed at White Sands by L. Myrabo where a 10 kW (average power) CO_2 laser (Myrabo, 2003), delivering 1 kJ in one 30 μs pulse at a repetition rate of 10 Hz was used. The principle of this test launch was to laser heat the air to 10,000–30,000 °C; the hot air (plasma) pushes a lightcraft upward. In this experiment, a 50-gram device achieved an altitude of more than 70 m. However, to launch a small satellite into the Earth's orbit, a CO_2 laser system with 100 kW average power is demanded. The Starshot concept, proposed by Breakthrough Initiative (Lubin, 2016), is to send a nanoprobe weighing 1 gram to Proxima Centauri and will require a 200 GW average power laser system for probe acceleration. Such power will be needed for the 8 min required to reach the desired probe speed. All proposed concepts for laser-based propulsion require high-power systems beyond current technology. Nevertheless, as P. Lubin indicated, the first phase of Starshot will be focused on laser manipulation of the probe and will require "only" a kW-class (average) power, which is already met by the largest current laser systems.

6 Laser Development and Small State Politics

6.1 The Story of the Czech Republic

There is a rich base of laser research in Czechia, with a tradition of almost 60 years. The first laser to be built and operated in the former Czechoslovakia was in 1963. Czechoslovakia thus became one of the first countries able to build its own laser. In

contrast to Mainman's ruby laser, the laser assembled by K. Pátek at the Institute of Physics, Czechoslovak Academy of Sciences, used Nd:glass amplification medium lasing at a wavelength of 1064 nm. Other laser types (ruby, semiconductor, helium-neon, CO_2, etc.) followed soon after the Nd:glass laser. There were several institutions developing these lasers (Institute of Radio Engineering and Electronics, Institute of Scientific Instruments, Institute of Solid State Physics, all of the Czechoslovak Academy of Sciences, Czech Technical University, and also Military Institute of the Ministry of National Defense).

However, such lasers were available on the market in the West during the Cold War, but not for countries behind the Iron Curtain. Since then, laser developer in Czechoslovakia found various applications in medicine (angioplasty surgery, eye surgery, dentist drilling, etc.), satellite ranging, speed measurement, diamond drilling, precise machining, etc.

Since 1965, the Institute of Scientific Instruments (ISI) has focused on the stabilization of laser frequency, mainly of helium-neon lasers using neon or iodine atoms. Currently, the iodine stabilization absorption cell developed by the ISI is at the core of LISA (Laser Interferometer Space Antenna) satellite stabilization. In 1968, the collaboration of the Czech Technical University (CTU), Faculty of Nuclear Sciences and Physical Engineering, and Geodetic Research Institute triggered laser satellite-ranging research. Their first laser was installed on Pecný Hill near the Astronomical Observatory in Ondřejov. Since that time, the CTU group lead by K. Hamal has delivered almost 50 of satellite laser-ranging systems to various stations around the world. Currently, the group is focused using solid-state detectors for satellite ranging, and this technology was used in lidar employed by Mars Polar Lander spacecraft.

High-energy laser research begun in 1985 when an iodine laser system, Perun, developed in the Soviet Union, was installed at the Institute of Physics. After its installation, this system was significantly upgraded with respect to its pumping scheme and energy. The successful operation of the Perun laser was a milestone toward the installation of the high-power kJ PALS laser system, following its decommissioning at the Max Planck Institute. The PALS laser is primarily dedicated to high-power laser plasma interaction research; nonetheless, recent research into laser interactions with asteroids, in particular the surface ablation and assessment of mineral composition of meteorites, has begun.

Currently, new high-power laser infrastructures are being commissioned, the ELI Beamlines and HiLASE (a part of the Institute of Physics, Czech Academy of Sciences). Both facilities included solid-state lasers with the highest average power in the world. The HiLASE infrastructure is focused on the development of high average power laser systems which can find application in industry and medicine, whereas lasers at ELI Beamlines are mainly dedicated to fundamental and applied research in plasma physics looking into charged particle acceleration, high-energy density physics, warm dense matter, X-ray radiation generation, etc. HiLASE also contributed to research into laser-meteorite interactions, and HiLASE lasers are capable of inducing high pressure on the meteorite surface which increases the signal when determining its mineral composition.

Nowadays, high average power fiber lasers are extensively studied and developed at the Institute of Photonics and Electronics (former Institute of Radio Engineers). The development of semiconductor lasers currently takes place at the Institute of Physics. Besides new laser system development, one of the main producers of laser crystals – Crytur – is located in Czechia. Thus, Czechia is among several countries with the capability to develop and build new laser systems from national sources.

