



The Proofs for the Existence of God in the Light of Modern Natural Science'

Address to the Plenary Session and to the Study Week on the Subject 'The Question of Microseisms'



In a long and often technical address, Pius XII dwells at length upon the structure of matter and the cosmos and the origins of the universe. He affirms that 'contrary to rash statements in the past, the more true science advances, the more it discovers God', and re-examines classical proofs of the existence of God on the basis of new scientific discoveries. A recognition of God as the Creator, 'a conviction shared by many modern scientists', should lead man to unite science with faith to achieve the progress of civilisation.

THE PROOFS FOR THE EXISTENCE OF GOD IN THE LIGHT OF MODERN NATURAL SCIENCE

We are grateful to the Almighty for a serene hour of happiness which offers us this gathering of the Pontifical Academy of Sciences, and gives us the welcome opportunity of meeting with a select group of Eminent Cardinals, of illustrious diplomats and of noteworthy personalities, and especially with you, Pontifical Academicians, who are truly worthy of the solemnity of this session; because in investigating and unveiling the secrets of nature and teaching men to direct their energies for their good, at the same time you preach, in the language of numbers, formulae and discoveries, the ineffable harmonies of the all-wise God.

Contrary to rash statements in the past, the more true science advances, the more it discovers God, almost as though He were standing, vigilant and waiting, behind every door which science opens. Furthermore, we wish to say that not only does the philosophical thinker benefit from this

progressive discovery of God, achieved in the increase of knowledge – and how could he do otherwise? – but those also profit who participate in the new discoveries or who make them the object of their considerations. The genuine philosophers especially benefit from it, since, by using the scientific advances as a springboard for their rational speculations, they can achieve greater security in their conclusions, clearer illustrations in possible obscurity, more convincing support in finding ever more satisfactory answers to difficulties and objections.

Nature and basis of proofs for the existence of God

Thus directed and guided, the human intellect moves to meet that demonstration of the existence of God, which Christian wisdom recognises in the philosophical arguments weighed through the centuries by giants of learning, and which is well known in the presentation of the ‘five ways’ which the Angelic Doctor St. Thomas offers as the sure and expeditious itinerary of the mind to God. Philosophical arguments, we have said; but not for that aprioristic, as an ungenerous and self-contradictory positivism has accused them of being. They are based upon concrete realities ascertained by the senses and sciences, even if they acquire conclusive strength only from the vigour of natural reason.

In this manner, philosophy and the sciences develop with analogous and compatible methods, taking advantage of empirical and reasonable elements in different measures and working together in harmonious unity toward the discovery of the truth.

But if the primitive experience of the ancients was able to offer sufficient arguments to reason to demonstrate the existence of God, now, with the amplification and deepening of the field of experience itself, the imprint of the Eternal upon the visible world is all the more splendid and radiantly visible. It seems profitable, therefore, to re-examine the classical proofs of St. Thomas on the basis of the new scientific discoveries especially those based upon the movement and order of the universe;¹ to consider, that is, if and to what extent the more profound knowledge of the structure of the macrocosm and the microcosm contributes to the reinforcement of philosophic arguments. On the other hand, it is not unprofitable to see if and to what point these arguments, as is not infrequently affirmed, have been shaken by the fact that modern physics has formulated new fundamental principles, abolished or modified ancient concepts, whose meaning was perhaps in the past adjudged fixed and definite, as, for example, time, space, movement, causality, substance, concepts of the greatest importance for the question that now holds our attention. Rather than a revision of the philosophic proof, it is a question of scrutinising the physical bases from which those arguments derive – and we must necessarily limit ourselves to only a few for reasons of space. But there is no fear of surprises: science itself remains firmly grounded in that world which today, as yesterday, presents itself in those five ‘modes of being’ from which the philosophic demonstration of the existence of God takes its motives and force.

Two essential hallmarks of the cosmos

Of these ‘modes of being’ of the world which surrounds us, perceived with more or less understanding, but with equal evidence, by the philosopher and the common intelligence, there are two which the modern sciences have sounded, verified, and probed wonderfully and beyond

all expectation:

1° The *mutability of things*, including their beginning and their end.

2° The *teleological order* which stands out in every corner of the cosmos.

