

# THE POPES AND ASTRONOMY

• Pope LEO XIII to Pope BENEDICT XVI •

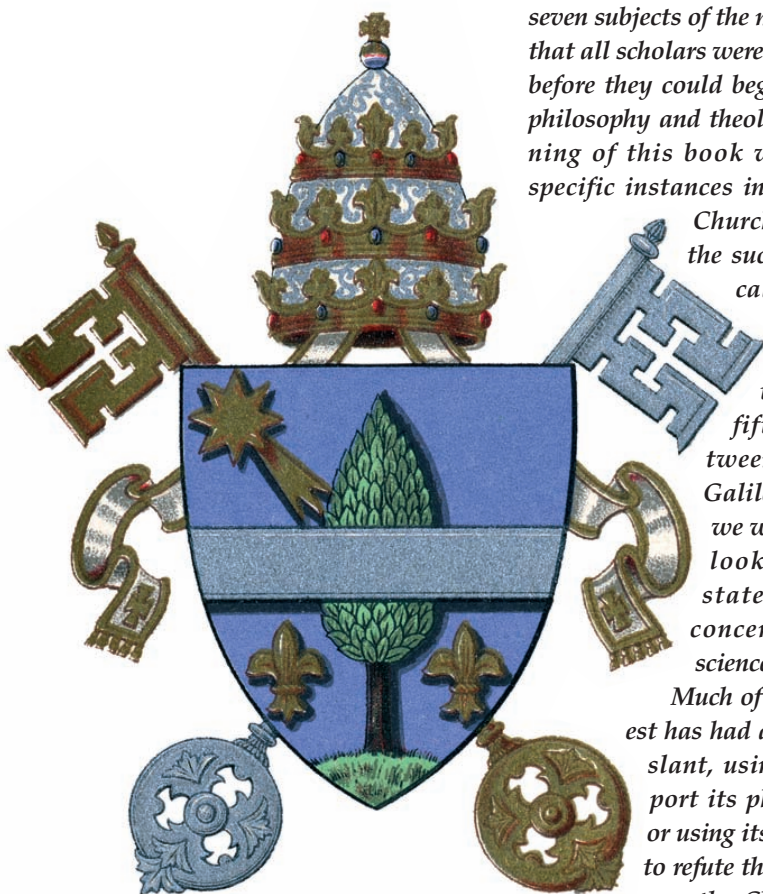
Astronomy has long featured in Christian theology. Indeed, astronomy was one of the seven subjects of the medieval university that all scholars were expected to master before they could begin their studies of philosophy and theology. At the beginning of this book we examined two specific instances in the history of the Church and astronomy: the successful reform the calendar under Pope Gregory XIII in 1582, and the tragic conflict just fifty years later between the Church and Galileo. Here, however, we would like to take a look at more recent statements of Popes concerning the modern science of astronomy.

Much of the Church's interest has had an overt apologetic slant, using science to support its philosophical ideas or using its support of science to refute those who would accuse the Church of opposing

progress and fearing newly-discovered truths. Even in Roman times, the apologetic need for the Church's teachers to have an up-to-date knowledge of the physical universe, to give credibility to the theological truths of the Church, was evident to St. Augustine. Writing in AD 400, he commented:



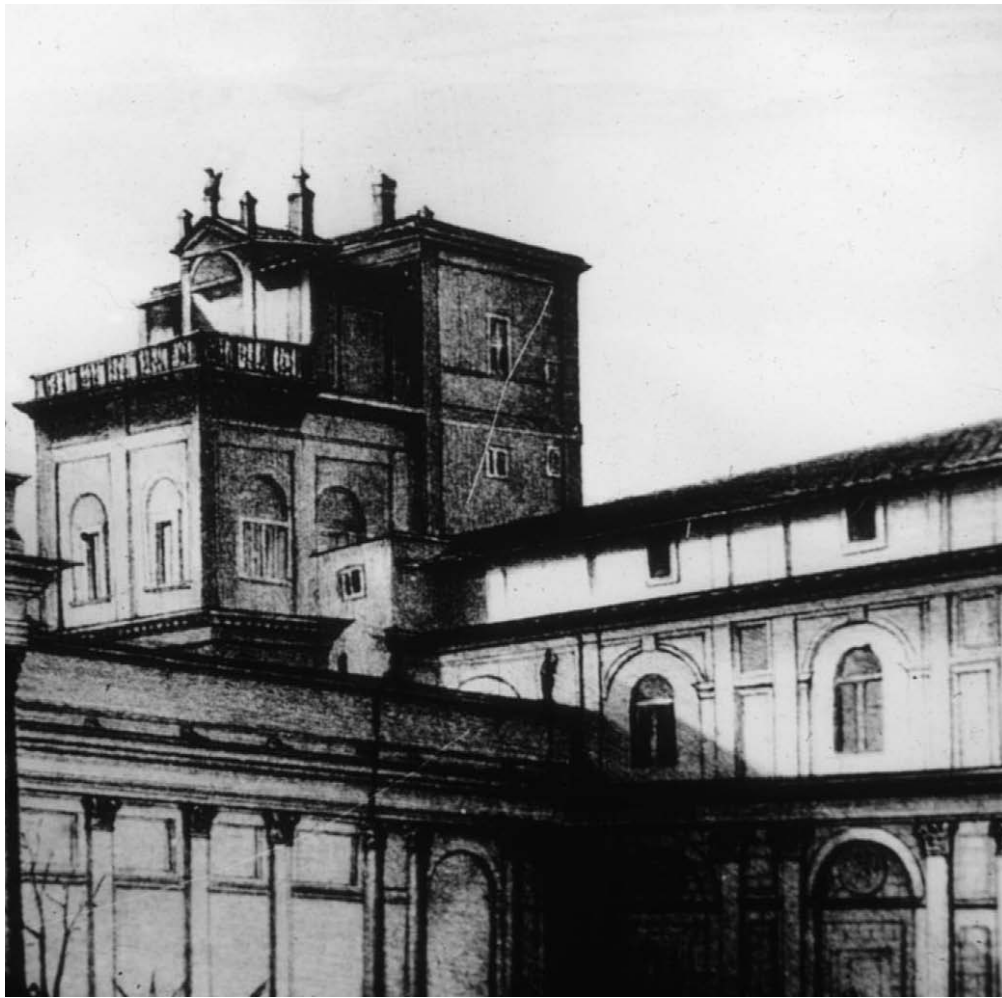
Even a non-Christian knows something about the Earth, the heavens, and the other elements of this world, about the motion and orbit of the stars and even their size and relative positions, about the predictable eclipses of the Sun and Moon, the cycles of the years and the seasons... and



*Above* By a happy coincidence, the coat of arms of Pope Leo XIII, the founder of the modern Vatican Observatory, included a comet! (It comes from his Pecci family coat of arms.)