6.2 Consequences for the Small State's Cosmopolitan Responsibilities

One of the key themes of this volume is the capability for small states to develop technologies with the potential to become a global security issue. Lasers definitely fall into this category. Popular culture made lasers into weapons, and high-power lasers in space are immediately linked to Star Wars and its Death Star. This problem of popular culture association might look banal but is seriously poisoning the debate on how to use lasers for civilian purposes. Moreover, national intelligence agencies are concerned about the capability of deorbiting lasers in the hands of, for example, failed states. The post-9/11 narrative of terrorists and failed states capable to trigger global catastrophe has been around for decades and not making the situation easier.

However, as the chapters in the first section of this volume state, despite small states not being considered powerful, they introduce and require a cosmopolitan morality from powerful states, which in return benefit from a security regime covering not only their powerful enemies but also the whole world. The Czech Republic is visibly in a very special position given laser installations and capacities it possesses but moves toward the regulation, and security of sensitive technologies must remain in the hands of our political representation. What we scientists can do is inform the reader and general public that we are very close to the era of high-power lasers capable not only of deorbiting debris (those we already possess) but also deflecting asteroids or enabling interstellar travel. The scientific community will move forward as usual, but the decision to build large-scale systems remains in the hands of decision-makers on which we appellate that a security regime is necessary to proceed with these technologies in a civilian context. Small states are great for this purpose because they promote to the world the technologies they possess, and the fact that current laser-ranging installations may slowly transform into orbital debris removal installations is a good argument for them to come up with some cosmopolitan responsibilities.

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References

Antier, M., Bourderionnet, J., Larat, C., Lallier, E., Lenormand, E., Primot, J., & Brignon, A. (2014). kHz closed loop interferometric technique for coherent fiber beam combining. *IEEE Journal of Selected Topics in Quantum Electronics, 20*(5), 182–187. https://doi.org/10.1109/JSTQE.2014.2302444

Babcock, H. W. (1953). The possibility of compensating astronomical seeing. *Publications of the Astronomical Society of the Pacific, 65*, 229. https://doi.org/10.1086/126606

Banerjee, S., Mason, P. D., Ertel, K., Jonathan Phillips, P., De Vido, M., Chekhlov, O., et al. (2016). 100 J-level nanosecond pulsed diode pumped solid state laser. *Optics Letters, 41*(9), 2089. https://doi.org/10.1364/OL.41.002089

Bayramian, A., Armstrong, J., Beer, G., Campbell, R., Chai, B., Cross, R., et al. (2008). High-average-power femto-petawatt laser pumped by the mercury laser facility. *Journal of the Optical Society of America B, 25*(7), B57. https://doi.org/10.1364/JOSAB.25.000B57

Bourderionnet, J., Bellanger, C., Primot, J., & Brignon, A. (2011). Collective coherent phase combining of 64 fibers. *Optics Express, 19*(18), 17053. https://doi.org/10.1364/OE.19.017053

Brignon, A. (Ed.). (2013). *Coherent laser beam combining*. Wiley-VCH.

Brunton, G., Erbert, G., Browning, D., & Tse, E. (2012). The shaping of a national ignition campaign pulsed waveform. *Fusion Engineering and Design, 87*(12), 1940–1944. https://doi.org/10.1016/j.fusengdes.2012.09.019

Clarkson, W. A., & Hanna, D. C. (1996). Two-mirror beam-shaping technique for high-power diode bars. *Optics Letters, 21*(6), 375. https://doi.org/10.1364/OL.21.000375

Creedon, K. J., Redmond, S. M., Smith, G. M., Missaggia, L. J., Connors, M. K., Kansky, J. E., et al. (2012). High efficiency coherent beam combining of semiconductor optical amplifiers. *Optics Letters, 37*(23), 5006. https://doi.org/10.1364/OL.37.005006

Den Hartog, D. J., Ambuel, J. R., Borchardt, M. T., Falkowski, A. F., Harris, W. S., Holly, D. J., et al. (2010). Pulse-burst laser systems for fast Thomson scattering (invited). *Review of Scientific Instruments, 81*(10), 10D513. https://doi.org/10.1063/1.3475723

Fan, T. Y. (2005). Laser beam combining for high-power, high-radiance sources. *IEEE Journal of Selected Topics in Quantum Electronics, 11*(3), 567–577. https://doi.org/10.1109/JSTQE.2005.850241

