The Laws that Govern the World

Address to the Plenary Session of the Academy

The Supreme Pontiff declares that scientists, in exploring the laws which govern the world, 'encounter God' and find regularity and order in the creation. He dwells at length upon the nature of natural laws and man's ability to understand them. Man, a spiritual being, also studies himself, and the sum of sciences may be seen as a 'hymn to God'. God is the author of both the laws of matter and of the spirit; divine love is at their centre. Lastly, in referring to the Second World War, the Supreme Pontiff declares that men must be moved by this love to achieve peace on earth.

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In this solemn assembly, honoured by the presence of Lord Cardinals, distinguished diplomats, persons of high rank, and men noted for their devotion to knowledge, our eye, once again, turns to you, most excellent members of the Academy, wise and untiring investigators of the universe. No doubt you never cease to admire the universe, if it is true what Plato puts in the mouth of Socrates and taught to his disciple Aristotle, that the feeling of wonder is most appropriate for the lover of wisdom, since without it, philosophy has no other beginning, whatever way it may be understood (in Θεαίτητος n. XI). You admire this universe from the outermost limits of the starry sky to the tiniest structure of the atom; and in the grandiose magnificence of the created world, you see the temple of order and of divine power. You know, you admire the immeasurable greatness of this universal machine. At the very least, the immensity of its boundaries, the multitude of its bodies and elements, the velocity of its movements, and the variety and beauty of its parts are to be appreciated. While – as we already observed in our last address to this Academy – the most wonderful thing to be considered is the disposition of order, which distinguishes and unites all, interweaves and links together, and harmonises the very same discordant irrational natures with

so much fidelity and mutual bond. Although each is operating according to the different instinct of its own inclination, they all conspire to an end without wishing it, from a beginning without knowing it.1 You contemplate, measure, study such a universal order: it is not, nor can it be, the fruit of absolute blind necessity, and neither can it be even of chance or luck: chance is a part of fantasy, and luck, the dream of human ignorance. In order, you seek a reason which intrinsically governs it, an arrangement of reason in a world which, even without life, moves itself as if it lived, and works by design as if it intended. In a word, you seek the law, which is precisely an arrangement of reason of One Who governs the universe and has fixed it in nature and the movements of its unconscious instinct.

Importance of the question

In this research of the laws which govern the world, you encounter God, and you investigate the traces left by Him, when He had accomplished the creation; and we admire your conquests in the immense fields of nature. The experimental investigations of the last ten years, which are certainly renewed with the studies and works of the end of the last century, boast discoveries of capital importance. One only has to think of the artificial transformations of the atomic nucleus, the splitting of the atom, and the wonders of the microcosm, revealed by the electron microscope. Scientific progress has led to the knowledge of new laws in the phenomena of nature, and clarified the question of the essence and value of physical laws with a new light. Today, there is not perhaps a problem, which may interest and occupy so much, the most eminent researchers of the modern world – physicists, chemists, astronomers, biologists and physiologists – and even the modern lovers of natural philosophy, as much as the subject of the laws which govern the order and action of matter, and of phenomena operating in our globe and in the universe. Indeed, fundamental questions are dealt with, whose solution is no less decisive for the object and aim of every natural science, as important also for the metaphysical comprehension, rooted in objective reality.

Changes in the concept of the physical law – dynamic and statistical laws

A true and rigid dynamic law represents a strict regulative norm of the existence and action of things, so as to exclude every exception of the natural order. Discovery by induction, from the examination and observation of many similar particular cases, allows one to forecast and more often still to calculate prematurely, in a deductive way, other particular cases in the ambit of their application. Examples of this include the law of gravity, the laws of reflection and refraction of light, the constancy law of weight relation in chemical combinations, and many others. But the concept of physical law has not remained the same; and it helps to follow the changes in its formation and valuation, which have occurred in the course of the last hundred years. At the start of the last century, the law of the conservation of mass was already known; knowledge of the relevant optical, electrical, and above all physical-chemical laws followed. These discoveries were finally crowned by that of the general laws of energy. It is not to be wondered therefore, if, in materialistic monism, the law of mechanics be exalted as goddess on the altar of science, and at its absolute dominion come to yield not only the world of matter, but also the kingdom of life and spirit, subject