*Opposite* The tower of the winds during the papacy of Pius VII in the early 19th century. It housed an earlier version of the Specola Vaticana, set up under his predecessor Pius VI.

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see clearly that  
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and promote it...  
**Pope Leo XIII**



this knowledge he holds to as being certain from reason and experience. Now, it is a disgraceful and dangerous thing for an infidel to hear a Christian, presumably giving the meaning of Holy Scripture, talking nonsense on these topics; and we should take all means to prevent such an embarrass-

ing situation, in which people show up vast ignorance in a Christian and laugh it to scorn."

[Saint Augustine, *The Literal Meaning of Genesis*, Vol. 1  
(trans. John Hammond Taylor, S.J.).  
New York: Paulist Press, 1982, pp. 42-43.]

The irony is, of course, that the cosmology the learned men of Rome knew so well, was the very Ptolemaic cosmology later overthrown by Copernicus and Galileo!

But through the writings of these modern Popes one begins to see developing a second realization: that, as the Psalmist knew, the Heavens themselves do proclaim the greatness of the Creator. The simple act of seeking truth in the natural sciences is in and of itself a religious act, independent of any apologetic agenda.

from **AETERNI PATRIS**, 1879  
(**POPE LEO XIII**)

In an encyclical letter proclaimed in 1879, subtitled "On the Restoration of Christian Philosophy in Catholic Schools in the Spirit (ad mentem) of the Angelic Doctor, St. Thomas Aquinas," Pope Leo XIII endorsed the study of scholastic philosophy and ignited a new interest in the rational understanding of the faith. In passing, he reflects on the role of the physical sciences, in a way that foreshadows his establishment, twelve years later, of the Vatican Observatory itself:

Our philosophy can only by ... the grossest injustice be accused of being opposed to the advance and development of natural science. For, when the Scholastics, following the opinion of the holy Fathers, always held in anthropology that the human intelligence is only led to the knowledge of things without body and matter by things sensible, they well understood that nothing was of greater use to the philosopher than diligently to search into the mysteries of nature and to be earnest and constant in the study of physical things. And this they confirmed by their own example; for St. Thomas, Blessed Albertus Magnus, and other leaders of the Scholastics were

never so wholly rapt in the study of philosophy as not to give large attention to the knowledge of natural things; and, indeed, the number of their sayings and writings on these subjects, which recent professors approve of and admit to harmonize with truth, is by no means small. Moreover, in this very age many illustrious professors of the physical sciences openly testify that between certain and accepted conclusions of modern physics and the philosophic principles of the schools there is no conflict worthy of the name.

#### THE REFOUNDATION AND RESTRUCTURING OF THE VATICAN OBSERVATORY, 1891

(POPE LEO XIII)

*Here is the text of Leo XIII's Motu Proprio, a personal decree that re-established the Vatican Observatory. In it he explains the apologetic need for supporting a scientific institution at that time, and also outlines the previous history of papal support for astronomy.*

So that they might display their disdain and hatred for the mystical Spouse of Christ, who is the true light, those borne of darkness are accustomed to calumniate her to unlearned people and they call her the friend of obscurantism, one who nurtures igno-

rance, an enemy of science and of progress, all of these accusations being completely contrary to what in word and deed is essentially the case.

Right from its beginnings all that the Church has done and taught is an adequate refutation of these impudent and sinister lies. In fact, the Church, besides her knowledge of divine realities, in which she is the unique teacher, also nourishes and gives guidance in the practice of philosophy which is essential to understanding the scientific foundations of knowing – to make its principles clear, to suggest the criteria necessary for rigorous research and for a systematic presentation of the results, to investigate the soul's faculties, to study life and human behavior – and she does this so well that it would be difficult to add anything worth mentioning and it would be dangerous to dissociate oneself from her teachings.

Furthermore, it is to the great merit of the Church that the legal code has been completed and perfected, nor can we ever forget how much she has contributed through her doctrine, her example and her institutions to addressing the complex issues arising in the so-called social sciences and in economics.

In the meantime the Church has not neglected those disciplines which investigate nature and its forces. Schools and museums have been founded so that young scholars might have a better opportunity to deepen those studies. Among the Church's children and ministers there are some illustrious scientists whom the Church has honored and assisted as much as she could by encouraging them to apply themselves with complete dedication to such studies.

Among all of these studies astronomy holds a preeminent position. It proposes to investigate those inanimate creatures which more than all others proclaim the glory of God and which gave marvelous delight to the wisest of beings, the one who exulted in his di-

vinely inspired knowledge, especially of the yearly cycles and of the positions of the heavenly bodies (Wisdom VII.19).

The Church's pastors were motivated, among other considerations, to see to progress in this science and to support its followers by the possibility that it alone offered to establish with certainty those days on which the principal religious solemnities of the Christian mystery should be celebrated. So it was that the Fathers at Trent, well aware that the calendar reform done by Julius Caesar had not been perfect so that time calculations had changed, urgently requested that the Roman Pontiff would, after consulting experts in the field, prepare a new and more perfect reform of the calendar.

It is well known from historical documents how zealously and generously committed was Our Predecessor Gregory XIII in responding to this request. He saw to it that at the place judged to be best for an observatory within the confines of the existing Vatican buildings an observing tower was constructed and he equipped it with the best instruments of those days. It was here that he held the meetings of the experts he had selected for the reform of the calendar. This tower still exists today and it brings back the memory of its illustrious and generous founder. The meridian constructed by Ignazio Danti from Perugia is to be found there. Along the meridian line there is a round marble tablet whose lines are designed with such wisdom that when the sun's rays fall on them it becomes obvious how necessary it was to reform the old calendar and how well the reform conformed to nature.

That tower, a splendid memory to a Pontiff who is to be much praised for his contribution to the progress of literary and scientific studies, was, toward the end of the last century after a long period of inactivity, restored to its original use as an astronomical observatory



by the auspicious orders of Pius VI. Through the initiatives of a Roman Monsignor Filippo Gili, other types of research were also undertaken on terrestrial magnetism, meteorology and botany. But, after the death in 1821 of this very capable scientist, this monument to astronomical research went into neglect and was abandoned. Right after this Pius VII died and the energies of Leo XII were completely taken up with the reform of studies in the worldwide Church, a huge undertaking aimed at promoting all branches of learning. Such a reform, which had already been planned by his immediate and immortal predecessor, came by his efforts to a happy ending with the Apostolic Letter, *Quod divina sapientia*. In this letter he established certain rules with respect to astronomical observatories, the observations which were to be made regularly, the daily list of data to be made, and the information that was to be distributed internally concerning discoveries made by others.

