Translation of MacLaurin's Dissertation

A Philosophical Dissertation,

Concerning Gravity, and other Natural Forces.

I. Among the various phenomena of corporeal nature, there are two, which, as they are very greatly distinguished almost before all others, having been examined in themselves, have occupied to a very great extent the philosophers of all time. One of these is that *general tendency* towards its centre of all bodies moving about the surface of the earth, which is commonly called *gravity*; the other is the *regular gyration of planets* in their orbits, which recurs with definite periods. Various hypotheses have been devised by various people for the explanation in mechanical terms of those phenomena. An impartial examination of these will prepare the way for explaining and developing that general law of universal *gravitation*, to which, it will be established, those two most noble effects are to be referred as a common foundation, even if at first sight they seem to have nothing in common; from this we will also seize the opportunity to consider along the way certain other forces of nature, which it is necessary to put in place for the solution of certain other phenomena, which philosophers have undertaken to explain likewise by mechanical theories.

II. To make a start from the gravity of terrestrial bodies, the opinion of *Descartes* and of his followers deserves the first consideration. Among other wonderful effects which they invent for the *celestial matter*, they also derive gravity from its very rapid perpetual gyration about the earth; this gyration necessarily imparts to that matter a violent impulse away from the centre of the recessional motion, as a result of which terrestrial bodies, having much less force, are pushed down towards the centre of the earth. In this way water, or any other fluid, pushes upwards a body thrown into it which is specifically lighter. However, this hypothesis operates with the obvious disadvantage that it ascribes a really rapid, and even circular, motion to the *celestial material* (no traces of which present themselves to us in the nature of things), and to explain mechanically the origin and conservation of this material is a matter of equally great labour and effort, as to give an explanation of gravity itself.

Moreover, since necessarily this very material has to be supposed devoid of all gravity, what can nevertheless restrain its centrifugal impulse, which is continually so violent? It is not the pressure of another encompassing fluid, for it would be necessary for the former to be restrained in turn by the latter material, and for motion to be communicated to it; and since this fluid has to be supposed to be restrained by some other encompassing fluid, that will also restrain in turn: in this way it will come about that the motion of this material decreases continually when extended to infinity, and is finally reduced to nothing. Finally, since this material necessarily performs its orbits in circles parallel to the equator, it will be necessary for all heavy bodies to descend in the planes of those circles, and consequently in lines which do not tend towards the centre of the earth, but are perpendicular to its axis; this is entirely contrary to experience.

(p.27) III. Others assert that *gravity* arises from the pressure of the overlying atmosphere, not noticing that the whole pressure of the atmosphere depends on this very gravity: for its elastic force itself, without some force acting against the elasticity, can cause no lasting pressure, since in this way the whole atmosphere would be rendered rapidly much thinner, as can be easily brought about in a pneumatic machine, in which we see clearly however that thinness of the atmosphere causes certain destruction to most, if not to all, animals. But this opinion is most effectively disproved from the fact that the force of gravity is found to be much more powerful, when the pressure of the atmosphere is removed, than when it remains: therefore it is so far from being the case that that pressure is the cause of gravity, that on the contrary it weakens the effect of this in all bodies, and in some it removes it completely: for it takes away from the gravity of any given body just as much as is equal to the gravity of the mass of air equal in volume to the given body; moreover, where a negative amount is left, as happens with bodies which are called *light*, the bodies do not descend but ascend.

IV. There are those who assert that *gravity* is an *attraction* of the same type as that by which a magnet attracts another magnet or iron; and consequently, if this can be explained mechanically, (which very many consider to be possible), the philosophical reasoning must apply equally to the former. However, a very brief comparison of both types of forces will show that the truth of the matter is quite different. As a result of the force of gravity the earth attracts in lines tending toward its centre, either exactly or approximately, any bodies which are moving round about it; and, as will be shown later, that occurs with forces which, at equal distances from the centre, are proportional to the amount of matter in the individual bodies, while at different distances they decrease in the ratio squared of the increased distances. A magnet, on the other hand, does not attract in this way towards its centre, but rather towards one or other of its poles; thus it does not attract equidistant bodies with forces proportional to their quantity of matter, so that in the case of equal bodies it attracts some with greater force, others with less

force, and the greater part with none at all: in general it decreases in the ratio of the distances to a higher power than the square.

