

A WHITE AND A RED STAR

(Special Historical Review)

CORNELIS DE JAGER

Laboratory for Space Research and Astronomical Institute, 3584 CA Utrecht, The Netherlands

(Received 22 September, 1996)

"Look, son," my father said, "you see these two stars? One shines white, but the other is rather orange-red. That is because the white one is hotter than the other. Think of the difference in colour between an electric and an oil lamp."

I was eleven years old, and vividly remember this. At that instant I came to realize that stars have temperatures and that one star can be hotter than another. I wondered how to measure their temperatures; certainly not by using a thermometer, I guessed. It started my interest in astronomy, and that remained throughout my life. At present, 64 years later, I still try to measure stellar temperatures.

This was not my first encounter with astronomy, though. At the age of five, on a clear, star-filled dark night, my father drew my attention to strange, faint, colourful glows hovering across the sky, while constantly changing colour and shape. It was the northern lights, he explained.

1. Texel

At that time we lived on the island of Texel, where I was born. It is one of the small Frisian islands north of the Netherlands mainland. My family from my father's side had been living there free and far from authority as long as history reports. Even in the time of my grandfather, after whom I was named, policemen were unknown in the little village at the inner slope of the sand dunes. Old Cornelis de Jager (or: Kees as he was always called) was for me the personification of freedom. He acted according to his conscience and moral judgment and law or convention were only vague notions to him. He knew every inch of the dunes and could find his way there even in heavy darkness. He and his wife, Engeltje Lap, lived by keeping a herd of half-wild sheep in the dunes, by growing some potatoes in a sandy field, and by occasionally shooting a rabbit. Their annual income ranged between some 50 and 100 dollars. They heated their cottage by burning driftwood collected on the beach. The wrecking of a ship on one of the many dangerous sandbanks around the island was a fortunate event because of the useful items eventually washing

ashore. But stealing was considered a crime that was not done in that closed village community, and saving shipwrecked persons from the sea, mostly in rough weather or heavy storms, was considered a natural duty. Not a few islanders lost their lives, while rowing their miserable sloops through the breakers towards a ship in danger.

My other grandfather, Klaas Kuiper, was a windmill maker and became a carpenter at the time that windmills became obsolete. His origin was in De Zaan, an area 60 kilometers south of the island, where windmills were counted by many hundreds in earlier centuries. He met my grandmother Trijntje Dogger, she was from a family of fishermen, when doing a job on the island. One of his windmills can still be seen in the village of Oudeschild on Texel.

Wind, sea and endless space, all around. We, the islanders, use to call it 'the golden islet'.

2. Indonesia

My father, Jan de Jager, was one of the seven surviving children of Kees and Engeltje. Being one of the brightest schoolboys, his schoolmaster gave him some additional teaching and thus prepared him for an application to one of the few annual state fellowships for training to become a primary school teacher. At the age of fourteen, he, who had never been off the island, was sent to school in Maastricht. After four years, to which four other years of military service had to be added during 1914–1918, he became a schoolmaster, of course on Texel.

After some six years however, he and my mother, Cornelia Kuiper, found that there might be more around than just the island. After all, my father had already been as far as Maastricht. So he applied successfully for a job in the overseas colonies, and on December 1, 1926 we embarked for the Netherlands East Indies, towards the little town of Manado, on the northern tip of Celebes (Sulawesi, it is called now), where we arrived after six weeks of steaming, seeing endless seas and incredible parts of the world, where people of other skins and cultures were living. My mother told me no longer to talk our island dialect, but to speak civilized Dutch, because from now on 'we will meet dignified people who would not understand our dialect.' I obediently did so, but wondered why these dignified people thought they were better than us on our island.

3. Minahasa

Manado is the capital of a small area called Minahasa. The people there speak the Tontemboan language, one of the more than 200 languages spoken in Indonesia. It is a remarkable area. As a schoolboy there, I learned from my local Minahasa teachers that Minahasa had never been a Netherlands colony. They considered it an independent territory linked to Holland by ties of friendship. That dates back

to around 1630 when the area was still under Spanish occupation. Three local chiefs of the area then went to Ternate, a few hundred kilometers east, which, they knew, was already Dutch at that time. They agreed with the Dutch military authorities there, that if the Dutch would dislodge the Spaniards, they, the chiefs, were willing to establish an agreement for cooperation on equal footing with the Dutch. It so happened. The area, Christian in Moslem surroundings, is well known for its relative richness and the high level of school education. In my youth the Minahasa people called it the 'twelfth province of the Netherlands'. Contrary to the rest of Indonesia, the Dutch language was frequently spoken there. Minahasa was also a region with a high degree of local democracy, with regular elections of *hukum-tua* (wise old man), and *hukum-kedua* (second wise man).

Because of the attachment to Holland and its Royal family the Minahasa was one of the breeding grounds for soldiers of the colonial army, and that, of course, was a source for conflict when in the middle of this century Indonesia became independent and Minahasa part of it. In 1960-63 there was even a military uprising against the central Government in Jakarta, very much to the embarrassment of the Netherlands Government who was expected by the Minahasa people to send military support but who, for obvious political reasons did not wish to get involved. In 1973, when I returned there, for the first time after 1933, I met one of the members of the former rebellian army, who told me of that recent history and how they had been fighting literally till the last bullet. When I expressed my respect for their perseverance he added in perfect Dutch: "But you do certainly remember, sir, we always were Her Majesty's soldiers".

By now, that situation has changed. Looking backward from my present distance I can only have respect for the skill of present-day Indonesian rulers who succeeded in uniting their country, this former colony, occupying an archipelago as big as Europe, with ten thousand islands and more than two hundred ethnic communities.

When I was just 8 years old we moved to an inland village at 800 meter altitude, called Langoan, where my father became head of the school. We were the only white people there, and I grew up in the Minahasa environment, speaking the local language and feeling one of them. A number of years ago, a young Minahasa student, Mesak Rataq, having finished University study in Indonesia, came to Holland to prepare his doctor's thesis in astrophysics. After having successfully obtained his degree, I congratulated him and added in the Indonesian language: "You are the second Minahasa subject who got a doctorate in astronomy". When he asked who then might have been the first I pointed at myself. For a long time I felt 'Minahaser' rather than Dutch.

4. Surabaia

When I was 12 years old, my father was transferred to Surabaia, the Netherlands East Indies naval basis, a sparkling commercial city on the main island, Java.