The fact that the tower in the Vatican was no longer used as an observatory, after others in Rome had been equipped for that very purpose, came about because those who were competent to judge were of the opinion that the nearby buildings, and especially the dome which crowns the Vatican basilica, would have obstructed observations. And so it was deemed preferable to have observatories in other higher places where unobstructed observations could be carried out.

It then happened that, after those observing sites along with the whole city of Rome fell into the hands of others, we were given, on the occasion of our 51st anniversary as a priest, many excellent instruments for research in astronomy, meteorology, and earth physics, as well as other gifts. It was the opinion of the experts that no place was better to house them than the Vatican tower, where, it seems, Gregory XIII had already in some way made prepa-

rations. After having evaluated this proposal and having examined the structure itself of the building, the history of its past glories, and the equipment already gathered there, as well as the opinions of persons renowned for their knowledge and judgement, we were persuaded to give orders that the observatory be restored and that it be equipped with all that would be required to carry out research not only in astronomy but also in earth physics

and in meteorology. As to the lack of an unobstructed view of the heavens in all directions from this Vatican tower, we saw fit to consider providing the nearby ancient and solid Leonine fortification where there is a quite high tower which, since it rises on the summit of the Vatican hill, provides for complete and perfect observation of the heavenly bodies. We, therefore, added this tower to the one of Gregory and we had installed there the large equatorial



Above Pope Leo XIII.

telescope for photographing the stars.

To this purpose we chose conscientious men, prepared to do all that was necessary for such an undertaking, and we proposed to them a most competent scholar in astronomy and physics, Father Francesco Denza of the Clerks Regular of Saint Paul, also

called the Barnabites. Relying on their dedicated work, we agreed wholeheartedly that the Vatican Observatory be chosen to collaborate with other renowned astronomical institutes in the project to reproduce from photographic plates an accurate map of the whole sky.

Considering the fact that we wish this work of restoring the Specola to be a lasting one and not one that terminates after a short time, we have established bylaws for it with rules to be observed both for internal administration and for the services which others require of it. Furthermore, we have appointed a Board of carefully selected persons whose responsibility it is to govern the observatory and they have the highest authority after our own for all decisions respecting the internal administration.

And so with the present letter we confirm those bylaws and that Board and we also assign the various jobs and all that, with our order or consent, has been done with respect to the Specola. And we desire that the Specola be considered at the same level as the other Pontifical Institutes founded to promote the sciences. In order to provide in a more secure way for the stability of this work, we even designate a sum of money which should suffice to cover the expenses required to keep it operating and to maintain it. Nevertheless, we trust that such a work will find its justification and support in the favor

and help of Almighty God more than in what humans can do. In fact, in taking up this work we have become involved not only in helping to promote a very noble science which, more than any other human discipline, raises the spirit of mortals to the contemplation of heavenly events, but we have in the first place put before ourselves the plan which we have energetically and constantly sought to carry out right from the beginning of Our Pontificate in talks, writings, and deeds whenever we were provided the opportunity. This plan is simply that everyone might see clearly that the Church and her Pastors are not opposed to true and solid science, whether human or divine, but that they embrace it, encourage it, and promote it with the fullest possible dedication.

We wish, therefore, that everything that has been established and announced in the present letter will remain into the future confirmed and ratified as it is proposed herein and we declare null and void any attempt at changes by whatsoever person. And it remains established and confirmed, despite any previous contrary declaration.

*Given in Rome at St. Peter's,  
14 March 1891*

**DEUM CREATOREM  
VENITE ADOREMUS, 1935  
(POPE PIUS XI)**

*As anyone with a smattering of Latin and Christmas Carols will recognize, the title of this discourse can be translated as "Come let us adore God the Creator." This text was delivered by Pius XI on 29 September 1935 at Castel Gandolfo on the occasion of the Inauguration of the New Specola headquarters.*

We are very happy and very grateful to God that we can be present among you, my beloved

sons and daughters, to rejoice in the inauguration of this new, and might we say improved, Specola Vaticana in this our residence at Castel Gandolfo, it itself having been renovated.

It is not just for the sake of using the simple usual expression, but rather deliberately and with reflection, that we say: We are very happy and very grateful to God.

Today we officially inaugurate the Astronomical Observatory and the As-



*Cortie S.J.  
Mons. Migone*

trophysical Institute. The high quality of the scientific instrumentation which has been acquired and the proven expertise of the scientists who will use it will undoubtedly make some important contributions to the progress in research of a science which, as a study of the heavens, can be said to be sover-



eign among the sciences. But this is not the only reflection which brings joy to our hearts today.

What we are doing today, and your presence my beloved sons and daughters makes it all the more beautiful and solemn, adds some lines to the truly golden and most glorious pages which have already been written about the history of the Roman Pontificate. It carries us, like winged Pegasus, through the centuries in an immense

and magnificent world of things, of ideas, of happenings.

Our dear and most capable Father Stein has given us a simple, but wise and most tasteful, account of that world. His brief history has for a moment thrown light upon and opened our eyes to the unfathomable depths of the heavens. We have been able to capture and enjoy at least a few notes from that immense hymn from on high where the heavens and the heavenly bodies sing the glory and reveal the power and the wisdom and the infinite beauty of the Creator.

And one might say that the Creator himself, He who at the end of his work of creation was pleased and proclaimed that all was good, is in a special way pleased with the magnificence of the heavens and the stars.

In fact, the divinely inspired Text emphatically and repeatedly calls upon the heavens and the stars to praise and bless the Lord (Psalm 148, 3; Daniel 3, 63 and elsewhere) and the Creator himself gives it the name Beautiful Star (Apocalypse 22, 16). That same sacred text finds one of the happiest expressions of divine wisdom when, in the presence of those infinite multitudes of heavenly bodies, which the new modern instrumentation magnifies and multiplies, it

sees God numbering the multitude of stars and listens to him calling each by name, a prerogative which God reserves to himself (Genesis 15, 5; Psalm 146, 4). Again it is the divinely inspired Text which sees the uncreated Wisdom (Wisdom 7, 29) shining sovereign among the stars: even more, in the

beauty of the heavens and in the glory of the stars it sees God himself who illuminates the world from on high (Ecclesiastes 43, 4). It is always the divine word which puts in the mouth of the disciple of Wisdom a special thanks for the knowledge that has been acquired of the stars (Wisdom 7, 19).

We should not be amazed then if the magnificent matters which astronomy studies and helps us to better understand, and if the ideas which are raised by even the most ordinary but solid view of those matters, become the source of a profound spirituality. I am referring to the relationship between Religion and the Science of the heavenly bodies which has reigned continuously over the centuries from the most remote antiquity to our times. The most recent important Congress of the Orientalist in Rome has also reminded us of this relationship and treated of it in some of the papers. Information from ancient cuneiform and hieroglyphic texts have helped us to understand how observations of the heavens were related to sacrifices and cultic practices. All of this is now well known. It is only yesterday, in comparison with those antiquities, that the reform of the calendar took place.