and liege to the birth of materialistic monism. The universe therefore, was not different from the unmeasured empire of movement; and according to one such conception, as du Bois-Reymond exposes synthetically in his discourse *Über die Grenzen des Naturerkennens* (Leipzig, 1907), a universal mechanical formula had to exist, knowing which, a universal genius or 'Laplacian' mind, would be able to understand fully everything that happens in the present. Nothing then would be uncertain for him, with both the buried past and the furthest future presenting themselves clearly at his glance. This concept was also expressed by the great French mathematician Henri Poincaré, when he wrote: *Tout phénomène, si minime qu'il soit, a une cause, et un esprit infini-ment puissant, infiniment bien informé des lois de la nature, aurait pu le prévoir dès le commencement des siècles*.2 The postulate on 'closed physical causality' consequently would not allow any exception, nor any intervention in the course of physical activities, for example, the case of a miracle. But this postulate equals the old saying in which, given the cause, even a sufficient one, the effect comes about necessarily. The great Doctor, Saint Thomas Aquinas, with Aristotle, demonstrated this saying as false, because not every cause is such, even when it is sufficient, that its effect is not possible to prevent itself, at least for free human action. In other words: every effect necessarily has a cause, but not always a cause operating necessarily, there being also causes which act freely.3

And yet a man of Virchow's ability uttered these serious words at the 47th annual assembly of German scientists and doctors: 'A presumption of natural science is uncertain, unless we affirm that natural laws are absolutely effective in all circumstances, and are not liable to suspension at any time'. But Virchow had not seen all the circumstances of past events nor those to come; and his words were truly a presumption, as the scientific unfolding of the last ten years allows us easily to recognise. The crass materialism of the past has shown itself untenable, or has been transformed into that dark angel of light,4 which is cloaked with spirit or with pantheism. The affirmation of natural laws, not tolerating any exception, has been shaken to such an extent by the progress of exact science, that nowadays one falls into the other extreme of speaking only of intermediate rules, of statistical norms and laws of probability. Such thought is legitimate insofar as many laws of the sensible world or macrocosm show a statistical character – since they do not express the mode of behaviour of every single being, but the average process of an immense number of similar beings – and so they lend themselves to be treated by means of probability calculations.

But the will to see only statistical laws in the world is an error of our times, as one alienated from the nature of human genius, who with his senses only, learns what he later will do in the light of reason5 – it is the assertion that it could do completely without the old, rigidly dynamic conception of the natural law, and that it may have become empty of sense. In fact, the recent positivism riding in tandem with conventionalism has gone so far that it even puts in doubt the value of the causal law.

What is science?

This positivistic thought is now rejected with good reason by sound philosophy. What indeed is science, if not the certain knowledge of things? And how is it possible to acquire this knowledge, if

the principles and the causes of things are not investigated, from which proceeds the demonstration of their existence, and of their nature and action? You observe, research, study and experiment with nature in order to understand its principles and intrinsic causes, so as to penetrate the governing laws of its constitution and action, to set in order the process of such laws, and to deduce from it a science with principles, causes and conclusions following through logical consequence. Consequently, you seek the regularity and order in the various kingdoms of creation; and which the investigating spirit of man has discovered in its great richness!

The system of natural laws

a) In the inorganic world

Behold indeed, even only because of hints, in the macrocosm of purely physical-chemical phenomena, the numerous particular laws of mechanics of solid, liquid, and gaseous bodies; the laws of acoustics and of heat, of electricity, of magnetism and of light; the laws of the progress of chemical reactions, and of chemical equilibria in organic and inorganic chemistry. These particular laws are often elevated to higher and more general norms, so groups of natural phenomena, which at first glance seemed devoid of every internal relation, may be understood and recognised in greater number, as consequences of a superior law. Behold the laws of planetary motion to be connected to the universal law of gravitation. Have not the famous equations of Maxwell built a bridge between optical and electrical phenomena, and are not all natural phenomena in the inorganic world subordinate to the law of constancy and entropy? If until recently two constant laws were known – that of the conservation of mass and that of the conservation of energy – the most recent research has proved with ever more convincing facts and arguments that every mass is equivalent to a determined quantity of energy and vice versa. Therefore, the two ancient laws of conservation are, in effect, special applications of a more general higher law, which says: In a closed system, despite all changes, even where there is a considerable transformation of mass into energy or vice versa, the sum of both remains constant. This higher law of constancy is one of the keys the atomic physicist uses today to penetrate the mysteries of the atomic nucleus.