There, I attended secondary school under excellent teachers. It was at that time that I got interested in astronomy, and my parents gave me my first book on that topic: Flammarion's 'Astronomie Populaire'. I learned it by heart, knew the names of all the craters of the Moon, of all bright comets and for the rest I did all that amateur astronomers used to consider important. My best memories at school are of four of my teachers: my physics teacher, Dr Lecluse, who awoke my interest in experimental physics, particularly in optics, my teachers of the Dutch language, Mr Vermeulen, and Mrs Franken, who excited my love for the Dutch language, and last, but not least, my teacher of physical training, Mr Dobbenga. The latter was at the same time President of the Netherlands Indies Athletics Union. He stimulated my interest in long-distance running. It was through him that I participated in 5-km running during the 1938 Java Athletics Championships; I arrived fourth. I stopped athletics at the age of 20, because of the war, and started again at 50. Since then, I have run several marathons and once got a silver medal in the annual Dutch cross-country contest. This fall I hope to run the New York Marathon, a long-standing ambition. All this is at least partly the result of the seed sown by Mr Dobbenga.

The girl from across the street participated also in the 1938 Java Athletic Championships; she did high jumping. She jumped at that time only 10 cm below the then world record of 163 cm. Duotsje (Doetie) Rienks and I were during part of these years in the same classroom, we were together at dancing lessons, we did our athletic training together, and have been good friends for more than 60 years by now. We will soon be married for fifty years, during which time we produced four fine, lovely and intelligent children.

Surabaia was different from Minahasa, though. In Langoan I was part of the population, living among them and talking and thinking the same way; in Surabaia I found myself in the colonial top layer, farther away from the local population. The school children were mainly Dutch and Chinese, with a relatively small number of (upper class) Indonesian children. Among the latter was a bright Javanese boy whom I knew already from my primary school time in Manado. His name was Joko Mangundiharjo. Later, he became Ambassador of Indonesia in Washington. In about 1979, when I was President of the International Council of Scientific Unions, it so happened that one of the agenda items in a Council meeting was the nomination of a new Rector of the United Nations University. The candidate was an Indonesian with excellent credentials. I was pleased to see one of my former countrymen being proposed, and suggested that the Council express their support, which they did. The long name of that Indonesian, however, seemed vaguely known to me, and stirred around in my head for many days until I suddenly realized that it was my former classmate from primary and secondary school that I had nominated.

Having spent nearly my whole period of consciousness in Indonesia I felt that country, rather than Holland, to be my home country. And when, after secondary school, I went to Holland for University training, it was with the outspoken intention of returning to the Netherlands Indies immediately after that.

5. War

Things went differently, however. I embarked in Surabaya harbour in August 1939, on a ship full of youngsters that were going to Europe for the same reason as I. But, a few weeks later, when steaming through the Red Sea, we learned of the war that had broken out in Europe. Germany had invaded Poland, and the UK and France had responded by declaring war. The next day I got a telegram from my parents summoning me to return; money for the trip back had been paid and they added that back in the Netherlands East Indies I could be trained to become an auditor. With youthful optimism I was, however, less scared of a coming war than my parents were. I wanted to study physics and thoroughly disliked the idea of becoming an auditor. I cabled back that I would continue on my way to Europe.

The arrival in Holland was kind of a deception. In Indonesia the approaching coast could be seen long before arrival: faint pastel-blue volcanoes rising majestically over the haze that covered the fertile green land behind the horizon, over which the sun stood high in the sky. How different the arrival was from the North Sea. Not long before arrival we suddenly spotted a low ridge of dunes and 10 minutes later we were there; a cold and damp country, where the sun, if visible, stood low above the horizon.

I had left my sweet Motherland for a chilly Fatherland.

6. Utrecht

I went to Utrecht, because 'uncle John was living there'; he could watch my activities and alert my parents, if needed. When I found out that astronomy could also be studied there, I chose that topic and wrote this to my parents. By return mail my father forbade me to do this: how could one ever think of earning a living in astronomy? But my professor of astrophysics Marcel Minnaert, a famous astrophysicist and a supreme teacher, told me not to worry. Indeed, there were only a few chances for a job in astronomy, but he thought that money was not the most important part of life, don't you agree? Certainly, I did.

A few months later, my parents and two younger sisters had arrived in Holland too, because the war did not seem to develop further, and it looked as if Holland would stay out. They used their regular leave, which was a period of half a year every six years. They stayed at Texel for that period.

While I loved Minnaert's fascinating astronomy lessons. I found the courses in mathematics not interesting and those in physics were given in a highly boring way: just pages full of formulae without any physical notion. I remembered with sadness Lecluse's fine physics courses in Surabaya and started wondering what University study meant. At the same time the threat of war became stronger and that aspect too caused me to have doubts with regard to my activities. The country was in danger, and I should sit down and just look at dry formulae? Since my heart had always been with the sea I decided to apply for a training as a Navy officer.

I was provisionally accepted and was at the point of undergoing physical tests, but it did not work out since on May 10 the Nazi army* invaded Holland; I awoke that morning at four o'clock to the sound and view of hundreds of Nazi planes flying westward. On May 14 Rotterdam was devastated by bombers and the day after, our army surrendered. Our Queen, the Government and the Navy went to Britain to continue the war and also the Netherlands Indies continued. One of the first things done there was to put the German civilians, living in the Netherlands Indies, in an internment camp.

7. Occupation

The feeling of sadness after the capitulation is hard to describe. Uninvited foreigners would henceforth rule the country and dictate our way of living. I realized also that my application for the Navy was out, but concluded after some thinking that the obligation to join the Free Forces had become even stronger than before. Hence I decided to escape to England. To that end I prepared a canoe, provided it with a mast and a sail and filled it with food for 12 days. But then the problem came: how to escape. I decided first to go through various inland canals to the harbour of Den Helder, which is the navy base just opposite Texel, and if I were then asked where I was going, I would just claim that I was going to go to Texel to visit my parents; at the appropriate time I would then escape to the North Sea, and then westward towards freedom.