It is well known that the astronomy of those times played an important role in this reform which bears the name of one of our great predecessors – Gregory XIII. Even today that role is very much appreciated by such competent judges as a Schiaparelli and a Father Hagen, not to speak of others whom we know personally and admire.

*From no part of Creation does there arise a more eloquent or stronger invitation to prayer and to adoration*  
Pope Pius XI



Above Pope Pius XI with members of the Specola on the occasion of the meeting of the International Astronomical Union in Rome in 1922. Immediately to his left is Fr. Johan Hagen, the director of the Specola.

PONDERING  
STARS  
THE POPES  
AND ASTRONOMY

That which we are doing now is more than all of that. We are taking up once more one of the threads of the history of the Roman Pontificate and it is a beautiful and precious one. That is the thread of its relationship over the centuries with the science of the heavenly bodies, a science one might in all truth say is by its nature religious, just like, as Tertullian so nicely phrased it, the human soul is naturally Christian. In fact, from no part of Creation does

as the immense vault of the sky passes over. Even the unbelieving poet [Carducci] in the silence of the starry heavens was wont to hear passing over the soft sweet prayer of the Ave Maria. It seems to us, dear sons and daughters, in this astronomical, may we call it, inauguration that we are fulfilling in the name of the whole Church, an act of our priestly ministry.

With a very fortunate thought the author of the new Specola, Father Stein,

It is also quite well known that the Supreme Roman Pontiffs have for many centuries needed astronomy and have called upon it to help in the placement of holy temples and especially in the calculation of the date of Easter.

As you see, what we are doing here is not just to continue and to imitate, within our resources, the patronage of Our illustrious predecessors who have never been sufficiently praised for what they did. It is not just that we are trying to assure for the present and future, as they did for the past with the quiet eloquence of their accomplishments, to assure I repeat that implicit, even explicit, defense of the Faith and of Religion. That defense shines and is more than ever persuasive whenever respect for the faith is joined in a spontaneous way with the development of Science.

there arise a more eloquent or stronger invitation to prayer and to adoration. As the Wise Men of old, to whom the stars announced the coming of God to the earth, expressed it: We have seen his star and have come to worship him. Even today the Beduin of the vast deserts sees the majesty of God shining



*Above Pope Pius XI at the dedication of the new telescopes on the roof of the Papal summer residence in Castel Gandolfo, 1935.*





recalled for us the imposing inscription ordered by Pius IX to be placed on the Pontifical Observatory of the Roman University on the Capitoline, an observatory which he had constructed: *Deo Creatori* (to God, the Creator). We could do no better than to follow in the wake which Our glorious predecessor so brilliantly left open and to complete his thought by Ourselves declaring and inscribing on the new Specola: *Deum Creatorem Venite Adoremus* (Come let us adore God the Creator).

from AN ADDRESS  
to the PONTIFICAL ACADEMY  
OF SCIENCES, 1939  
(POPE PIUS XII)

The Pontifical Academy of Sciences can be traced back to the Academy of the Lynxes, founded in 1603 by Prince Federico Cesi under the patronage of Pope Clement VIII; it claimed Galileo as one of its most notable members. In 1923 Pope Pius XI gave the Academy its current building within the Vatican gardens, and in 1936 he reorganized the Academy as a "Scientific Senate" composed of leading scientists of the world, invited from all nations and faiths, chosen "without racial or religious discrimination." One of the churchmen he appointed to this academy was Eugenio Cardinal Pacelli, who would later become his successor, Pope Pius XII.

Soon after his election as Pope, in December 1939 Pope Pius XII addressed the Plenary Session of the Academy. In it, he endorsed the work of the Academy, calling it his predecessor's "greatest achievement." In these excerpts from his opening address, he begins by quoting from the same book of Augustine on Genesis that we referenced above:

As Saint Augustine tells us, God, having created the universe, did not abandon the world but kept man's thoughts in his counsel. While maintaining the universe in existence and motion, God left it to men to dispute amongst themselves without their being able to discern God's full project. God has given fallen man this task of understanding this great enigma; the enigma of the unknown God working in creation, to which Paul the Apostle pointed when addressing the Epicurean and Stoic philosophers in the Athenian council of the Areopagus. Paul stated that this unknown God had created the whole human race on the entire earth so that they could find their way towards God since He is not

Top Pope Pius XI at the dedication of the new spectrochemical laboratory on the ground floor of the Papal summer residence in Castel Gandolfo, 1935. Third from the left in the group of priests to the Pope's left is Father Ledókowski, the Superior General of the Jesuits.

far from any of us.

The enigma of creation has for centuries stretched the intellect of all peoples; the various solutions proffered have filled the schools of the academy; volumes have filled both ancient and modern libraries; attempts to find the solution to this enigma have been the cause of disputes between wise investigators of nature, of matter, and of the spirit. These labors, these lessons, these volumes, these battles are nothing other than the searchings for the truth hidden deep in the enigma itself...

Reality speaks to us and communicates her word to us through the wonderful sense of our nature moulded out of flesh and spirit. It is this reality which we seek through the immeasurable ways of the universe. We are neither responsible for creation nor are we

the creators of Truth; neither our doubts, nor our opinions, nor our carelessness, nor our negations can alter it... Our human investigations measure

the truth found by our scientific implements and instruments and various machines; they are able to transform, capture and dominate the material offered to us by nature, but they cannot create her; our minds have to remain faithful in following nature just as a disciple does with his master from whom he learns his work...

Man ascends to God by climbing the ladder of the Universe: the astronomer, when reaching the sky, footstool to the throne of God, cannot remain an unbeliever before the voice of the firmament; from beyond the suns and astral nebulae emanates the thought, followed by the love and adoration, which sails toward a sun which

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PONDERING  
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vestigating 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

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**Pope Pius XII**

illuminates and gives warmth not to the clay of man but to the spirit which animates him.

from **THE PROOFS  
FOR THE EXISTENCE OF GOD  
IN THE LIGHT OF MODERN  
NATURAL SCIENCE, 1951  
(POPE PIUS XII)**

**I**s it possible for the Church to endorse science too much? That became an issue following the comments of Pope Pius XII given below. Speaking to the Plenary Session and to the Study Week on the Subject 'The Question of Microseisms', the Pope addressed at length the structure of matter and the cosmos and the origins of the universe, using them to re-examine classical proofs of the existence of God on the basis of new scientific discoveries. We include here his opening comments and the section in which he dealt with modern astronomy:

**W**e 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 in-



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 philoso-

phers 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...