The contribution made by the sciences to the two philosophical demonstrations is truly notable; and upon them hinge and are constituted the first and fifth ways. Physics especially has contributed to the first an inexhaustible mine of experience, revealing the fact of mutability in the profound recesses of nature, where before now no human mind could ever even suspect its existence and amplitude, and furnishing a multiplicity of empirical facts which gave highly valid support to the philosophical reasoning.

We say support, because the very direction of these transformations, while verified by modern physics, seems to us to surpass the value of a simple confirmation and almost attains the structure and the level of physical argument which is largely new, and more acceptable, persuasive and agreeable, to many minds.

With equal richness, the sciences, especially astronomy and biology, have recently supplied to the subject of order such a wealth of knowledge and such an intoxicating vision, as it were, of the conceptual unity which animates the cosmos, and of the finality which directs its march, as to give to modern man in advance that joy which Dante imagined in the empyrean Heaven when he saw how 'all that is dispersed through the universe is united by love in the mind of God'.²

Providence has disposed that the idea of God, so essential to the life of each man, while it can be easily grasped by a simple glance at the world so that not to comprehend the voice of nature is sheer foolishness,³ shall receive confirmation from every deepening of the understanding and progress in the field of scientific knowledge.

We wish, therefore, to give a few rapid examples of the precious service which modern sciences render to the demonstration of the existence of God. We limit ourself first to the fact of mutations, revealing principally the amplitude, the vastness, and, as it were, the totality which modern physics meets with in the inanimate cosmos. Then we shall pause for a look at the significance of their direction, which has been also ascertained. It will be as though one listened to a concerto within the immense universe, which sings 'the glory of Him Who moves all things'.⁴

A) The mutability of the cosmos

a) in the macrocosm

It is truly astonishing at first glance to see how the knowledge of the fact of mutability has steadily gained ground in both the macrocosm and the microcosm as the sciences have gradually progressed, almost confirming with new proofs the theory of Heraclitus: 'Everything flows': πάντα ῥεῖ.

Daily experience demonstrates the enormous quantity of transformations in the world, near and far, which surrounds us, especially the local movements of bodies. But in addition to these true and actual local motions, multiform chemicophysical changes are equally easy for us to see, such

as, for example, the mutation of the physical state of water in its three phases of vapour, liquid, and ice; the profound chemical effects brought about by the use of fire, the knowledge of which goes back to prehistoric ages; the disintegration of stone and the corruption of vegetable and animal bodies. To this common experience natural science was added, which teaches us to understand these and other similar events as processes of destruction or construction of corporeal substances in their chemical elements, that is to say, in their smallest parts, the chemical atoms. It further teaches us that this chemicophysical mutability is in no way restricted to terrestrial bodies, according to the belief of the ancients, but is extended to all bodies of our solar system and the great universe, which the telescope, and, even more, the spectroscope, have shown to be formed of the same kind of atoms.

b) in the microcosm

Against the indisputable mutability of nature, including inanimate beings, there arose the enigma of the unexplored microcosm. It seemed, indeed, that inorganic matter, as opposed to the animated world, was in a certain sense immutable. Its smallest parts, the chemical atoms, could certainly unite among themselves in the most various ways, but it seemed that they enjoyed the privilege of an eternal stability and indestructibility, issuing unchanged from every chemical synthesis and analysis. A hundred years ago, elementary particles were still believed to be simple, indivisible, and indestructible. The same was thought of the energies and material forces of the cosmos, especially on the basis of the fundamental laws of the conservation of mass and energy. Some naturalists considered themselves authorised to the extent of formulating in the name of their science a fantastic monistic philosophy, the inglorious memory of which is bound to the name of Ernst Haeckel, among others. But during his own times, toward the end of the last century, this oversimplified conception of the chemical atom was also upset by modern science. The growing knowledge of the periodical system of chemical elements, the discovery of the corpuscular irradiation of radioactive elements, and many other similar facts have demonstrated that the microcosm of the chemical atom with dimensions in the order of one ten-millionth of a millimetre is a theatre of continual mutation, no less than the macrocosm.