After two days of paddling I arrived in Den Helder. There I was told that it was only allowed to enter the open sea with a Navy permit. So I had to see the Navy commander, who appeared to be an open sailor with a friendly face and bright seaman's eyes. He was apparently amused by meeting this young boy who dared to cross the open sea with his canoe to see his family on Texel. So we had a pleasant conversation, among other things about my University study, till he asked for my passport and found that it had been issued in the Netherlands Indies, a territory that was at war with Germany, and then he found on me a sheet of paper with a shopping list for all the food I had bought. That made him realize quickly that this quantity was much more than just for a trip of a few days. His suspicion was aroused, and after some deliberation with others he forbade me to cross the open sea; instead my passport was confiscated by the Gestapo (secret state police), and I was told to present myself daily to the military authorities on Texel, every day at noon as long as I stayed there.

I often think of this German Navy officer. He saved my life. With my canoe, an absolutely unseaworthy vessel, I would not have reached far, if I had not been shot before.

* I speak of the Nazi army, not of the Germans, to distinguish the two clearly. I admire German science and culture, and like our neighbours. I have many good friends in Germany and excellent colleagues, but I hate fascism.

8. Into Hiding

The only alternative was to continue study, and this I did as hard as I could. That attitude was stimulated by Minnaert's address to the students on the early morning of 25 November, 1940, the day on which the Nazis had dictated that henceforth Jewish professors were no longer allowed in Dutch University buildings. In his beautiful Dutch Minnaert protested solemnly against this act and ended by explaining that in the long run the forces of science and culture, though seemingly weak, will always turn out to be stronger than just brute force, racism and oppression. He ended his unforgettable speech calling out: "Students! Work! In your study room you are undefeatable!"

Through his speech I came to realize that in the long run a better society is not just realized through military action – however necessary that may be in the short term – but by advancing culture and science, in particular by promoting and explaining the methods of scientific reasoning, because its basic aspects are similar to those of democracy. Since that time, I have made that viewpoint mine, and I try to act accordingly.

Minnaert was punished for his speech. In May 1942 he was taken as a hostage and brought to an internment camp. The same had happened earlier to my future father-in-law, Sieds Rienks, who was, like my father, a Government employee from the Netherlands East Indies, and was just temporarily in Holland at the outbreak of the war. Sieds Rienks was taken hostage on 17 July 1940, as revenge for the Netherlands Indies act of interning Germans in Indonesia. He was brought to the concentration camp Buchenwald. On the same day, Nazi officers had also visited our home to pick up my father for the same purpose, but he lay seriously ill in bed and could not be transported; the Nazis never returned and in that way he escaped from being brought to Buchenwald, and that saved his life.

Early in 1943 more happened. Military police invaded university classrooms and transported the students attending courses to a concentration camp. The students who were not seized had to sign a declaration of loyalty to the Nazis or else they would be transported to Germany for forced labour. Those who did not want to do either had to go into hiding. But where?

I had good luck. With my fellow astronomy student, Hans Hubenet, we asked Dr Jacob Houtgast (then acting as director of the Observatory to temporarily replace Minnaert) permission to seek refuge in an empty room in the Observatory. This was accepted after some hesitation, and there we were. No better place to live. During the day we sat together in a small closed room in a remote part of the building, but in the night we came out, cooked our food, had access to the library and the telescopes. I watched the Galilean moons of Jupiter and wrote my first publication, on the limb darkening of Ganymede. Once a week my father came on his bicycle to bring us food for the next week. He entered the old Observatory, which is built on a 16th century fortification, through a well-hidden lower entrance, of which he got the key. I was able to finish my university study during that period; secretly

I visited the various professors for an illegal examination each time when I had finished the study of a topic. After the war I could therefore immediately pass my official final examination.

9. The V2

Before that, however, things had worsened seriously. Early in September, 1944 the allied forces had tried to pierce towards the north, over three bridges to Arnhem, but they failed at the last bridge. During the battle of Arnhem, the Dutch railways went on a general strike to prevent the Nazis from using the railway system. Since Montgomery's attack failed, that strike continued till the liberation. The consequence was hunger and mass starvation in the western part of the country. Food was with the farmers, but it could not be transported. There was no longer reason for me to hide, but rather there was the obligation to go to the countryside south of Utrecht, on a shaky bicycle, to buy potatoes at prices that were running upward by the day. That food could no longer be obtained after two weeks.

During these trips, we occasionally saw in the west white vapour trails running steeply upward. We wondered what this was, till someone told us that he had heard of a mysterious weapon, that was launched at the shore and then flew over the North Sea to bombard England. We tended to laugh at that fantastic story. At that time there was no radio, since there was no electricity; telephones were not working, and we had no newspapers. Letters arrived only occasionally, taking several weeks and longer.

We remained wondering, till a few weeks later, when I met Doetie, who lived in The Hague. She confirmed the story. She had actually witnessed the first military V2-launching. As a student in The Hague, the schoolgirls (all male students were in Germany or hiding) were summoned one day to help evacuate the city of Wassenaar within the next 12 hours, because the area was needed for urgent military operations. At the end of that day, when virtually the whole population of Wassenaar had left, she was still around and suddenly heard a terrible noise and then she saw a huge cigar-shaped structure moving up from behind a grove of trees, first rising slowly, then accelerating. When she approached that area a few minutes later she saw the launching pad and some excited military people.

It was September 8, 1944; the first V2 had been fired towards London.

Little did I realize at that time that some 25 years later I would be the first Dutch professor with a chair in Space Physics, and then President of COSPAR, the world organisation for scientific space research.

10. Liberation

The liberation came with the first Canadian troops entering Utrecht in long columns of armoured vehicles, infatigably cheered welcome by all of the population. A few

days earlier, on my birthday, 29 April, we had witnessed an unforgettable attempt to lessen the starvation, when allied planes bombarded cities in the west of the country with packages containing food. The occupying forces were still around but had to consent. The population, sitting on roofs of houses, waving white banners and sheets, welcomed the coming liberators. We then so clearly realized that liberation was imminent. Many years later I heard from a colleague, the well-known astrophysicist Mike Seaton of London, that he was serving in one of these bombers. It was the most cheerful bombardment of the whole war, he would tell me later.

We were expecting a new world, with new vigour and high ideals. To us the liberation gave the opportunity to take up study again and I started preparing my thesis, on the hydrogen lines in the solar spectrum. That fall I became assistant in astronomy 'without charge', which means it did not cost the University anything; in other words, without salary. I was immensely proud and remembered what Minnaert said when I was a freshman: "Money is not the most important part of life". But I soon found out that complete lack of money is disadvantageous for staying alive. So I was pleased when a few months later I was offered an assistantship in theoretical physics by Rosenfeld, a well-known nuclear physicist. Salary, 100 guilders (then: 35 US dollars) monthly. Minnaert was less pleased. He did not understand why I should leave astronomy, and complained that money was apparently all-determining, even in science. My remark that the ratio 100/0, being infinite, is not negligible did not strike him as very relevant.