## 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 realize 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 utiliz-

able 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.

### 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

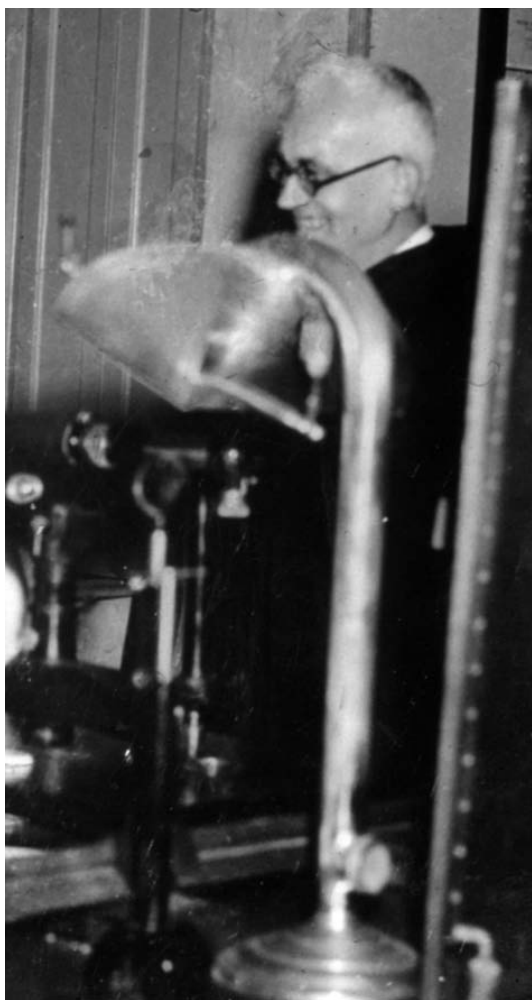
demonstrated the significant result – though tempered by reserve – that these far-off systems of galaxies tend to rush away from one another at such speed that the space between two such spiral nebulae doubles in the period of about 1300 million years. If one looks back across the period of this process 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 un-



*Above Pope Pius XII visiting the Vatican Observatory Spectrochemical Lab in 1948. With him is the Vatican astronomers Fr. Gatterer (left) and Fr. Junkes (right).*



heard 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.

### 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

*Creation,  
therefore,  
in time,  
and therefore,  
a Creator...  
Pope Pius XII*

enormous intensity, as can be seen in the recent work of A. Unsold, director of the Observatory in Kiel. 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 recognizes 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 investiga-



Above Pope Pius XII at the finderscope of the Schmidt telescope, newly installed in the Papal Gardens of Castel Gandolfo, in 1957. He held a private ceremony for the astronomers of the Specola, blessing their instrument and their work.

tion 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'. 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.'

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  $10^9$  or  $10^{10}$  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."

### 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 – Immutus in te permanens – lucis diurnae tempora – successibus determinans*.

The knowledge of God as unique Creator, a conviction shared by many



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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 civilization (because they were centuries of religion), now the need is not to find God for the first time, but rather to recognize 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.

*The divine Spirit  
reveals itself  
from the coldness  
of space  
to the scientist  
open to finding  
a purpose for the whole  
of existing reality.*

**Pope Pius XII**

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 civilization.

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 deciderat – light for our life in time, light for eternal*

life.

**T**he Pope's text is careful to state that "the facts verified up to now are not arguments of absolute proof of creation in time... [but] 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." Nonetheless, it appeared to many to be an endorsement of a particular cosmology theory, popularly known as the "Big Bang."

The most startling reaction against this speech came from Fr. Georges Lemaître, the Belgian diocesan priest and astrophysicist whose work in the 1920's actually laid the foundation for the Big Bang theory. Lemaître was very leery at reading such an interpretation into his theory.

*The  
human spirit  
has surpassed  
all the limits  
of the body's senses...  
and succeeded  
in seizing  
the immense  
Universe.*

**Pope Pius XII**

For one thing, he recognized that his theory was still controversial, and only one of several possible cosmologies given the evidence available at that time. (It would be more than a decade before the the discovery of the cosmic microwave background radiation finally convinced most cosmologists that some sort of "big bang" actually did occur.) Worse, in 1951, there was still some suspicion that this "priest's theory" might have been invented precisely to find a scientific excuse to support the Genesis description of "fiat lux." Lemaître wanted his work to be judged purely on its scientific merits. He knew that even the best scientific theory is eventually superseded by later work. And, in any event, while it is good that theologians be aware of the latest advances in science, it is certainly not theology's role to judge or endorse scientific theories. Nor, for that matter, is it wise to base theology on the latest advances of science, since that is a ground that is forever shifting.

#### ADDRESS

TO THE GENERAL ASSEMBLY  
OF THE INTERNATIONAL  
ASTRONOMICAL UNION, 1952  
(POPE PIUS XII)

**L**emaître spoke personally to the Pope about his concerns, and clearly he was heard. The following year, when the International Astronomical Union (of which the Vati-

can is a member state) met in General Assembly in Rome, the Pope was invited to address the assembled astronomers; in his address, presented on September 8, 1952, no such endorsement of The Big Bang or any other particular theory was put forward.

Instead, the Pope presented an up-to-date overview of the state of astronomical knowledge of the time, prepared with the assistance of the Director of the Vatican Observatory, Fr. Daniel O'Connell SJ. And then he reflected on the deeper implications of the very nature of the astronomical enterprise.

This hauntingly beautiful appreciation of the love of the Universe marked an important transition in the nature of the Church's appreciation of astronomy. No longer was astronomy merely an apologetic tool for the Church; now it was recognized to be in itself a profound act of worship of the Creator.

Here is a modern translation from the French text, prepared by the Jesuit astronomer Fr. Paul Gabor S.J., who has included a note (appended as italicized passage at the end) to describe how modern astronomy has developed beyond the situation cited by Pope Pius XII in 1952.

### I. The Cosmic Panorama

The presence of such a myriad gathering of renowned astronomers from all over the world brings to our mind an image of the panorama of the Universe obtained by modern astronomy, which you have brought to its current perfection thanks to your untiring observations and brilliant analysis. We are grateful to you for many reasons, but in particular because your scientific research of the Universe and its exalting contemplation brings our spirits to philosophical considerations of a more universal value and lifts them up ever more to the knowledge of the End in its ultimate truth which surpasses all knowing and marks all existence with

its seal: "The Love which moves the Sun and other stars" (Dante, *Paradiso*, 33, 145).

Although we are aware that we speak before elite representatives of science, much more knowledgeable on the subject than we are, we cannot refrain from recalling at least in broad lines the admirable progress of astronomy and astrophysics over the last fifty years, and to indicate the milestones which will thus serve as a basis for our higher considerations.