(p.27) V. Not a few other arguments can be introduced, which overthrow sometimes only the proposed hypotheses, sometimes all other possible hypotheses, offering a mechanical solution of gravity; so far they certainly show that the descent of heavy bodies can result from no bodily impulse. In particular, since the momenta of the motions are always as the quantities of matter whenever the velocities are equal, and since heavy bodies at the same distance from the centre of the earth tend towards it with equal velocity (if we ignore the resistance from the atmosphere), it is clear that the impressed forces are directly as the quantities of matter in the bodies themselves, no account having been taken of the shape, texture or bulk. But if gravity were to arise from any impulse of a surrounding fluid, that impulse would consist either of a percussion of the parts, freely moved, of the fluid towards the same region to which the impelled body is driven, or of a pressure of the whole fluid pressing more powerfully against an obstruction placed on the other side: in the former case the force is impressed in proportion to the surface, in the latter in proportion to the bulk of the impelled body; in neither case is it in proportion to the quantity of matter. Moreover, every impulse pushes a body at rest to a greater extent than a body set in motion, so that, the greater the velocity by which the impelled body is moved, the less the impelling body adds increment of velocity to it, until the whole impulse stops, as well as the acceleration of the motion, the velocity of the impelled body and of the impelling body having been made equal: but gravity (as has been ascertained from very accurately set-up experiments) adds equal increments of velocity in equal time both to a very rapidly descending body and to a body starting at rest. It is therefore clear that gravity can arise from no corporeal impulse.

(p.27) VI. If to the Proposition now proved two others are joined, it will be clear what is to be thought about the cause of gravity. One of these is as follows: suppose that a body placed at rest is moved from its position, the motion to be forced on it by some external cause, either corporeal or incorporeal; all the more so if the body, having been projected towards one plane, is cast back into the directly opposite plane; then that new and opposite motion is to be considered as resulting from an external cause. The other is that no body can move another body, unless by impulse, *i.e.*, a body can exert no force at a distance, in other words, it cannot act where it is not present. Therefore let us mention that, whenever we are following the commonly accepted and concise method of speaking of bodies *attracting* other bodies or *repelling* them without impulse, we wish to indicate by such phrases, not the true and properly named cause of the motion which is being discussed, but only the purpose for whose effect the force is applied for such movement in accordance with some general law of nature, and at the same time the boundary towards which, or from which, that force is directed: let it suffice to have advised of this once. The former shows that the gravity of terrestrial bodies arises from

some external cause; the latter shows that its cause is not some corporeal thing, if indeed it is proved by the *above Proposition* that it does not arise from an impulse. Therefore it only remains for the cause of gravity to be recognised as a will capable of some incorporeal and intelligent cause which exercises its force uniformly according to a certain general law. But of what type this intelligent cause may be, will easily be accessible to anyone who considers that the whole structure of the globe of the earth is preserved and strengthened by this very gravity; otherwise this would rapidly fall to pieces, having been broken up by the centrifugal impulse. Gravity prevents mountains, seas, cities, people, and other living beings thrown off the surface of the earth from being scattered far through the vast region of the heavens. The subsistence and nutrition of both humans and the other living beings depend on gravity; thus it is that the lord of the earth and the preserver of mankind is to be recognised most deservedly as the creator of gravity.

(p.27) VII. That the parts of the remaining planets and of the *Sun* are also joined together by gravity of this type is shown by their rotations about their axes, necessarily producing a centrifugal tendency, which would scatter rapidly those parts unless they were held together by gravity: indeed, these rotations in the *Sun* and very many of the planets are known through observations; moreover, in *Jupiter* especially they are known not only from the occasional gyration of the spots but also from the spheroidal shape arising from the same rotation, which is sufficiently discernable on account of the size of the body and the rapidity of the motion. Moreover, it will be clear from what is to be said later that this mutual gravity of the parts of individual planets towards each other agrees in all respects with our terrestrial gravity.

VIII. But the effectiveness of this principle is not contained within these boundaries; for a careful comparison of those effects will show quite clearly that that force by which planets are held in their orbits is certainly of the same type as that by which terrestrial bodies are pushed down towards the centre of the earth. It was demonstrated long ago that a body which is moved about another in such a way that, when radii have been drawn to the centre of the latter, it describes areas which are proportional to the times, is held in its orbit by a force which is constantly directed towards the centre of that other one. Therefore, since it has been determined that this is in fact the case with all primary planets and comets relative to the *Sun* and secondaries relative to their primaries, it is thus established that the force by which planets are kept in their curvilinear orbits has this in common with the gravity of terrestrial bodies: they tend towards the centre of some large body. Their agreement in other respects can be shown no less clearly.