I found a satisfactory answer; I told Minnaert that I would do my job at theory daily from 9 am to 5 pm, which is 8 hours as prescribed, and then take up my job at the Observatory from 6 pm to 2 am, also 8 hours. Although Minnaert first replied that according to State Laws accumulation of functions was not allowed, he finally agreed. So I had two full University jobs at the same time. I think I am the only one in the history of Utrecht University who can claim that. That period of really hard work lasted for half a year, until I got a job at Leyden Observatory, under Oort's eminent scientific leadership. I worked on variable stars and gaseous nebulae. There I also met old Hertzsprung, already retired, but working day and night, and remaining devoted to astronomy which would continue until his last days.

That period was again followed by an appointment in Utrecht, and there I have remained ever since. I defended my thesis on the Hydrogen Spectrum of the Sun in 1952.

My political life went less smoothly than my scientific career. On 17 August, 1945, President Sukarno declared Indonesia an independent state. While first being deeply upset that my own motherland, the land of my youth, would be detached from Holland, I intellectually came to realize the rightness of this act, and although with feelings of pain, I could understand and appreciate this move: why deprive Indonesians the freedom that we had just acquired? The subsequent decision of our Government to send an expedition army of a few hundred thousand men to

Indonesia, not only saddened me but made me wonder. Was not the coming move of history clear to anyone? Why spend lives of Dutch and Indonesian young men in a desperate attempt to turn the course of history?

I could not stay silent and thus got involved in peace movements and anti-military actions. But at that time, actions of that kind were minority activities that were mainly restricted to the Communist movement. Hence I was rapidly labeled.

That had its disadvantages. When I was invited for a Visiting Professorship in Princeton in 1955, my visa was refused. It was the cold war period and the McCarthy influence was all around. A few years later I got a very attractive invitation by Jack Evans to become one of his first staff members in the new solar observatory that was being developed on Sacramento Peak. I decided not to complicate things for Jack, and to decline politely before McCarthy would do so. My first visit to the US was therefore only in 1961 on the occasion of the IAU General Assembly, when the US Government had promised that any invited *bona fide* scientist would obtain a visa.

11. The Quiet Sun

Minnaert's career was built around his solar spectrograph, which was at the time of its construction the third largest in the world. His work on the interpretation of Fraunhofer lines and the first 'Atlas of the Solar Spectrum' made him famous. He was a perfect scientist, consistently trying to link observations with theoretical interpretation. He tried to bring us, his students, up in the same spirit: theory or observations for their own sake do not markedly advance science, but the combination of the two does. I call myself neither an observer nor a theorist (though in 1961 I was appointed the first Chairman of the newly created IAU Commission for the Theory of Stellar Atmospheres), but wish to be seen as an interpretator of observations, which I find the most attractive and challenging aspect of astrophysics.

At the time that I prepared my thesis, one of the issues was: would it be possible to establish detailed models of stellar atmospheres? Pannekoek had already tried so in the thirties and Bengt Strömgren followed, but Unsöld was of the opinion that the time was not yet ripe for this and contented himself with 'average' models characterized by one temperature and pressure. However, Barbier succeeded in constructing an empirical photospheric model on the basis of limb darkening observations in continuous light. I tried to continue this line of research by building a model based on my centre-limb observations of H-line profiles. When seeing my work (1952) Martin Schwarzschild stimulated me to continue that way; he added that the structure of the quiet photosphere should be determined when the Sun was in its quiet period. Thereafter, around the 1959 maximum, one should have a sufficient body of basic knowledge to successfully approach the topic of solar activity.

I found that a good ‘eleven-year plan’ and tried to proceed accordingly. It was a great help in that respect that two years later I was invited to write a chapter for the new Encyclopedia of Physics (Handbuch der Physik) on the Structure and Dynamics of the Solar Atmosphere. The Chapter became a book of more than 200 pages, and working on it was a fine opportunity to get a broad and detailed overview of solar problems.

Investigating the quiet solar photospheric model continued over the next solar maximum and minimum till 1968, when I organized an international meeting in Holland to agree on a model of the solar photosphere; there originated the ‘Bilderberg Model of the Solar Atmosphere’. Since one cannot finish all details in just a week’s time, the Bilderberg model was subsequently refined and improved by our Harvard colleagues and this resulted in 1970 in the ‘Harvard-Smithsonian Model of the Photosphere’. My own activity in that field terminated with Bilderberg.

Gradually I had moved to solar activity, first by studying the structure of sunspots. During 1957–1959 the Geophysical Year took place, an enormous, worldwide activity aimed at improving knowledge of the solar outer layers and Sun-Earth relations. I improved our solar spectrograph and collected a considerable body of observational data on the variation of the $H\alpha$ line profile during solar flares. In spite of a well-developed alarm system, that let me obtain the first spectra within a minute after the detection of a flare, I obviously missed the phase that I considered most important: that of flare ignition. The spectra were usually taken during or even after the flash phase of flares – which occurs later than the phase of ignition. Therefore I never published that material.

A failure can lead to better views, though. The IGY period made me realize that if one wants to understand why a flare is there and how it originates, one should have data on flares from before their start. That philosophy led to what I would call my second main subject of solar investigation: trying to find the origin of solar flares.

It was helpful that the era of space research had started. That presented us with the opportunity to observe flares from spacecraft, from before their start till the very end.

12. Space Research; Many Organizational Activities and Some Research

When in 1957 the first Sputniks were launched, soon followed by the first Explorers, the wish arose in Europe to follow the US and the USSR in embarking on space research. The UK and France had already started their national rocket programs, and in 1962 NASA launched the first UK satellite. In Europe, preparations started to establish a cooperative European space research organisation, that was successively called COPERS, ESRO and ESA. I was involved in it from the start, in various capacities. I was chairman or member of an uncountable number of commissions and committees, of which I most liked the membership in the first Launching

Program Advisory Committee, a 4-man group headed by Reimar Lüst and further consisting of Jaques Blamont and Robert Boyd; three eminent scientists, with whom it was a pleasure to cooperate.