Such a scientific system of the macrocosm, rich in internal connections and well organised, contains beyond all doubt many statistical laws, which however, because of the multitude of elements – atoms, molecules, electrons, photons, etc. – are not, as regards certainty and accuracy, inferior to strictly dynamic laws. In any case, they are founded and anchored, as it were, in rigidly dynamic laws of the microcosm, although knowledge of the microcosmic laws is in its details still almost completely hidden from us, despite the formidable efforts made by recent research to penetrate the mysterious activity within the atom. Gradually these veils may fall; then the apparently noncausal character of microcosmic phenomena will disappear: a wonderful new kingdom of order, even in the smallest particles, will be discovered.

And these intimate processes of the investigation of the atom will appear as really surprising to us, not only because they open up before our eyes a world hitherto unknown, whose richness, multiplicity, and regularity seem somehow to vie with the sublime grandeur of the firmament, but also for the unpredictably grandiose effects that technology itself can expect from them. In this

connection we cannot abstain from mentioning an astonishing phenomenon about which the Nestor of theoretical physics, Max Planck, our Academician, has written in a recent article of his, *Sinn und Grenzen der exakten Wissenschaft*.6 The curious transformations of the atom have for many years occupied only research workers in pure science. The amount of energy sometimes developed in it was undoubtedly surprising; but since atoms are extremely small, it was never seriously thought that they might become important even from a practical point of view. Today, on the other hand, this question has taken on an unexpected aspect as a consequence of the results of artificial radioactivity. It has in fact been established that in the splitting a uranium atom undergoes if it is bombarded by a neutron, two or three neutrons are freed, each of which may meet and smash another uranium atom. In this way the effects are multiplied, and it may happen that the growing number of collisions of neutrons with uranium atoms increases in a short time the number of freed neutrons and, proportionally, the sum of energy developed from them, to an extent so great that it is almost inconceivable. A special calculation shows that, by this reaction, a cubic metre of uranium oxide powder, in less than a hundredth of a second, develops enough energy to lift a weight of a billion tons to a height of 27 kilometres: an amount of energy which could supplant for many years the activity of all the great electric power stations in the world. Planck ends with the observation that, although the technical utilisation of such a tempestuous process cannot yet be envisaged, it nevertheless opens the way to serious possibilities, so that the thought of the construction of a uranium machine cannot be regarded as merely utopian. It is important above all, however, to prevent this reaction from taking place as an explosion, and to brake its course by apt precautionary chemical means. Otherwise, a dangerous catastrophe might occur, not only in the locality itself but also for our whole planet.

b) In the spheres of vegetative and sensitive life

If now from the boundless realm of the inorganic we elevate ourselves to the spheres of vegetative and sensitive life, we find there a new world of laws in the property, the multitude, the variety, the beauty, the order, the quality, and the utility of the various forces of nature that are part of our globe. Beside many laws of the inorganic world, we meet also special higher laws, laws peculiar to life, which cannot be reduced to the purely physicochemical ones, so that it is impossible to consider living beings as mere sums of physicochemical components. Nature opens up to us here a marvellous new horizon; let it be enough for us to mention as examples: the laws of the development of organisms, the laws of external and internal sensations, and, above all, the fundamental psychophysical law. Higher spiritual life, too, is regulated by natural laws, for the most part of such a quality that to define them precisely becomes more difficult the higher they stand in the order of being.