(p.28) IX. And first of all, it is proved as follows that the centripetal force of the *Moon* (by which it is pushed towards the centre of the *Earth*, as is clear from what has just been said) is the same as our terrestrial gravity. Gravity (according to very carefully set-up experiments with pendulums)

drives terrestrial bodies down by $15\frac{1}{12}$ *Parisian* feet in one second, and thus (since the distances traversed by heavy bodies are as the squares of the times) by $60 \times 60 \times 15\frac{1}{12}$ feet in the first minute: in this same time the *Moon* is taken away from the tangent, to be diverted towards the *Earth* through a length of $15\frac{1}{12}$ feet: for a comparison of the periodic time and the size of the orbit shows clearly that the versed sine of the arc described in that time is of this size: therefore the accelerating force of the *Moon* towards the centre of the *Earth* is to the accelerating force of terrestrial bodies towards the same as $15\frac{1}{12}$ to $60 \times 60 \times 15\frac{1}{12}$, or as 1 to 60×60. And since the mean distance of the *Moon* from the centre of the *Earth* is sixty times the distance of terrestrial bodies turning about its surface from the same, it is clear that terrestrial bodies, as well as the *Moon*, are pushed towards the centre of the *Earth* by forces which are reciprocally proportional to the squares of the distances from the same. Further, since this is the nature of the centripetal forces of the *Moon* in the various parts of its orbit, being an ellipse described about the *Earth*, which is located at a focus, it is clear that terrestrial bodies as well as the *Moon* are pushed towards the centre of the *Earth* by the same force, varied according to the aforementioned law at the different distances.

(p.28) X. Moreover, since this same law, namely, that centripetal forces are [reciprocally] as the squares of the distances, holds for all bodies describing some conic section about another point located at a focus, and since the orbits of all planets and comets are known to be of that type (if perhaps you exclude the *Jovian satellites*, whose perfectly circular orbits, if viewed separately, can be reconciled by means of some law of centripetal force), it is clear that the centripetal forces of them all are of the same type as is that force by which the *Moon* and terrestrial bodies are pushed towards the centre of the *Earth*.

XI. This same law of centripetal forces holds no less for different planets revolving about the same central body, as for the same planet at different distances from the body towards which it tends: in fact it has been demonstrated that, where several bodies revolve about the same central body in such a way that the squares of the periodic times are in the ratio of the cubes of the mean distances, they are all attracted to that central body by forces which are reciprocally proportional to the squares of the distances from the same body. Moreover, it has been ascertained from very accurate observations that all planets which revolve about the same central body, obey that very ratio of distances and times.

XII. Therefore, since the accelerating force of terrestrial bodies towards the *Earth* and of planets as well as comets towards their own central bodies decreases in the square of the ratio of the increased distances, this force will be equal in different bodies tending towards the same centre, at the same distance from it; and so their inertial forces, or weights, will be proportional to the quantities of matter in them. Moreover, since the reaction is always

equal to the action, the tendency of that central body towards those other bodies will be equal to their weight, and so proportional to the amount of matter in them. It is therefore clear that universally the weights of bodies are in the ratio compounded of the direct ratios of the quantities of matter of the gravitating bodies and of the bodies into which they gravitate, and of the reciprocal ratio of the squares of the distances. And so, since the centripetal forces of planets and comets and the gravity of terrestrial bodies are clearly of the same type, there is no reason why we should not think that the former just as the latter are to be ascribed to the efficacious and uniformly acting will of the wisest and most powerful creator as the single cause.