Mutability in the electronic sphere

The character of mutability was first verified in the electronic sphere. From the electronic structure of the atom, irradiations of light and heat emanate, which are absorbed by external bodies in a manner corresponding to the level of energy of the electronic orbits. In the exterior parts of this sphere the ionisation of the atom is carried out as well as the transformation of energy and the analysis of chemical combinations. It was supposed, however, that these chemicophysical transformations still left one refuge for stability, because they had not reached the nucleus itself of the atom, home of the mass and the positive electric charge, by which the place of the chemical atom in the natural system of the elements is determined; and it almost seemed that the type of the absolutely stable and invariable had been met.

Mutability in the nucleus

But already in the early days of the twentieth century, the observation of radioactive processes which are referable, in a last analysis, to the spontaneous dissolution of the nucleus, indicated that such a type did not exist. With the instability of the known aspects of nature verified as far as its most profound recesses, there was one fact which left investigators perplexed, because it seemed that the atom was impregnable at least to human forces, since in principle all the attempts to accelerate or arrest the natural radioactive dissolution, even the splitting of the nonactive nuclei, had failed. The first rather modest splitting of a nucleus (of nitrogen) goes back a bare three decades, and only for the past few years has it been possible, after great efforts, to bring about, in considerable quantities, processes of formation and decomposition of nuclei. Although this result, which, in so far as it serves the purposes of peace, will certainly be a matter of pride for our century, can be considered only a first step in the field of practical nuclear physics, nevertheless, it lends weight to our consideration: the atomic nuclei are certainly, for many orders of magnitude, less active and more stable than the ordinary chemical compositions, but notwithstanding that, they are also in general subject to similar laws of transformation, and therefore mutable.

At the same time, it has been discovered that such processes have the greatest importance in the economy of the energy of the fixed stars. At the centre of our sun, for example, according to Bethe, a temperature which averages around twenty million degrees centigrade is reached, a recurring chain reaction in itself in which four nuclei of hydrogen are joined to a nucleus of helium. The energy which is thus freed compensates for the loss due to the irradiation of the sun itself. In modern physics laboratories also, it is possible to bring about transformations of nuclei by means of a bombardment with particles furnished with great energy, and with neutrons. This has been accomplished with the uranium atom, for example. In this connection, the effects of cosmic radiation should be mentioned, which can split the heaviest atoms, not infrequently giving off entire swarms of subatomic particles.

We wished to cite only a few examples, enough to place beyond doubt the definite mutability of the inorganic world, large and small: the thousandfold transformations of the forms of energy, especially in the chemical decomposition and combinations in the macrocosm, and no less the mutability of the chemical atoms as far as the subatomic particles of their nuclei.

The eternally immutable

The scientist of today, penetrating with his investigations more deeply into nature than his predecessor of a hundred years ago, knows that inorganic matter in its very marrow, in a manner of speaking, is stamped with the mark of mutability and therefore its being and its existence demand an entirely different reality and one that is by its nature immutable.

Just as in a painting in chiaroscuro, the figures stand out from the dark background, obtaining in this manner alone the full effect of modelling and of life, so the image of the eternally immutable emerges clear and resplendent from the torrent that carries away with it all the material things in the macro- and microcosms and whirls them into an intrinsic mutability which never stops. The scientist who stands on the edge of this immense torrent finds relief in that cry of truth with which God defines Himself:⁵ 'I am He who is', and Whom the Apostle praises as *Pater luminum, apud quem non est transmutatio neque vicissitudinis obumbratio* – the Father of lights, with whom there

is no change nor shadow of alteration.⁶

B) The direction of the transformations

a) in the macrocosmos: the law of entropy

But modern science has not only enlarged and deepened our knowledge of the reality and magnitude of the mutability of the cosmos; it has also offered us valuable indications concerning the direction according to which the processes of nature are carried out. While a hundred years ago, especially after the discovery of the law of constants, it was thought that the natural processes were reversible, and therefore, according to the principles of strict causality – or, rather, determination – an ever-recurring renewal and rejuvenation of the cosmos was considered possible. With the law of entropy, discovered by Rudolf Clausius, it became known that the spontaneous natural processes are always related to a diminution of the free and utilisable energy, which in a closed material system must finally lead to a cessation of the processes on the macroscopic scale.