What once was an enigma and a dream for the astronomers of the past, and what has become for the astronomers of the present age a reality beyond all our dreams, may perhaps be expressed with some justice as the conquest of space. Observations, understanding, and new technological means have, as it were, put a gigantic compass into the hands of astronomical science, opening up the Universe more every day, to the point where it now can embrace dimensions surpassing all expectation. How many barriers, especially those of enormous distances, have fallen over the last decades under the relentless pressure of the enquiring spirit, never satisfied: the spirit of the scientist!

The previous century witnessed the first laborious attempts at exploring the depths of space when Bessel, Struve and Henderson measured the first trigonometric parallaxes; by the turn of the century one could feel a legitimate satisfaction at being able to determine with some certitude the distances of 58 fixed stars ranging up to 30 or 40 light years from our Sun. After 1912, however, a new, different, and more efficient method for measuring

cosmic distances took human sight even further. Miss Leavitt discovered in a certain type of variable star, the Cepheids, a relationship between the period of their variability and their magnitude or brightness. Thus, wherever a Cepheid was discovered in the sky, one could deduce its absolute luminosity from the period of its variability, and comparing the absolute luminosity to the apparent brightness, easily calculate its distance.

At the same time, observations were given a boost by the growing sensitivity of photographic emulsions and by progress in the building of ever more powerful telescopes, which allowed the radius to which the human eye could penetrate to increase several million times, reaching unsuspected depths in space. The astronomer Shapley took the first great step beyond the closest stars with his classic research on the spatial distribution of globular clusters. This research led to a complete transformation of the idea of the galactic system's structure.

Meanwhile other inquiries, such as those dealing with stellar motions and the decrease of light when it passes through opaque matter in interstellar space, improved this new idea. We have thus acquired a certainty that the Milky Way of the ancients, which inspired so many naïve myths, is an immense accumulation of about a hundred thousand million stars – some larger, some smaller than our Sun – spanned by vast clouds of cosmic gas and dust. The whole system, obeying the general law of gravity, keeps revolving on gigantic orbits around a center located in the great stellar clouds of Sagittarius. Re-

*What a happy  
and sublime  
encounter  
over the contemplation  
of the cosmos  
is that of the human spirit  
with the Spirit  
of the Creator!  
Pope Pius XII*



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sembling in its whole an enormous spinning biconvex lens, this system has a diameter of about 100,000 light years and a thickness of about 10,000 light years at its centre. As for us with our solar system, we are not, as was believed earlier, at the centre of this incommensurable accumulation of stars: in fact, we are about 30,000 light years from it. And even though we revolve around it at the dizzying speed of about 250 km per second, it takes us 225 million of our solar years to make one whole revolution!

It is with legitimate pride that our century's astronomical science can claim to have conquered the galactic system. This first and happy leap forward was soon followed by another leap, which was to take human knowledge beyond the Milky Way into the immensity of space. It is mainly thanks to the gigantic telescopes of Lick, Yerkes and Mount Wilson that this decisive step could be accomplished. When in 1917-19 Ritchey discovered several novae in the Andromeda nebula, few scientists believed the hypothesis that we were

dealing with stars in an extragalactic nebula at a distance of hundreds of thousands light years. It was only when Hubble, using the great two-and-a-half meter mirror of Mount Wilson, succeeded in resolving the external parts of the Andromeda nebula into isolated stars and globular clusters and in identifying several Cepheids that the adversaries surrendered their opposition. We have become certain that these spiral nebulae are in fact great stellar systems resembling our galactic system in their composition and their size, but so distant that they appear to the eye as mere tiny speckles of luminous haze. The distance of the nebula closest to us, Andromeda, was found to be 750,000 light years; that of the Triangulum nebula, about 780,000.

Tirelessly searching the skies, astronomers then started to look at other nebulae apparently much smaller than these galaxies and to calculate their respective distances, measuring their apparent diameters and brightnesses and

comparing these data with the known characteristics of the closest nebulae. Finally, Humason's spectroscopic research led to the discovery of an unsuspected law: the shift of spectral lines towards the red increases proportionately with a nebula's distance,

*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.*

**Pope Pius XII**

*You have two works to do. One is to explain the world of science to the Catholic Church. The other is to explain the Catholic Church to your fellow scientists. I think you do the second much better!*

**informal comments  
of Pope John XXIII  
to Fr. Martin McCarthy SJ  
at the Vatican  
Observatory**



*Above* Though giving no formal addresses concerning the world of astronomy, Pope John XXIII had a great love of the Specola and the Jesuits who shared his summer home. *In 1959, on the feast of St. Ignatius, founder of the Jesuits, he came to see the Astrophysical Laboratory (above) and the meteorite collection (right).*

so that the measure of this shift allows us to evaluate distance itself, despite the faintness of the light which reaches us, so long as it is sufficient to produce a measurable spectrum.

During this research, it was observed that – when considering broad and deep zones of the sky – these extragalactic nebulae appear as roughly equally distributed in cosmic space, and so far it has been impossible to observe the slightest decrease in their den-



Over the years he paid other occasional informal visits to the community during his summer stays. The diary of Fr. O'Connell, then director of the Observatory, notes two occasions when the Pope left with the community "the gift of an excellent wine."

sity. In the space reached by the telescope on Mount Wilson, we estimate the number of galaxies at about 100 million, distributed in a sphere of an approximate diameter of a thousand million light years, each of them containing about a hundred thousand million stars similar to our Sun.

After this brief imaginary trip through the immensity of the Universe, let us return to our little planet which, with the mass of its mountain ranges, with the limitless span of its oceans and deserts, with the violence of its hurricanes, its volcanic eruptions and seismic movements, sometimes appears to us so vast and powerful. In fact, in the space of a second, a beam of light would circle our equator more than seven times. In a little more than a second – a blink of an eye – it would reach our neighbor, the Moon. In a little more than eight minutes, it would reach the Sun. And in five and a half hours, it would touch the farthest planet of our system, Pluto. As for the closest fixed stars, which during serene nights on mountain tops seem so close that we can almost touch them, a light message would take more than four years to reach them and it would need 30,000 years to reach the centre of the Milky Way. The light coming to us from the Andromeda nebula

left its source about 750,000 years ago, whereas for certain very distant nebulae which only the most powerful modern optical instruments can detect with great difficulty on a photographic plate after a very long exposure, as tiny stars, are at a distance of 500 to 1000 million light years.

*Lord,  
I am ready  
to walk in the night,  
step by step,  
enlightened  
by the stars.  
Pope John XXIII*

What numbers, what dimensions, what distances in space and time! And yet we have to believe that astronomical science is far from being considered as having reached the end of its marvelous adventure.