At the same time, our government made money available to establish the Utrecht Laboratory for Space Research. On October 1, 1961 I started this organization, and ten years later the laboratory had 100 employees. We embarked on three main topics: monitoring solar flares in X-rays, UV stellar spectroscopy, and non-solar X-ray astronomy.

There was during that time a lot of organizational labour and committee meetings and only little time for research. Several of the research papers that I still managed to write during that period were written partly in the noisy environments of waiting rooms at airports, or in planes.

Do I regret this? Certainly not. The outcome justified the efforts.

13. The Astrophysical Institute in Brussels

This was a period of hard work, also because, in 1961 too, I was appointed extraordinary Professor at Brussels University, Belgium. The appointment had to do with the particular situation in the bilingual country of Belgium. In the northern part, the people speak Dutch (it is often called Flemish, but Dutch and Flemish are the same language, differing from each other less than, e.g., Scottish and English). The northern Dutch-speaking part of Belgium had for centuries been underdeveloped, culturally as well as economically, and only in the second part of the present century did the increasing economic strength of Flanders make the Belgian government realize that at Universities in a Dutch speaking part of the country, the courses should actually be given in Dutch, not in French. But the cultural underdevelopment of the northern part was at that time still so large that there were no Flemish teachers available for several topics, including astrophysics.

Therefore, when the decision was taken that in Brussels University the courses should be given in the two languages of the country, I was appointed to teach astronomy. I accepted because I had seen in Indonesia what a drawback it is for young people to get their instruction in a language other than their own. The best students are evidently always able to master instruction in any language, but for the average student it can just make the difference between success and failure. That experience convinced me that a people's freedom depends on three factors: its cultural and linguistic independence as well as its economic development. Certainly, these aspects are linked. The Flemish part of Belgium had indeed started a period of impressive economic development after the last war, and that has also stimulated the call for cultural and linguistic freedom. I found it my duty to contribute to that.

Once a week I therefore went to Brussels where I gave my courses and founded the Astrophysical Institute of the Free University. That period lasted till 1973. Although it took of my time, I never regretted the decision to accept the nomination

there. I am proud to witness the fine development of the Brussels Astrophysical Institute since that time. During the past forty years, the previously existing economic and cultural underdevelopment of Flanders has virtually disappeared, and I am satisfied to have contributed in some way to that development.

14. JOSO

At an IAU symposium in Budapest in 1967 Kiepenheuer, Righini and I met in a Konditorei to discuss the need for establishing a common European solar observatory of high quality at an excellent site. That was the origin of the Joint Organisation for Solar Observations, JOSO. Kiepenheuer became the first President and I the Secretary. A number of years of very pleasant cooperation with a stimulating person and an excellent friend found an untimely end with Kiepenheuer's very much regretted death, in 1974. Thereupon I became his successor. In 1980 I was succeeded as JOSO President by Edith Müller.

We agreed that the first task should be to find the best site. Kiepenheuer had some ideas. The site should be on an island or coastal area where prevailing winds were normally blowing from the sea, which would guarantee a stable atmosphere with reduced convection. Of course, there was the requirement of a sufficient amount of sunshine. Initially we were hopeful that such a site should not necessarily be situated at high altitude, and therefore we started exploring the Mediterranean coastal areas. We were soon, i.e., after a few years, driven out of the Mediterranean region because we found, to our initial surprise, that orographic effects were far more important than we assumed before, and extended to large distances: at a site situated some 100 km leeward of a mountain top the air is still too much disturbed to allow for good observations.

A long story – many years of site testing at more than a dozen sites – should be told briefly here. We chose the Teide mountain top in the Canaries, but for reasons of environmental protection it was not allowed to build the observatory at that – indeed scenically beautiful – top. We ended our research in 1975 at the next best site; the Roche de los Muchachos on the island of La Palma. Kiepenheuer died just a year too early to witness that decision.

A few years later, stellar astronomers from a few European countries selected the same site for their purposes, too. At present the location houses the International La Palma Observatory, where excellent solar and stellar telescopes provide outstanding observational data.

15. Global Organisational Activities; the IAU

In 1967 I was invited by Jean-Claude Pecker, at that time General Secretary of the International Astronomical Union, to become Assistant General Secretary, which

implies that three years later I would become General Secretary. This led to a moment of thinking. The new task would somewhat detract me from my scientific activities, in particular from building up the Laboratory for Space Research, but the attractive aspects of truly contributing to international cooperation in science were very attractive to me. I decided to consult Minnaert, although I could know his position offhand: in such matters we thought very much alike. Of course his position appeared to be mine: if the international community calls, one should have strong arguments for refusing.

I accepted and was for nine years involved in IAU activities, first as Assistant General Secretary, then General Secretary, then Advisory Member of the Board. They were good years in which I met fine scientists. The cooperation with my three Presidents: Otto Heckmann, Bengt Strömgren and Leo Goldberg stands high in my esteem and memory.

16. Global Organisational Activities: COSPAR

COSPAR is the international organisation for cooperation in space research. Its Council contains representatives from all scientific unions that have ties with or that are involved in one way or another in space research. Since space research was my specialty among the IAU Board members, I was appointed in 1968 IAU representative to COSPAR. That way I entered into this very dynamic organisation; a highly interesting environment with some funny aspects.

COSPAR was a product of the cold war and that was reflected in its structure: its Charter prescribed that the two Vice-Presidents should be proposed by the USA and USSR Academies of Sciences, respectively; that thereupon each of these would propose two other Board members, and that the Board should then elect a President. It was like balancing on a rope over the Niagara. That aspect was indeed reflected in the way I became COSPAR President.

In 1971 the USA Academy of Sciences put my name forward as their candidate for the COSPAR Presidency, but as a reaction, the USSR Academy became suspicious about me, and did not want to support that proposal. No new President was therefore elected in 1971.

During the year after, the USSR Academy apparently found out that I was not as bad as they initially thought, and so I was nominated a year later (1972) by the USSR Academy. In the meantime, however, the USA Academy had already selected another candidate, Sir Harrie Massey. When the latter heard of my nomination, he withdrew. That way I became President of COSPAR in 1972, as a successor to Prof Roy from France. I held that position for two terms, till 1978, and was later elected again for the period 1982 till 1986.

From the many remarkable, often delicate, matters that we were confronted with, I will mention only one here, because it sheds light on an interesting and at the same time human episode from the cold war period.