This fatal destiny, which only hypotheses, sometimes far too gratuitous ones such as that of the continuous renewal of creation, forcibly try to deny, but which instead comes from positive scientific experience, eloquently postulates the existence of a necessary Being.

b) in the microcosm

In the microcosm, this law, which is actually statistical, is not applicable, and furthermore, at the time of its formulation, hardly anything was known of the structure and behaviour of the atom. However, the most recent investigations of the atom and the quite unexpected development of astrophysics have made surprising discoveries possible in this field. Results can be mentioned here only briefly; they indicate that in the atomic and intra-atomic development a sense of direction is clearly noticeable.

In order to illustrate this fact it suffices to recall the already mentioned example of the behaviour of solar energy. The electronic structure of the chemical atoms in the photosphere of the sun gives off each second a gigantic quantity of radiant energy into the surrounding space, an energy that does not return. The loss is compensated for from the interior of the sun by means of the formation of helium from hydrogen. The energy which is thus liberated derives from the mass of hydrogen nuclei, of which in this process a small part (seven per cent) is converted into equivalent radiation. The process of compensation is carried out, therefore, at the expense of the energy which originally existed as mass in the nuclei of hydrogen. Thus this energy, in the course of billions of years, is slowly but irreparably transformed into radiation. A similar phenomenon occurs in all radioactive processes, whether natural or artificial. Here too, then, in the narrow confines of the microcosm itself, we meet with a law which indicates the direction of evolution and which is analogous to the law of entropy in the macrocosm. The direction of spontaneous evolution is determined by means of the diminution of the energy utilisable in the structure and the nucleus of the atom, and up to now processes have been noted which could compensate or cancel this diminution by means of spontaneous formation of nuclei of high energetic value.

C) The universe and its development

In the future

If, then, the scientist turns his gaze from the present state of the universe to the future, however far off, he will be forced to realise that the world is growing old, both in the macrocosm and in the microcosm. In the course of billions of years, even the quantity of atomic nuclei, which is apparently inexhaustible, loses its utilisable energy and matter approaches, to speak figuratively, the state of a spent and wasted volcano. And the thought presents itself inescapably: if the present cosmos, today so pulsating with rhythm and life, is not sufficient to account for its existence, as we have seen, how much less will it be the case for that cosmos once the shadow of death shall have passed over it.

In the past

We now turn our eyes toward the past. In proportion to the distance in time to which we turn backward, matter is seen to be richer and richer in free energy and the theatre of great cosmic upheavals. Thus, everything seems to indicate that the material universe has had, in finite time, a powerful start, provided as it was with an unimaginable abundance of reserves in energy; then, with increasing slowness, it has evolved to its present state.

Two questions spontaneously come to mind:

Is science in a position to say when this powerful beginning of the cosmos took place? And what was the initial, primitive state of the universe?

The most noted experts in atomic physics, in co-operation with the astronomers and the astrophysicists, have put great effort into shedding light on these two difficult but extremely interesting problems.

D) The beginning in time

First, to cite some figures, which serve only to express the order of magnitude in the designation of the dawn of our universe, that is, its beginning in time, science has at its disposal several paths of investigation, each fairly independent of the other, though they are convergent, as we indicate briefly:

1. The velocity of travel of the spiral nebulae or galaxies

The examination of numerous spiral nebulae, carried out especially by Edwin E. Hubble at Mount Wilson Observatory, has demonstrated the significant result – though tempered by reserve – that these far-off systems of galaxies tend to rush away from one another at such speed that the space between two such spiral nebulae doubles in the period of about 1300 million years. If one looks back across the period of this process of the 'Expanding Universe' the conclusion is that from one to ten billion years ago the matter of all the spiral nebulae was compressed into a relatively narrow space, at the time of the beginning of the cosmic processes.

2. The age of the solid crust of the earth

To calculate the age of the original radioactive substances, highly approximate data are deduced from the transmutation of these substances into the corresponding isotope of lead, for instance the transformation of the isotope of uranium 238 into RaG (an isotope of lead), of the uranium isotope 235 into actinium D, and of the isotope of thorium 232 into thorium D. The mass of helium which is formed thereby can also serve as a check. In this way the average age of the most ancient minerals is indicated at a maximum of five billion years.