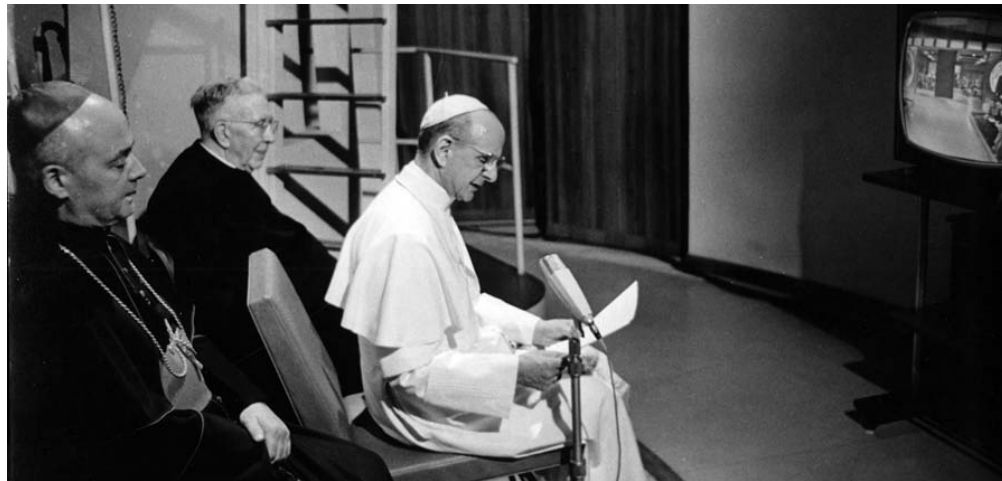
Who can say what future steps forward can be achieved in the near future by the five meter mirror on Mount Palomar, and the rapid development of radio astronomy? How small does man appear in the prodigiously extended framework of space and time: a minute speck of dust in the immensity of the Universe. And yet!

## II. The Work of Inquiring Spirit

When we look at the picture of the Universe sketched above, a picture which is the fruit of long and laborious research by generations of researchers hailing from the most diverse nations, what is most striking beyond what has already been said is not so much the gigantic mass of the universe and all its parts, or the harmony of its movement;



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rather, it is the behavior of the inquisitive human spirit in discovering such a vast panorama. By its nature tied to the body's condition of minute dimensions, the human spirit has surpassed all the limits that the feeble power of the body's senses seemed to be capable of, and succeeded in seizing the immense Universe.

This is truly an enormous accomplishment. Consider the starting point of this admirable trek through heavens. Our senses, with which this trek begins, are severely restricted by being generally limited to the sphere of space and time that immediately surrounds us. The first grace of the spirit was thus to overcome the narrow enclosure im-



*Here,  
from His Observatory  
at Castel Gandolfo, Pope Paul  
the Sixth is speaking to you astronauts.  
Honor, greetings, and blessings to you,  
conquerors of the Moon, pale lamp  
of our nights and our dreams! Bring to her,  
with your living presence, the voice of the spirit,  
a hymn to God our Creator and our Father.  
We are close to you, with our good wishes  
and with our prayers. Together  
with the whole Catholic Church,  
Pope Paul the Sixth greets you.  
Pope Paul VI  
to the Apollo astronauts,  
July 21 (Rome time),  
1969*

posed on the senses due to the conditions of their own nature, by inventing the means of building ingenious instruments to increase the size and precision of their perception beyond all limits: the telescope, which

nearly annuls the enormous distances between the eye and the far stars, making them present and as if within reach; and the photographic plate, which collects and fixes the faintest light of the farthest nebulae.

With this increase of the senses' power by the human mind, gradually the spirit has employed this gained power to deepen our research into nature, inventing a thousand ingenious methods to unveil the most subtle and hidden phenomena. Thus, for example, it sums up the smallest effects over and over in order to obtain a perceptible integrated signal, inventing instruments



such as the photoelectric cell or the Wilson chamber to explore the finest atomic processes of radioactive matter and cosmic radiation. Searching ever more, it discovers the laws governing energetic processes and so can change forms of energy which are beyond the sphere of sensible perception – such as the electric waves of infra-red and ultra-violet radiation – into others which can enter into the realm of direct and very precise perception by the senses.

The spirit puts nature to the test in laboratory experiments from which it deduces laws, valid provisionally over the restricted conditions of its attempts. Not satisfied with this, it experiments and extends the radius of these experiments' application to the realm of observational astrophysics. The practical and theoretical knowledge of molecular spectra enable it to reach into the dense atmospheres of the gas giant planets and to verify the composition, tempera-

interprets astronomical spectral lines even before it is possible to obtain them in the laboratory, and explains where they belong and where they come from. The depths of the Sun's sphere itself cannot escape its penetrating glance, armed with astrophysical theories. It follows the dissociation of matter there, the nuclear processes that take place in the center of the Sun and which serve to provide the energy emitted by its radiation over thousands of millions of



*Left, above and below Pope Paul VI addressing the Apollo astronauts on the Moon, as a part of a world-wide broadcast of world leaders to the Moon on July 21, 1969. He is speaking from the dome of the Vatican Observatory's Schmidt telescope.*

*Right Pope Paul VI with the Director of the Vatican Observatory, Fr. Daniel O'Connell, observing the Moon in the finderscope of the Schmidt telescope, the night of the first Moon landings.*

ture, and density of their gas. Using the facts and the theories of spectroscopic science, it raises its inquisitive eyes to the fixed stars to reap exact knowledge of the composition, temperature, density and ionization of their mysterious atmospheres. With the help of modern quantum theory, the investigative spirit

years. The daring and brave human spirit cannot be stopped by the most formidable cataclysms of Novae or Supernovae. It measures the enormous speeds of ejected gas and tries to discover their causes. It embarks upon the trail of galaxies fleeing through space, retracing the journey they followed

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*So  
much of our world  
seems to be in fragments...  
But at the same time  
we see a growing critical openness  
towards people of different  
cultures and backgrounds...  
discovering values and experiences  
they have in common  
even within their diversities.*  
**Pope John Paul II**

over  
thou-  
sands of mil-  
lions of years of past time, and thus be-  
comes akin to a spectator of cosmic  
processes that took place at the dawn of  
creation.

What is then the spirit of this tiny  
being which is man, lost in the ocean of  
the material Universe, that it dares to  
ask its infinitesimally small senses to  
discover the face and history of the im-  
mense cosmos, and to have uncovered  
them both? There is only one possible  
answer, only one overwhelming fact –  
the human spirit belongs to a category  
of Being fundamentally different from  
matter, and superior to it, even though  
matter may be of unlimited dimen-  
sions.