The first annual COSPAR meeting that I had to preside over was that of 1973 in Konstanz, Germany. There, we had to decide on the location of the meeting after next, in 1975. It so happened that there were two candidate countries proposed: Bulgaria and Israel. Selecting Israel would, of course, offer great difficulties for the Eastern European countries who had no political ties with Israel. No eastern European scientist would most probably be allowed by his government to go there. We realized that, and although many Council members (Council was composed of the representatives of the 35 Adhering Countries and the 12 Scientific Unions) felt sympathetic to meeting once in Israel, they felt it politically wiser not to do so. I rapidly discovered that feeling while consulting a number of Council members before the meeting. Hence, in its wisdom the Council would vote for Bulgaria. That tendency was not felt so by the USSR Vice-President, General Blagonravov, who was very concerned indeed that the Council would still select Israel.

When the meeting was at the point of voting, Blagonravov, who I normally respected for his temperate judgment, asked for the floor and then launched a fierce and partly unjustified attack on Israel. During his unbalanced address I could see from the faces in the room how some Council members were changing their opinions in a direction contrary to Blagonravov's intentions. Because of the subtle character of the matter under discussion, I decided thereupon that voting would be secret, hence in writing and not just by lifting hands, as was usually the case for items like this one in which persons were not involved. The result was a slight majority for Israel.

Blagonravov was furious and commented immediately that this decision was impossible and could not be maintained. He contacted me instantly after the meeting, urging me to reverse the decision. My point was that the decision was not mine, but the Council's, that it was taken in a democratic way and could not be reversed, unless by another decision of Council, for which I saw no possibility.

Although in my heart I liked the decision – it was a first expression of democracy in COSPAR, and I voted for Israel too – I was worried at the same time, because we might end up with no Eastern European scientists at the Israel meeting of 1975. That would counter the aim of COSPAR to bring eastern and western space scientists together. But I had hope that a satisfactory compromise could be found. The year after that meeting I had therefore several talks with Blagonravov and his adviser Geinrich Balayan. Things stagnated somewhat when Blagonravov died early in 1974.

During these discussions I developed an idea that might satisfy all parties: let us somewhat give in to the USSR and agree not to meet in Israel in 1975, but instead in Bulgaria, but let us agree at the same time to have the COSPAR meeting in Israel two years after that, in 1977. This latter date seemed sufficiently far away to make that decision acceptable to the parties involved.

I met initially with heavy opposition from Israel: why change a decision taken in a democratic fashion? I had to make a trip to Israel trying to convince them that in the long run my proposed solution might turn out to be the best. Of course, the

USSR Academy did not agree either. But the ground was prepared and at the 1974 meeting of COSPAR, in São Paulo, we had several meetings between David Abir (Israel), Kyril Serafimov (Bulgaria), Mrs. Alla Mashevitch, a well-known Soviet astronomer who temporarily replaced Blagonravov, and me. After a full week of nearly daily talks we indeed came to the above described decision. It was signed by all parties, including Alla Mashevitch "*from* the USSR Academy of Sciences" (note the subtle formulation: not *for* the ..).

We drank a toast to the outcome. After that, Alla and I walked back to the hotel. She suddenly stopped: "You do understand, Kees, that I did more than I was allowed to?" I realized that and added that I had deep respect for her courage and wisdom. Alla Mashevitch is one of the women I admire most.

The COSPAR meeting in Tel Aviv turned out to be a great success with the participation of a delegation of some 20 Soviet scientists and delegates from all the other Eastern European countries. One of my ideals was always to bring peoples and cultures together; I am still very pleased with the outcome of a debate that started in 1973 and that ended so successfully in 1977.

17. Global Organisational Activities; the International Council of Scientific Unions

As IAU representative, and later as representative of the Netherlands Academy of Arts and Sciences, I used to attend the General Assemblies and General Committee meetings of the International Council of Scientific Unions. That body is the world's scientific umbrella organisation, covering all scientific Unions and the Special and Scientific Committees established by these Unions. It is the most important organisation in world science, maintaining direct contacts with relevant UN organisations and with the scientific Academies and Science Foundations, at that time in more than 60 member countries. The ICSU is, obviously, less well known to the individual scientist, who is closer to his own Union - such as IAU or COSPAR.

In 1976 I was elected vice-president of ICSU and two years later I became President; I happen to be the fourth astronomer to take this function, after Hale, Spencer Jones and Ambartsumian. I feel honored to find myself in that sequence of eminent astronomers. The job was interesting, for the topics dealt with, and because of the fine people I learned to know. My General Secretary was Sir John Kendrew, Nobel laureate. The President during my vice-presidency was Bruno Straub from Hungary, a wise and balanced person. In 1990, during the time of political transitions in Eastern Europe, he was elected President of the Republic of Hungary, where he assumed a role similar to Gorbachov's in the USSR.

A presidential period of two years is too short for really building up a coherent policy; therefore I took the initiative to henceforth prolong the President's term to 4 years (not for myself obviously). The main activities that took place during my term were the start of the International Geosphere Biosphere Programm (IGBP) and

the continuation of discussions with the Peoples's Republic of China and Taiwan about both becoming members of ICSU and all its bodies. These prolonged but interesting discussions had started already in 1974 but were seemingly endless. China claims that Taiwan is just a Chinese province and Taiwan in a way agreed with that. They only do not agree where the Government is seated. So, why have two members in ICSU (and in its bodies like the scientific Unions) from one and the same country. That would be contrary to the ICSU Charter. On the other hand, one should be realistic: *de facto* Taiwan and China are two countries. In the course of these negotiations ICSU changed its Charter in such a way that the notion 'state' or 'nation' no longer figures in it: ICSU accepts as members representative scientific organisations from 'independent territories' evidently only if there is a sufficient amount of scientific activity. The need to have China, the largest 'independent territory' of the world, in ICSU is obvious, but we should take care very strictly that such does not happen at the cost of expelling another territory.

After a number of visits to Beijing and Taiwan, the parties finally agreed to sign a statement saying, in very balanced wording, that although Taiwan is a province of China, we agreed 'for the time being' that this one country, China, was represented in ICSU and its Unions and Committees by two scientific institutions, *viz.* the China Association for Science and Technology and "the Academy located in Taipei, Taiwan". Note the subtlety in the last phrase: that Academy calls itself 'Academia Sinica', but that name could, of course, not figure in any official statement that would be acceptable to mainland China.