3. The age of meteorites

The preceding method, when applied to meteorites to calculate their age, gives about the same figure of five billion years. This result takes on special importance because the meteorites are generally believed to be of interstellar origin and, except for terrestrial minerals, they are the only examples of celestial bodies which can be studied in scientific laboratories.

4. The stability of the systems of double stars and star masses

The oscillations of gravitation within these systems, like the wearing away of the tides, again restrict their stability within the limits of from five to ten billion years.

Although these figures are astonishing, nevertheless, even the simplest believer would not take them as unheard of and differing from those derived from the first words of Genesis, 'In the beginning ...', which signify the beginning of things in time. These words take on a concrete and almost mathematical expression, and new comfort is given to those who share with the Apostle an esteem for that Scripture, divinely inspired, which is always useful *ad docendum*, *ad arguendum*, *ad corripiendum*, *ad erudiendum* – to teach, to prove, to correct, to educate.⁷

E) The state and nature of original matter

With equal earnestness and freedom of investigation and verification, learned men, in addition to the question of the age of the cosmos, have applied their audacious talents to another question which we have already mentioned and which is certainly much more difficult, and that is the problem concerning the state and quality of primitive matter. According to the theories which are taken as a basis, the relative calculations differ considerably one from the other. Nevertheless, the scientists agree in holding that not only the mass but also the density, the pressure, and the temperature must have attained degrees of enormous intensity, as can be seen in the recent work of A. Unsöld, director of the Observatory in Kiel.⁸ Only under these conditions can one comprehend the formation of the heavy nuclei and their relative frequency in the periodical system of the elements.

On the other hand, the eager mind, in its search for truth, rightfully insists upon asking how matter came to be in a state so unlike that of our common experience of today, and what preceded it. One waits in vain for an answer from natural science, which honestly declares that this is an insoluble enigma. It is true that this is asking too much of natural science as such; but it is also true that the human spirit versed in philosophical speculation is able to penetrate the problem more profoundly.

It is undeniable that a mind illuminated and enriched by modern scientific knowledge, which calmly

evaluates this problem, is led to break the circle of a matter preconceived as completely independent and autonomous – either because uncreated or self-created – and to acknowledge a Creative Spirit. With the same clear and critical gaze with which he examines and judges facts, he also catches sight of and recognises the work of the omnipotent Creator, Whose power, aroused by the mighty ‘fiat’ pronounced billions of years ago by the Creative Spirit, unfolded itself in the universe and, with a gesture of generous love, called into existence matter, fraught with energy. Indeed, it seems that the science of today, by going back in one leap millions of centuries, has succeeded in being a witness to that primordial *Fiat Lux*, when, out of nothing, there burst forth with matter a sea of light and radiation, while the particles of chemical elements split and reunited in millions of galaxies.

It is true that the facts verified up to now are not arguments of absolute proof of creation in time as are those which are drawn from metaphysics and revelation, in so far as they concern creation in its widest sense, and from revelation alone in so far as they concern creation in time. The facts pertinent to natural sciences, to which we have referred, still wait for further investigation and confirmation, and theories founded upon them have need of new developments and proofs, in order to offer a secure basis to a line of reasoning which is, of itself, outside the sphere of the natural sciences.

Notwithstanding this, it is worth noting that modern exponents of the natural sciences consider the idea of the creation of the universe entirely reconcilable with their scientific conception, and indeed they are spontaneously brought to it by their researches, though only a few decades ago such a ‘hypothesis’ was rejected as absolutely irreconcilable with the present status of science. As late as 1911, the celebrated physicist Svante Arrhenius declared that ‘the opinion that something can proceed from nothing is in contrast with the present status of science, according to which matter is immutable’.⁹ Similar to this is Plate’s affirmation: ‘Matter exists. Nothing proceeds from nothing: in consequence matter is eternal. We cannot admit the creation of matter’.¹⁰