Objective reality of knowledge

This admirable and ordered system of qualitative and quantitative, particular and general laws of the macrocosm and the microcosm, is today largely unveiled in its intricacy to the scientist’s eyes. And why do we say unveiled? Because it is not projected or constructed by us into nature, thanks to some innate subjective form of consciousness or of the human intellect, nor is it created

purposely on behalf and for the use of such an economy of thought and study, that is, to facilitate our knowledge of things; nor is it finally, the fruit or the conclusion of agreements or understandings among scientists studying nature. Natural laws exist, so to speak, incarnate and secretly operative within nature, and we, by observation and experiment, look for them and discover them.

It cannot be said that matter is not a reality, but an abstraction fashioned by physics; that nature is in itself unintelligible and that the world that can be apprehended by the senses is a world apart, where the phenomenon, which is appearance of the exterior world, gives us a vague notion only of the reality of the things it hides. No: nature is reality, recognisable reality. If things seem to be and are mute, they have, however, a language that speaks to us, that emerges from their bosom, like water from a perennial spring. This language is their causality which reaches our senses with the sight of colours and movement, with the sound of metals, the roar of whirlwinds, and the cries of animals, with the sweetness and the bitterness of honey and gall, with the scent of flowers, with the weight and temperature of their material substance, impressing upon us an image or likeness which is the vehicle for our intellect to lead us to the reality of things. Hence we speak not of the image or likeness of our intellect, but of the things themselves; and we can distinguish the phenomenon of the world of the senses from the substance of things, the appearance of gold from the gold itself, as the appearance of bread from bread itself, from whose substance we make food in order to assimilate it and identify it with the substance of the body itself. The movement of things toward us calls forth an image in us; without an image there can be no conformity of our intellect with real things, and without an image knowledge becomes impossible; and we cannot call anything true unless it has some equivalent in our intellect. The things from which our mind takes its knowledge provide measurements to our mind and to the laws we find in them and take from them; but they, in turn, are measured by that eternal divine intellect which embraces all things created, as the mind of the craftsman embraces every work of his art.[7] What do the hand and the brain of the scientist do? They discover them, reveal them, distinguish them, and classify them, not like one who follows flying birds, but like one who is in possession of them, and is investigating their nature and intrinsic properties.

When, in 1869, Lothar Meyer and Mendeleev arranged the chemical elements in that simple scheme which today is recognised as the natural system of the elements, they were deeply convinced that they had found a regular order, based on their properties and internal tendencies, a classification suggested by nature, the progressive development of which promised the most penetrating discoveries regarding the structure and essence of matter. In fact modern atomic research began from that point. At the time of the discovery the so-called mental economy did not come into consideration, since that primitive scheme still showed many gaps; nor could it be a matter of convention, since the qualities of the matter itself imposed such arrangement. This is only one example among many, and therefore the most inspired scientists of the past and present have come to the lofty conclusion that they are heralds of a truth identical and the same for all peoples and races that walk the earth and look up at the sky; a truth resting, in its essence, on an *adaequatio rei et intellectus*, which is nothing but the acquired conformity, more or less perfect, more or less complete, of our intellect with the objective reality of natural things, in which the truth

of our knowledge consists.

Confutation of phenomenalism

But do not be mistaken, like those philosophers and scientists who thought that our cognitive faculties know only their own mutations and sensations, so that they were induced to say that our intellect arrived at knowledge only from the images of things, and, therefore, that only the images of things, and not the things themselves, were the object of our science and of the laws we formulate with respect to nature. A manifest error! Are they not in all probability the same things, both those things which you interpret, and those things of which your science speaks, reasons, and discusses? Are we speaking to you yourselves, or to the images that are formed in our eye from seeing you present here? If consequently what you interpret and know were only the images of your sensations, it would follow that all your physical sciences, from the stars to the atom, from the sun to the electric lamp, from the minerals to the cedars of Lebanon, from microbes to man and to the medicines for his infectious diseases, would not deal with things that are outside of your mind, but only with those intelligible similarities which you contemplate inside your mind perhaps dreaming. Science, exalted by a Copernicus and a Galileo, a Kepler and a Newton, a Volta and a Marconi, and other famous and distinguished investigators of the physical world that surrounds us externally, would accordingly amount to a beautiful creation of day-dreaming and a beautiful phantasm of physical knowledge; appearance would take the place of the reality and truth of things; and it would be just as true to assert as to deny the same thing. But no; science knows not dreams or images of things, but the things themselves through the images we receive from them, because, as the Angelic Doctor, following Aristotle, has taught, a stone cannot be in our mind, but the image or figure of the stone can – the image which it produces, a true likeness, in our senses and then in our intellect, so that by this likeness it can be, and is, in our mind and in our study, and makes us return to it and to reality.8 Even the recent research in experimental psychology testifies, or rather confirms, that these likenesses are not the mere product of autonomous, subjective activity, but psychic reactions to stimuli independent of the subject, coming from the things themselves; reactions in conformity with the different qualities and properties of things, which vary with the variation of the stimulus.