The installation of China should have taken place under my presidentship during the 1980 General Assembly, but that was stagnated at the very last moment, actually two days before the meeting, by the Chinese reaction to a statement, made earlier by the candidate for the USA presidency, Ronald Reagan. The latter had claimed during his election campaign that the USA would officially recognize Taiwan if he were elected. Of course he did not follow up that promise after the election, since there are differences between such promises and reality, but it was a sufficient reason for China to lean backward for two more years, to my sincere disappointment. Only in 1982 did China become a member.

Once being in a running train, it is hard to jump out. In 1980 I was nominated for the Presidency of the Royal Netherlands Academy of Arts and Sciences. Though I initially accepted, I finally turned the invitation down, when our Government suddenly decided to reduce by 30% the budgets of a number of scientific institutions, including the personnel and material budget of the Laboratory for Space Research. I found it not correct to leave the Laboratory at that difficult instant.

Five years later, when I was no longer in charge of the Laboratory, I accepted to become the Academy's first Foreign Secretary, a job of six years, that ended in 1991.

18. Editorialities

In 1961 I started the development of the Utrecht Laboratory for Space Research. The first staff members were engineers and physicists from greatly different origins and training: industry, university. None of us was hindered by too much experience in the new discipline, but we were enthusiastic about the new tools given to us. The prospect of observing the Sun in many other wavelengths than just the visual spectral region looked fascinating to me, and I had great expectations of continuously monitoring the Sun to reveal the secrets of the origin and initial development of flares.

To improve our knowledge, I sent younger coworkers to the USA and to England and France to gain some experience. I found it a drawback for myself, that my general knowledge of space physics was too limited: I had grown up in solar spectroscopy; I also had good training in developing and constructing optical instrumentation, but now we found ourselves confronted with things like proportional and scintillation counters, with problems like how to develop spectrographs for X-ray spectroscopy, instruments for X-ray imaging and more of that. I wished there was a kind of book or journal introducing scientists like me to the complicated and vast field of space physics, and keeping them abreast of new developments, but such a source did not yet exist.

In the course of 1961 I was visited by Mr Anton Reidel, director of a Dutch publishing house carrying his name. So far he had been publishing books and journals in fields far from astronomy, but he saw the new marked opening and asked my advice. I suggested that he start a journal containing invited reviews on the various aspects of space research. For this journal I suggested the title *Space Science Reviews*.

The replying question was if I would be willing to become editor-in-chief of that journal. That was another matter, but given my deep interest and my fresh involvement in that field, I realized that such a position would make it easier for me to ask just the questions to which I sought an answer, hence why not? I decided to accept and I started selecting an editorial advisory board of some 20 persons.

The coming of the new journal was generally welcomed by scientists who felt a similar need as I did, but in circles around COSPAR, the just-created (1959) world organisation for space research, there was some initial objection. Some COSPAR officials were of the opinion that the new journal should rather be a COSPAR undertaking. I agreed with them and therefore selected a number of prominent COSPAR Council members in the Editorial Board, thus linking the new journal *de facto* to COSPAR. In an efficacious meeting of the Editorial Board, in Washington during the COSPAR congress of 1962, the policy of the journal was further defined.

A couple of years later, Anton Reidel, pleased with the success of *Space Science Reviews*, visited me again: would there perhaps be room for yet another journal in the field of astronomy. Oh, yes, I said, it would be good if solar scientists could have a forum for discussing their results without being snowed under by other topics.

But, having learned from the previous experience, I hastened to add that I had a sufficient task with *Space Science Reviews* and that he should look for another Editor for *Solar Physics* than myself. Reidel seemingly agreed, but commercial people are always smarter than scientists. He asked me to help him in one matter only: to write to some colleagues to invite them to the Editorial Board. One of the first I contacted was Zdeněk Švestka in Prague, whom I knew already since a visit to Ondřejov in 1950, and who was at that time Chairman of IAU Commission 10, on solar variability. He immediately wrote back that this was exactly his idea, already for a long time, and suggested that the two of us would become the Chief Editors of the new journal. Since I liked the opportunity to cooperate with Zdeněk, I agreed. And that's how it happened.

We have been working together for more than 30 years. Thank you, Zdeněk, for your fine friendship and wonderful cooperation over all these years!

In 1987 the addition of Bob Howard completed our troika, and that gave the journal better ties with solar scientists in America. With Bob I have cooperated already for nearly 10 years. I owe much to him for his wise and friendly consideration and his stimulating initiatives.

19. Solar Flare Research

Let me return to science, because that is what it all is for. Since the IGY, I had been fascinated by the problem of flare origin. Where is the seat of all this energy and why this nearly explosive behaviour. Theory says the best scenario is to look for conversion of magnetic energy into heat and motion, but how? I therefore proposed to ESRO to equip one of their satellites with a soft X-ray monitor. The ESRO-2 satellite, launched 1968, contained such a monitor, but we soon found out that soft X-rays from flares just display what we would now call the 'gradual component', i.e., the radiation of the hot plasma created during the impulsive phase, which occurs, as we now know, after flare ignition. It shows the impulsive phase's aftermath and gives no information on the ignition process.

We began to suspect that already before ESRO-2 was actually launched. Science can sometimes progress quicker than spacecraft can be built. In 1964 we obtained some balloon observations of a remarkable flare observed in hard X-rays by Jean-Pierre Legerand from France. The observations showed two highly impulsive, very hard X-ray bursts slightly prior to the origin of the flare as seen in $H\alpha$. There should exist a yet invisible source for these very short-lived bursts. Leen de Feiter coined the name 'superthermal plasma nodules' for these sources and these were the objects we decided to look for. Since we did not yet know how to image the Sun in hard X-rays, we proposed a hard X-ray monitor for the ESRO TD-1A spacecraft.

That spacecraft was launched in 1972 and immediately gave a useful hint. During what we now call the 'impulsive phase,' the Sun appeared to emit short-

lived fierce bursts of hard X-rays, the impulsive phase bursts, apparently, as we thought, linked to our ‘nodules’. But we were lacking images.

In the meantime, three excellent coworkers, Frank van Beek and Bill Lafleur, with astrophysical help by Peter Hoyng, in cooperation with George Simnett from Birmingham, had conceived a way to image the Sun in hard X-rays. Their Hard X-ray Imaging Spectrometer (HXIS), launched 1980 in the Solar Maximum Mission, did provide us with images and showed the ‘footprints’ originating in the chromosphere after the bombardment of the chromosphere from ‘above’ (from where?) by beams of charged particles or by plasma, apparently streaming along magnetized loops having their feet at these locations. In 1977 Zdeněk Švestka had joined forces with us, and, working together, the members of our group could advance some aspects of the scenario of flare ignition.