How different and reflecting great vision is the language of a modern top grade scientist, Sir Edmund Whittaker, a Pontifical Academician, when he speaks of his researches concerning the age of the world: ‘These different estimates converge to the conclusion that there was an epoch about 109 or 1010 years ago, on the further side of which the cosmos, if it existed at all, existed in some form totally unlike anything known to us: so that it represents the ultimate limit of science. We may perhaps without impropriety refer to it as the Creation. It supplies a concordant background to the view of the world which is suggested by the geological evidence, that every organism ever existent on the earth has had a beginning in time. If this result should be confirmed by later researches, it may well come to be regarded as the most momentous discovery of the age; for it represents a fundamental change in the scientific conception of the universe, such as was effected four centuries ago by the work of Copernicus’.¹¹

Conclusion

What, then, is the importance of modern science in the argument for the existence of God drawn from the mutability of the cosmos? By means of exact and detailed investigations into the macrocosm and the microcosm, it has widened and deepened to a considerable extent the

empirical foundation upon which the argument is based and from which we conclude a self-existent Being (*Esse per essentiam*) immutable by nature. Further, it has followed the course and the direction of cosmic developments, and just as it has envisioned the fatal termination, so it has indicated their beginning in time at a period about five billion years ago, confirming with the concreteness of physical proofs the contingency of the universe and the well-founded deduction that about that time the cosmos issued from the hand of the Creator.

Creation, therefore, in time, and therefore, a Creator; and consequently, God! This is the statement, even though not explicit or complete, that we demand of science, and that the present generation of man expects from it. It is a statement which rises from the mature and calm consideration of a single aspect of the universe, that is, of its mutability; but it is sufficient because all mankind, the apex and rational expression of the macrocosm and the microcosm, is made conscious of its sublime Creator and feels His presence in space and in time, and, falling to its knees before His sovereign Majesty, begins to call upon the name *Rerum Deus, tenax vigor – Immotus in te permanens – lucis diurnae tempora – successibus determinans*.¹²

The knowledge of God as unique Creator, a conviction shared by many modern scientists, is certainly the extreme limit which natural reason is capable of reaching; but it does not constitute the last frontier of truth. Science, which has encountered the Creator in its path, philosophy, and, much more, revelation, in harmonious collaboration because all three are instruments of truth, like rays of the same sun, contemplate the substance, reveal the outlines, and portray the lineaments of the same Creator. Revelation especially renders the presence almost immediate, full of life and love, which is what the simple believer and the scientist are aware of in the intimacy of their spirits when they repeat without hesitation the concise words of the ancient Creed of the Apostles: *Credo in Deum, Patrem omnipotentem, Creatorem caeli et terrae!*

Today, after so many centuries of civilisation (because they were centuries of religion), now the need is not to find God for the first time, but rather to recognise Him as a Father, to revere Him as Legislator, to fear Him as Judge; it is urgent for the salvation of all peoples that they adore the Son, the loving Redeemer of mankind and they bend the knee to the gentle urgings of the Spirit, fruitful Sanctifier of souls.

This conviction, which takes into account the deepest movements of science, is crowned by faith which, the more it is rooted in the consciousness of peoples, the more it can really lead to a fundamental progress for civilisation.

It is a whole vision, of the present and of the future, of matter and of spirit, of time and of eternity, that, illuminating the mind, will save the men of today from a long and stormy night. And that faith, which makes us in this moment raise to Him Whom we have just called *Vigor, Immotus* and *Pater*, a fervent prayer for all His sons, who are given to us to look after: *Largire lumen vespere – quo vita nusquam decidat* – light for our life in time, light for eternal life.¹³

1 S. Th., I, 2, 3.

- 2 *Paradiso*, Canto XXXIII, 85-87.
- 3 *Ws* 13:1-2.
- 4 *Paradiso*, Canto I, 1.
- 5 *Ex* 3:14.
- 6 *Jm* 1:17.
- 7 2 *Tm* 3:16.
- 8 *Kernphysik und Kosmologie*, in the *Zeitschrift für Astrophysik*, 24, B (1948), pp. 278-305.
- 9 *Die Vorstellung vom Weltgebäude im Wandel der Zeiten* (1911), p. 362.
- 10 *Ultramontane Weltanschauung und Moderne Lebeskunde* (1907), p. 55.
- 11 *Space and Spirit* (1946), pp. 118-119.
- 12 *Hymn for None*.
- 13 *Ibid*.