(p.28) XIII. Meanwhile the *Cartesians* undertook to solve mechanically this phenomenon, as almost all others: the refutation of their hypotheses must destroy all hope of a mechanical explanation. According to them, by rotating about its axis, the *Sun* carries around a certain subtle fluid and the primary planets, which are swimming in it; these also have individually their own vortices, in several of which the secondaries are carried away. But first, since planets do not describe circles, they cannot be carried around in vortices which are infinitely extended or confined by a spherical vessel; but if the bounds of a vortex are arranged otherwise, the planets will deviate more from a circular path the further they are from the centre; and the aphelia of them all will be found in the same celestial region: for otherwise the eccentricity of the lower planets would be much greater than that of the higher planets; the aphelia of *Mars* and *Venus* would be almost opposite; for their distance at the beginning of *Virgo* is almost one and a half times the distance of the same at the beginning of *Pisces*. This observation provides another argument against the vortex hypothesis. For, since the motion of a fluid carried around through unequally sized canals must be more rapid in narrower places, it is clear, according to the *Cartesian* hypothesis, that a fluid in which the *Earth* is swimming (and therefore the earth itself), intermediate to those two orbits, must be carried more rapidly at the beginning of *Pisces* than at the beginning of *Virgo*: this is clearly incompatible with observations. Furthermore, if the vortices are homogeneous, the periodic times will be as the squares of the distances; but if they are heterogeneous and the parts further away from the centre are more dense, as *Descartes* maintained, and the theory requires, the periodic times will be as some higher powers of the distances; however, the periodic times of the planets are only in the ratio of the mean distances, raised to the power one and a half. But the *Cartesian* vortices are most effectively rebutted by the inclination of the planetary orbits to the axis of the *Sun* and to one another, and by the motion of the comets, at one time directly opposed to the movement of the planets, at another time perpendicular to their orbits.

(p.29) XIV. Therefore, since the *celestial material* (if there is any) is not carried around with the planets, and besides it will not have impeded their motion to any noticeable extent over so many thousands of years, and since it opens

up such an easy way for comets swimming very rapidly through it, it is clear that the regions of the heavens are as free as possible and consequently no material, which is sufficient to deflect regularly the continuous motion of so many bodies, is to be found in them. Therefore the motion of planets and comets in curvilinear orbits arises from no impulse of any imperceptible small bodies, and so from no mechanical cause. And hence it adds much to the magnificent idea, established by the *6th Proposition*, of the creator of gravity, who, it is now agreed, is master not only of the whole earth, but also of heaven, and the protector of all its inhabitants; who preserves the structure of all heavenly bodies; by whose powerful right hand the planets, driven in perpetual orbits about a common central body, are saved from being perpetually frozen and enveloped by the densest darkness and losing all other things which are concerned with the preservation of vegetation or animals as a result of having been carried away by a centrifugal impulse through the empty vastness and deprived of every benefit which they now receive from the *Sun*. But, just as this centrifugal impulse, if it were not restrained by gravity, would cause to all planets certain damage, by carrying them away from the *Sun*, so no less would gravity bring upon them certain destruction, by casting them into the burning atmosphere of the *Sun*, if projectile motion had not been impressed upon them: indeed, when these two forces have been combined, it is necessary that they are carried about the *Sun* in some curved line; this line will be circular if the direction of the projectile motion is perpendicular to the radius drawn to the *Sun*, and its force will be equal to the force of gravity: but if either of these conditions is lacking, that curve will be some conic section. The things that are said here concerning the primaries with respect to the *Sun*, are to be understood for the secondaries likewise with respect to their primaries.

(p.29) XV. Now it has been shown that the primary planets gravitate towards the *Sun* and the secondaries towards their primaries: moreover, since any body which describes about another, however it is moved, areas which are proportional to the times, is driven by all the accelerating force by which that other is driven in addition to the force tending towards that other, it is thus clear that the secondary planets, no less than the primaries, are heavy towards the *Sun*. But it is clear from certain perturbations of their motions, which can be derived from no other cause, that mutual gravitation affects not only the primary planets in connection with the *Sun*, and the secondaries in connection with the *Sun* and their primaries, but also planets of the same order, *e.g.*, the primaries among themselves; such effects are the migrations of the *apsides* and the *nodes*, etc., which are quite perceptible whenever they reveal themselves, especially those in *Jupiter* and *Saturn* round about the heliocentric conjunctions of these planets, on account of their vast size and distance from the *Sun*, and the simultaneous slowness of their motion. Moreover, since the motions of their *satellites* are also found to be perturbed

perceptibly in those conjunctions, it is clear that there is also an interaction of gravitation between the primary planets and the secondaries of others.