But the true source of the flare’s origin, our ‘nodules’ of 1974, had not yet been seen.

I retired from the directorship of the Utrecht Space Research Laboratory in 1983 (and from the University in 1986) and my successor at the Laboratory, Johan Blecker, decided to quit solar physics and to embark fully on non-solar X-ray, infrared and gamma-ray astrophysics, an excellent choice that I understand and fully justify. But in 1990, *Yohkoh* was launched in Japan, and although I was initially not involved, Jun-Ichi Sakai pulled me in, by visits to Utrecht and by inviting me to Japan. Thanks to *Yohkoh*’s fantastic imaging achievements in soft and hard X-rays, we have now the feeling – or dare I say: we are convinced? – that flares originate by the interaction of current-carrying loops, which leads to an explosion in the point of interaction, followed by the rest of the observed phenomena. Sakai and I have just published a long review on the relation between flares and current-carrying loops, which summarizes our views. I do hope to continue for many years in this attractive area of research.

20. Hypergiant Stars

At the end of the seventies, hoping that I would get more time for science after my ICSU Presidentship, I considered how to start again. While we were still fully involved in solar flare research with the forthcoming launching of the Solar Maximum Mission, I also had the feeling that changing the subject of my research could be refreshing and might provoke new ideas. During previous years I had already been working in stellar photometry and spectroscopy, often in cooperation with Neven from Brussels, and I was intrigued by the question why there are no stars brighter than a certain upper limit. In other words, what mechanism(s) determine(s) the upper limits of stellar atmospheric stability? I did some research in this field and thereafter wrote a book ‘The Brightest Stars’, that appeared in 1980.

Since that time, I have spent a good deal of my research in this field, together with my coworker of the last ten years, Hans Nicuwenhuijzen, and with research students like Alex Lobel from Brussels. So far we found that atmospheric instability is strongest in the so-called yellow hypergiants, of which ρ Cas is a notorious case. Their instability is related to a negative depth-gradient of the atmospheric density, which causes in parts of the atmosphere a net outward acceleration. This instability appears to be restricted to a small area in the Hertzsprung-Russell diagram; we call this the ‘Yellow Evolutionary Void’. It is significant that the Void applies only to very evolved stars, which evolve blueward after the red supergiant phase. For stars in the Void, the sonic point of the stellar wind is situated inside the photosphere, which causes an enhanced rate of mass loss. We also found that shock waves are the drivers of mass loss in these stars, and we succeeded in quantitatively explaining the observed rate of mass loss by this mechanism. An additional result, that came fully unexpected was that the enormously high observed values for the stellar ‘microturbulence’ are not due to stochastic motions, as is implied in the notion ‘turbulence’, but that they are due to stochastically distributed fluctuations of the kinetic temperature in the hot sheets behind the many photospheric shock waves. While the observed r.m.s. microturbulence in ρ Cas is 11 km s^{-1} , the real hydrodynamic r.m.s. turbulence is only 0.4 km s^{-1} , but the hot sheets behind the many shocks simulate the large observed value.

We have collected more observations by now, since the non-linear pulsations, the formation of a remote stationary shell, the refinement of the shock-wave picture ... etc. are all topics that are worth further investigation.

21. Present Days

Although I feel young, it is already long ago that my father showed me the difference between a white and a red star. Looking backward one sees the long way one has gone. Yet, there is so much that should be done.

I deeply enjoy life. I practice my long-distance running, and I just found, while preparing myself for the coming New York marathon, that intensified training causes improvement in performance to an unexpected degree – even when the body is getting older. One should apparently not think too early to be too old for enhanced physical efforts.

I look forward to continuing research in solar flares, where we seem so close now to seeing how flares ignite. I am sure it will open a brand new field of research, with unexpected aspects. I also hope to further study the hypergiants, these near-unstable stars with their odd behaviour.

One of the items of my concern has often been the proper dealing with science. I am in accord with a saying by the Dutch astronomer Kapteyn, early this century, when he was talking of somebody who was caught in fraudulent science: “This is the only person I hate”. I am of the opinion that democracy and the methods

of science have identical bases: a critical and skeptical attitude, discussion, and consent, and I find it important to present these basic ideas to the public at large. I dislike pseudoscience; therefore I have been since 1987 chairman of a Dutch organisation 'Skepsis' dealing with the critical scientific investigation of alleged paranormal phenomena and with debunking pseudoscience. Since 1995 I am also chairman of the European Council of Skeptical Organisations.

Doetic and I are still living in the old Utrecht Observatory, at present for 33 years already. When the University staff left the Observatory, in 1987, to move to a building on the University Campus, the Observatory was transformed into a public Observatory. It presently earns its income by showing laymen the beauties of the universe. I am naturally closely linked with the Observatory's weal and woe, and when seeing their difficult financial position, I offered in 1992 to give, for the Observatory's financial benefit, a monthly public lecture on the general theme: 'Recent Discoveries in Astronomy'. The actual topic is different every month, depending on the most recent findings. For me it is a fine way to stay abreast of astronomy, and the lectures appear to fill a need and are popular; all lectures have to be given twice (because of the full classroom) and several of them thrice. Since 1995 I have published the lectures annually in a book for the general public. Is it not remarkable that our science is so dynamic that each month another new finding can be described to a lay audience?

During my summer vacation periods I go to my cottage on Texel. There, in cooperation with a local amateur archeologist, Willem Kikkert, I am involved in archeological and historical research on the history of the southern part of the island, an area that was over the centuries shaped and reshaped by the interplay of wind, sand and sea. We found some remarkable results and will publish these in a book to appear in 1998.

22. Thank you, everybody

Looking backward again I see so many faces, many of them no longer with us: my parents who guided my first steps; my father who put me on the track to astronomy, my teachers, among whom are Lecluse and Minnaert, my wife coaching me in athletics and in all aspects of life, my children so dear to me, and the hundreds and thousands of friends, coworkers and colleagues all over the world whom I have met in so many different capacities and circumstances. In my memory I see them; I see their friendly faces smiling, some sharply, others only vaguely or already fading thank you for the privilege of having met you, thank you for a wonderful life.