The images, therefore, which natural things, by way of light and heat, or by way of sound, taste, and smell, or by any other means, impress on the organs of our senses and which, through the inner senses, arrive at our intellect, are nothing but the instrument provided us by nature, our first teacher of knowledge, to make herself known to us; but it is no less true that we can examine, study, investigate this instrument and think about these images and how much they present to us of nature, and the way in which they become our sources of knowledge of the world which surrounds us. From the act of cognition by which our intellect understands a stone, we pass on to the act of understanding how our intellect understands a stone: an act which follows the first, since man, born without innate ideas, and without recollections of a previous life, enters the world devoid of images and knowledge – born and created, as We have already recalled, ‘with his senses only, to learn what he later will do in the light of reason’.

Conclusion

Admire, O probers of nature and of the laws that govern it, in the centre of the material universe the greatness of man, to whose first encounter with light, greeted by his infant wailing, God holds open the spectacle of the earth and the firmament with all the marvels to enchant him and attract his innocent eyes! What is this spectacle if not the fundamental and first object of all human knowledge, which embarks from there with thousands upon thousands of inquiries with which the teacher nature entices again and again the avidity of our senses? You wonder at yourselves; you scrutinise your inner acts, you withdraw within yourselves to seek their sources, and you find them in these internal senses, in these powers and faculties, which you make the object of a new science of yourselves, of your intimate rational nature, of your feeling, your intellect, and your will. And so we have the science of man and of his corporeal and psychic laws, anatomy, physiology, medicine, psychology, ethics, politics, and that sum total of sciences which, even with all its errors, is a hymn to God, Who, when He moulded man, breathed into him a vital spirit, superior to that of other living beings, making him into His image and likeness. Thus the material extrinsic macrocosm has a great deal to say to the spiritual intrinsic microcosm: one and the other in their operating power are supremely regulated by the Author of the laws of matter and spirit. But the changes of the spirit, which listens to the voice and the marvels of the universe, are sometimes terrible, sometimes give it vertigo, sometimes raise it powerfully and make it take strides, also in the progress of science, which are more gigantic than the regular movements of the planets and the constellations in the heavens, to the point of sublimating it from the material physical world of its study to the spiritual world beyond the created one to praise ‘The Love that moves the sun and all the other stars’.9

This Love, which has created, moves, and governs the universe, also rules and directs the history and progress of all humanity, and guides everything toward an end, hidden from our thought by the mists of time, but fixed forever by Him for that glory which the heavens show forth and which He awaits from the love of man, whom He has permitted to fill the earth and subdue it with his labour. May this love arouse and direct the desire and the good will of the powerful and of all men to become brethren, to act in peace and justice, to be inflamed by the fire of the immense, beneficial charity of God, and cease drenching in blood and filling with devastation and tears this earth, on which all of us, under whatever sky, have been placed to struggle as the children of God, for an eternal life of happiness.

1 Cf. Bartoli, *Delle Grandezze di Cristo*, Ch. 2.

2 *Science et méthode*, p. 65.

3 Cf. *In libros Peri Hermeneias,* Bk. I, Ch. IX, Lect. XIV, n. 11.

4 Cf. *Ep* 6:12; 2 *Co* 11:14.

5 *Paradiso*, Canto IV, 41-42.

6 In *Europäische Revue* (February 1942).

7 Cf. St. Thomas Aquinas, *De Veritate*, q. 1, a. 2.

8 Cf. *S. Th.*, I, 76, 2 ad 4.

9 *Paradiso*, Canto XXXIII, 145.