(p.29) XVI. Indeed nothing demonstrates more clearly the effectiveness of that universal law, according to which all bodies gravitate mutually towards each other, than those variations which have so racked the minds of astronomers of all time, namely, the irregularities of the lunar motion. For, if the law of gravitation is assumed, the accelerating force towards the *Sun* of the *Moon*, whose distance from the *Earth* is of significant magnitude (even when it is compared with the distance of the *Earth* from the *Sun*), must sometimes be greater and sometimes less than the accelerating force of the *Earth* towards the *Sun*: this inequality will be greatest when the *Moon* is in the syzygies; in the quadratures it will be least, or there will be none at all; as a result of this it turns out that its motion from the quadratures to the syzygies (other things being equal) is accelerated, while that from the syzygies to the quadratures is retarded; and so the curvature of its orbit and the distance from the primary (other things being equal) will be greater in the latter, than in the former: hence the *Moon* also does not always describe areas about the *Earth* which are exactly proportional to the times: these things all agree very well with observations. In a word, whatever irregularities in the motion of the *Moon* are detected by observations (indeed very many are detected), they are explained *a priori* as a necessary consequence of the assumption of what we have called the universal law of gravitation, which is therefore to be considered as corroborated to a very great extent by them. Also from the same law, and with equal clarity, is deduced the known *precession of the equinoxes* and the *oscillation of the axis of the Earth*, which takes place twice a year.

(p.30) XVII. Moreover, according to this law, the parts of any terrestrial fluid gravitate towards the *Moon* or the *Sun*, perceptibly more when turned directly towards the *Moon* or the *Sun*, but less when turned away, than the centre of the *Earth*, or its whole mass taken together; in this way such an amount is consequently taken away from their gravity towards the *Earth*: however something is added to the gravity towards the *Earth* of the parts which are lateral or intermediate between the averted and obverse parts, when the attraction of the *Sun* or of the *Moon* acts together with it a little: hence it follows necessarily that, while the averted and obverse parts are lighter, the lateral parts on the other hand are heavier, the former having been pressed upwards by the latter, until they counterbalance through the height of the columns, because there is a deficit in their accelerating gravity: moreover, the forces of the *Sun* and of the *Moon* bring about the rise of the terrestrial fluids (namely, the atmosphere and the sea), which is not a twofold effect but a unique one to be determined from their combination; because of the different distances of those luminaries from the *Earth* and their declinations from the equator, this must vary, namely, in the cube of the inverse ratio of those distances. And from this fact, and no other, all phenomena of

the tide of the sea can be very easily deduced; these things therefore bring the greatest confirmation to the principle of gravitation, which has now been validated.

XVIII. In addition to that gravity, which we have been discussing so far, by which all particles of matter tend mutually towards each other, without any distinction of shapes, forms, circumstances or motions, the forces decreasing in the square of the ratio of the distances, there is also a certain other force, by which very small particles of matter which touch each other, or are very close to contact, tend mutually towards each other more powerfully than according to the law of gravitation just explained: this force is reduced in more than the square of the ratio of the increased distance: and since this force acts only where there is contact or almost contact, the cohesion of any two particles of matter will be stronger according as their contact is greater; and so particles which have larger surfaces which are flat, or at least mutually congruent, adhere very firmly to each other; but those which are spherical, or else have convex surfaces, adhere more weakly (if at all); particles of the former type make up a moderately hard body, while those of the latter type form a fluid; and from the various intermediate types of contact arise various cohesions: thus, in a word, otherwise unsolvable phenomena, both of *solidity* and *fluidity*, can easily be explained. But since this force reveals itself not a little at very small distances, although the parts of the body may be separated somewhat by some external force, as long as they coalesce no more closely with new particles, then, when that external force has been taken away, they will revert to their former contacts and cohesions; in this way the body will recover its former shape, which otherwise it will necessarily lose completely. And the nature of *elasticity* and *flexibility* is very well explained in this way. And from these things it can be understood how a great difference of attractions arises in different particles as a result of their different shape and texture; for on this account some things tend mutually towards each other with scarcely any force, while others do so with very great force: most notable among the latter are the acid salts which generally predominate in solvents; for, having been attracted by the particles of the body to be dissolved, they fall down into its pores, as long as they are of suitable size, with such a large force that they separate the particles unless they stick together very strongly. The solutions of all bodies are easily explained in this way.