Fsaifes, I., Daniault, L., Bellanger, S., Veinhard, M., Bourderionnet, J., Larat, C., et al. (2020). Coherent beam combining of 61 femtosecond fiber amplifiers. *Optics Express, 28*(14), 20152. https://doi.org/10.1364/OE.394031

Fulkerson, E. S., Telford, S., Deri, R., Bayramian, A., Lanning, R., Koh, E., et al. (2015). Pulsed power system for the HAPLS diode pumped laser system. In *2015 IEEE Pulsed Power Conference (PPC)* (pp. 1–6). Presented at the 2015 IEEE Pulsed Power Conference (PPC), Austin, TX, USA, IEEE. https://doi.org/10.1109/PPC.2015.7296854

Gao, X., Zheng, Y., Kan, H., & Shinoda, K. (2004). Effective suppression of beam divergence for a high-power laser diode bar by an external-cavity technique. *Optics Letters, 29*(4), 361. https://doi.org/10.1364/OL.29.000361

Guan, B.-O., Zhang, Y., Wang, H.-J., Chen, D., & Tam, H.-Y. (2008). High-temperature-resistant distributed Bragg reflector fiber laser written in Er/Yb co-doped fiber. *Optics Express, 16*(5), 2958. https://doi.org/10.1364/OE.16.002958

Haefner, C. L., Bayramian, A., Betts, S., Bopp, R., Buck, S., Cupal, J., et al. (2017). High average power, diode pumped petawatt laser systems: A new generation of lasers enabling precision science and commercial applications. In G. Korn & L. O. Silva (Eds.), *Presented at the SPIE optics + optoelectronics, Prague, Czech Republic* (p. 1024102). https://doi.org/10.1117/12.2281050

He, Z., Smith, C., Zhang, Z., Biewer, T. M., Jiang, N., Hsu, P. S., & Roy, S. (2019). Pulse-burst laser-based 10 kHz Thomson scattering measurements. *Plasma Science and Technology, 21*(10), 105603. https://doi.org/10.1088/2058-6272/ab2e30

Heilmann, A., Le Dortz, J., Daniault, L., Fsaifes, I., Bellanger, S., Bourderionnet, J., et al. (2018). Coherent beam combining of seven fiber chirped-pulse amplifiers using an interferometric phase measurement. *Optics Express, 26*(24), 31542. https://doi.org/10.1364/OE.26.031542

Joly, S., & Taira, T. (2011). Novel method for pulse control in Nd:YVO4/Cr4$+$:YAG passively Q-switched microchip laser. In *CLEO/Europe and EQEC 2011 conference digest* (p. CA8_1). Optical Society of America. http://www.osapublishing.org/abstract.cfm?URI=CLEO_Europe-2011-CA8_1

Jourdain, N., Chaulagain, U., Havlík, M., Kramer, D., Kumar, D., Majerová, I., et al. (2021). The L4n laser beamline of the P3-installation: Towards high-repetition rate high-energy density physics at ELI-Beamlines. *Matter and Radiation at Extremes, 6*(1), 015401. https://doi.org/10.1063/5.0022120

Lai, Y., Martinez, A., Khrushchev, I., & Bennion, I. (2006). Distributed Bragg reflector fiber laser fabricated by femtosecond laser inscription. *Optics Letters, 31*(11), 1672. https://doi.org/10.1364/OL.31.001672

Le Dortz, J., Heilmann, A., Antier, M., Bourderionnet, J., Larat, C., Fsaifes, I., et al. (2017). Highly scalable femtosecond coherent beam combining demonstrated with 19 fibers. *Optics Letters, 42*(10), 1887. https://doi.org/10.1364/OL.42.001887

Le Pape, S., Berzak Hopkins, L. F., Divol, L., Pak, A., Dewald, E. L., Bhandarkar, S., et al. (2018). Fusion energy output greater than the kinetic energy of an imploding shell at the National Ignition Facility. *Physical Review Letters, 120*(24), 245003. https://doi.org/10.1103/PhysRevLett.120.245003

Liu, T., Sui, Z., Chen, L., Li, Z., Liu, Q., Gong, M., & Fu, X. (2017). 12 J, 10 Hz diode-pumped Nd: YAG distributed active mirror amplifier chain with ASE suppression. *Optics Express, 25*(18), 21981. https://doi.org/10.1364/OE.25.021981

Lubin, P. (2016). A roadmap to interstellar flight. *JBIS – Journal of the British Interplanetary Society, 69*(2–3), 40–72.

Mason, P., Divoký, M., Ertel, K., Pilař, J., Butcher, T., Hanuš, M., et al. (2017). Kilowatt average power 100 J-level diode pumped solid state laser. *Optica, 4*(4), 438. https://doi.org/10.1364/OPTICA.4.000438

Myrabo, L. N. (2003). Brief history of the lightcraft technology demonstrator (LTD) project. In *AIP conference proceedings* (Vol. 664, pp. 49–60). Presented at the BEAMED ENERGY PROPULSION: First International Symposium on Beamed Energy Propulsion, Huntsville, Alabama (USA), AIP. https://doi.org/10.1063/1.1582095

Nuckolls, J., Wood, L., Thiessen, A., & Zimmerman, G. (1972). Laser compression of matter to super-high densities: Thermonuclear (CTR) applications. *Nature, 239*(5368), 139–142. https://doi.org/10.1038/239139a0

Okishev, A. V., & Seka, W. (1999). High-repetition-rate, diode-pumped multipass preamplifier for the OMEGA master oscillator. In C. Chang-Hasnain Knox, W. Kafka, & J. Vahala (Eds.), *Conference on lasers and electro-optics* (p. CThK15). Presented at the conference on lasers and electro-optics, Baltimore, Maryland, Optical Society of America. http://www.osapublishing.org/abstract.cfm?URI=CLEO-1999-CThK15

Quinn, M. N., Jukna, V., Ebisuzaki, T., Dicaire, I., Soulard, R., Summerer, L., et al. (2015). Space-based application of the CAN laser to LIDAR and orbital debris remediation. *The European Physical Journal Special Topics, 224*(13), 2645–2655. https://doi.org/10.1140/epjst/e2015-02577-5

Schall, W. O. (1998). Laser requirements for the removal of space debris from orbit. In *Presented at the twelfth international symposium on gas flow and chemical lasers and high-power laser conference, St. Petersburg, Russia* (p. 426). https://doi.org/10.1117/12.334466

Smithson, R. C. (1987). A segmented active mirror for solar observations. In S. Gowrinathan (Ed.), *Presented at the technical symposium southeast, Orlando, FL* (p. 18). https://doi.org/10.1117/12.940475

Soulard, R., Quinn, M. N., Tajima, T., & Mourou, G. (2014). ICAN: A novel laser architecture for space debris removal. *Acta Astronautica, 105*(1), 192–200. https://doi.org/10.1016/j.actaastro.2014.09.004

Thoss, A., & Crump, P. (2019). Diode Lasers: Research gives high-power diode lasers new capabilities. *LaserFocusWorld*. https://www.laserfocusworld.com/lasers-sources/article/16556280/diode-lasers-research-gives-highpower-diode-lasers-new-capabilities. Accessed 28 Sept 2021.

Van Arsdall, P. J., Bettenhausen, R. C., Holloway, F. W., Saroyan, R. A., & Woodruff, J. P. (1999). National Ignition Facility integrated computer control system. In W. H. Lowdermilk (Ed.), *Presented at the third international conference on solid state lasers for application to inertial confinement fusion, Monterey, CA* (p. 538). https://doi.org/10.1117/12.354167

Vorontsov, M. A., Weyrauch, T., Beresnev, L. A., Carhart, G. W., Ling, L., & Aschenbach, K. (2009). Adaptive array of phase-locked fiber collimators: Analysis and experimental demonstration. *IEEE Journal of Selected Topics in Quantum Electronics, 15*(2), 269–280. https://doi.org/10.1109/JSTQE.2008.2010875

Wang, P. Y. (2001). Beam-shaping optics deliver high-power beams. *LaserFocusWorld*. https://www.laserfocusworld.com/optics/article/16556441/beamshaping-optics-deliver-highpower-beams. Accessed 28 Sept 2021.

Yasuhara, R., Kawashima, T., Sekine, T., Kurita, T., Ikegawa, T., Matsumoto, O., et al. (2008). 213 W average power of 24 GW pulsed thermally controlled Nd:glass zigzag slab laser with a stimulated Brillouin scattering mirror. *Optics Letters, 33*(15), 1711. https://doi.org/10.1364/OL.33.001711

Yu, C. X., Augst, S. J., Redmond, S. M., Goldizen, K. C., Murphy, D. V., Sanchez, A., & Fan, T. Y. (2011). Coherent combining of a 4 kW, eight-element fiber amplifier array. *Optics Letters, 36*(14), 2686. https://doi.org/10.1364/OL.36.002686

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N. Schmidt (ed.), *Governance of Emerging Space Challenges*, Space and Society, https://doi.org/10.1007/978-3-030-86555-9

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