XIX. Also from this mutual attraction of very small particles of matter, an exceedingly large number of phenomena of fluids, which would otherwise be unsolvable, can be easily explained. For, from the fact that particles of water attract particles of wood or glass more powerfully than each other, arises that known phenomenon that water confined in a wooden or glass vessel is higher near the sides of the vessel than in other places; and so in very small tubes immersed a little in it the water is higher inside the tube than outside; but since particles of mercury attract each other more powerfully than particles of wood or glass, the effect is quite the reverse. Hence it may

also be that, since they must fall under the force of gravity, tiny drops of water and of other fluids are propped up by glass, wood and very many other bodies. And just as a spherical figure of the planets necessarily arises from the equal gravity of the parts in the planets mutually towards each other, so from the equal centripetal force of the particles of water, mercury and similar fluids, mutually approaching right up to each other, arises the spherical shape of tiny droplets in those fluids. From what has just been said the reason for the congruity of water with wood, glass and other bodies and the incongruity of mercury with the same bodies can be understood; and with equal ease all remaining phenomena of the congruity and incongruity of fluids are resolved. Finally, it is clear from this why grains of sand and several other tiny bodies which are specifically heavier than water nevertheless do not sink in it: namely, the mutual attraction of particles of water, although it may be very small, nevertheless produces some resistance, to the overcoming of which the gravity of those small bodies is not equal. Most of these phenomena were explained by very many people through the action of the atmosphere; their error is shown by the fact that these phenomena are also found to occur in a vacuum.

(p.30) XX. The same mutual attraction of the particles of matter having been supposed, the phenomena of crystallisation, precipitation, the congealing of fluids, electricity, and very many others can be explained very easily; it is not possible to dwell on these matters. But the explanation of the refraction of rays of light, which comes out from this, is a matter more worthy than something which deserves to be passed by completely untouched. Tiny particles or rays of light are bent in their passage near the corners of bodies (as is confirmed by the observations of the distinguished *Newton*), the effect being greater the nearer they approach to the bodies: it is quite clear that such a regular bending results from no impulse of particles flowing out from the bodies, but from some completely unmechanical force, which is impressed upon them by the Author of nature, according to a certain law, in proportion to the various distances from the bodies, towards which they are directed, or from which they are receding: a force of this type having been assumed, the author who has just been extolled has shown that it necessarily follows that the sine of refraction is always in a given ratio to the sine of incidence, whatever the obliquity of the incidence; this he shows to be the case by experiment. It is therefore necessary that the rays which fall obliquely from a rarer medium into another, which is more dense or in some way more attracting, having been attracted by this denser medium, are bent before they come in contact with it, so that the line of direction of the ray after it has entered the body makes a smaller angle with the perpendicular than before the bending: and hence comes about refraction towards the perpendicular. But if the ray of light falls obliquely from a denser medium into a rarer one, or one that is at least less attracting, then, on account of the greater attraction of the former, it will be curved towards it on or immediately after exit, so that the

direction of the ray now makes a greater angle with the perpendicular than before: and hence comes about refraction away from the perpendicular. But, if in this case the angle of incidence is exceedingly large, refraction will be changed into reflection, so that the angle of incidence is equal to the angle of reflection: it is clear that meanwhile the motion of a particle of light is accelerated in the former case but retarded in the latter; and hence it is that the velocity of light is generally much greater in a denser medium than in a rarer one. Moreover, when the ray is directed only towards the parts lying perpendicularly below it, clearly the ray stays in the same plane perpendicular to the refracting surface throughout the whole period of bending. Again, from the different forms of the rays of light, or perhaps from different velocities, there arise different attractions among the rays of light and some bodies and so different degrees of refractability. Also by some similar principle may be explained those amazing alternations of easier reflection and transmission, which the same most distinguished author has shown by very many experiments to occur in rays of light.

COROLLARIES.

I. The simple and unordered nature of the mind does not allow it to exist in any part of space in such a way that it is coextensive with it; nor indeed does it prevent it from being present in one place, namely, where the body is, in such a way that it is not present similarly in another place.

II. Although the real or absolute essences of substances are unknown to us, it in no way follows from this that we can pronounce nothing certain concerning their dispositions and mutual relationships.

III. Moral philosophy rests as it were on the necessary foundation of the existence and providence of the greatest divine power, especially in so far as this reveals itself in the dispensing of rewards and penalties.

IV. For the sake of preserving life or averting some serious injury, any laws can be set aside, namely by actions indicating agreement, even if extorted by the very unjust ferocity of the one in whose favour they are put forth, until they are set aside; thus it can happen that as a result of such action one man does not have the right to seek anything or to keep something in his possession, while another, who has willingly committed himself to bringing some law to the matter and thus to taking an obligation upon himself, is bound entirely by trust.

THE END.