### III. Eternal Creating Spirit

Finally a question comes sponta-  
neously to mind: would the path to  
which the human spirit has committed  
itself, in a way which unquestionably  
honors it up to now, be always open

before it? Will it follow this path with-  
out interruption until it discovers the  
last of the enigmas that the Universe  
keeps in store? Or, on the contrary, is  
the mystery of nature so ample and so  
hidden that the human spirit, because  
of its smallness and intrinsic dispro-  
portion, could never succeed in prob-  
ing it completely? The answer of those  
powerful minds who have penetrated  
the deepest into the secrets of cosmos  
is quite modest and reserved: they  
think we are at the beginning. So much  
of the path remains to be followed. It  
will be followed unremittingly;  
nonetheless, there is no likelihood that  
even the greatest researcher could ever  
succeed in knowing, and even less in  
solving, all the mysteries contained  
within the physical Universe. One may  
therefore postulate the existence of a  
Spirit infinitely greater, a divine Spirit  
that creates, conserves, governs and  
thus knows and penetrates in one  
supreme intuition, now as at the dawn  
of the first day of creation, all that ex-  
ists: *Spiritus Dei ferabatur super aquas*  
(the Spirit of God moved upon the face  
of the waters) (Gen 1: 2).

What a happy and sublime en-  
counter over the contemplation of the  
cosmos is that of the human spirit with  
the Spirit of the Creator! A Spirit truly  
divine, not a sort of “soul of the world”  
merged with the world as dreamed up  
by pantheism. The Universe of our ex-  
perience itself rebels against this error:  
it speaks of a composed whole in spite  
of its dynamic unity and shows, apart  
from its beauties and undeniable har-  
monies, clear imperfections, irreconcil-  
able with the divine fullness of Being.  
Divine Spirit, distinct and different  
from the world; not outside of the  
world, as if withdrawn in a disdainful  
solitude, abandoning its works to their  
destiny as deist theories assert; but on  
the contrary present in the world, as an  
almighty Creator, guardian and law-  
giver to whom the world is tied by an  
essential dependence in the heart of its

being and its action. The divine Spirit  
reveals itself from the coldness of space  
to the scientist open to finding a pur-  
pose for the whole of existing reality:  
Spirit moved by a breath of goodness  
and love penetrating and explaining all  
which focuses and reveals itself, partic-  
ularly in the human being made in its  
image and likeness. Because of this,  
this Spirit does not disdain from sur-  
rounding the human spirit with contin-  
uous and ineffable acts of love, such as





the redemption accomplished through its mysterious Incarnation. Similarly, the breadth of this conception of the Universe may have legitimately dethroned the ancient geocentric and anthropocentric ideas and thus, so to speak, shrunk our planet to the size of a grain of star dust and reduced man to the size of an atom on this speck of dust, relegating both to a corner of the Universe; but this does not represent (as some assert in speaking of the mys-

tery of Incarnation) an obstacle to the love or the almightiness of He who, being pure spirit, possesses an infinite superiority over matter, however great its cosmic dimensions in space, time, mass and energy.

As so, friends, above and beyond the deep respect which we entertain for all the sciences and for yours in particular, this is yet another reason why we are moved to pray: may the science of astronomy, founded on the highest and most universal horizons, the ideal of so many great men in the past such as Copernicus, Galileo, Kepler, and Newton, continue to bear the fruit of marvelous progress and, through to the heartfelt collaborations promoted by such groups as the International Astronomical Union, bring the astronomical vision of the Universe to an ever deeper perfection.

And finally, may the eternal light of God guide and enlighten you in your work, whose goal is to unveil the traces of His perfection and collect the echoes of His harmonies. Upon all those present we call heavenly favor, and as a token we invoke upon you Our Apostolic Blessing.

*As of 2009, we have seen much further than the astronomers of 1952, and we have been able to refine many of the distance calculations the Pope quotes here. Our current best estimates for the dimensions of the Milky Way have not changed much since then – the distance from our sun to the center of the Milky Way galaxy is now determined to be 26,000 light years – but new measurements place the Andromeda Galaxy a full 2.5 million light years from us. The most distant objects seen by our telescopes are in the Hubble Ultra Deep Field image (shown on page 173); it contains an estimated 10,000 galaxies, the most distant being more than 13 thousand million light years away, which means that their light was emitted just at*

*most about 800 million years after the Big Bang. And, of course, Pluto is no longer a considered a planet, but the first discovered representative of a different class of objects; the furthest “planet” of the solar system is therefore Neptune, and on average light from Neptune takes about 4 hours and 10 minutes to reach us. But a whole family of trans-Neptunian objects (of which Pluto was the first discovered) have now been seen, out to nearly 100 times the Earth-Sun distance or more than three times the distance to Neptune.*

LETTER OF HIS HOLINESS  
JOHN PAUL II  
TO REVEREND  
GEORGE V. COYNE, S.J.,  
DIRECTOR OF THE VATICAN  
OBSERVATORY  
(POPE JOHN PAUL II)

*I*n 1987 the Pontifical Academy of Sciences held a study week in honor of the 300th anniversary of the publication of Newton's Principia. Following that event, Pope John Paul II prepared a letter for publication with the proceedings of that study week, addressed to the editor of those proceedings, Fr. George Coyne S.J. then the director of the Vatican Observatory. In fitting with that occasion, this letter outlined the Pope's thoughts about the relationship between science and religion in a more complete and systematic way than had ever been done before. It has become a classic description of why we do our science.

*We reprint it here in full:*

*Opposite Pope John Paul II examines a model of the Large Binocular Telescope with its designer, Dr. Roger Angel of the University of Arizona, and Fr. George Coyne, director of the Vatican Observatory, in Phoenix, Arizona, in 1987.*





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“Grace to you and peace from God our Father and the Lord Jesus Christ” (Eph. 1,2).

As you prepare to publish the papers presented at the Study Week held at Castel Gandolfo on 21-26 September 1987, I take the occasion to express my gratitude to you and through you to all who contributed to that important initiative. I am confident that the publication of these papers will ensure that the fruits of that endeavor will be further enriched.

The three hundredth anniversary of the publication of Newton’s *Philosophiae Naturalis Principia Mathematica* provided an appropriate occasion for the Holy See to sponsor a Study Week that investigated the multiple relationships among theology, philosophy and the natural sciences. The man so honored, Sir Isaac Newton, had himself devoted much of his life to these same issues, and his reflections upon them can be found throughout his major works, his unfinished manuscripts and his vast correspondence. The publication of your own papers from this Study Week, taking up again some of the same questions which this great genius explored, affords me the opportunity to thank you for the efforts you devoted to a subject of such paramount importance. The theme of your conference, “Our Knowledge of God and Nature: Physics, Philosophy and Theology”, is assuredly a crucial one for the contemporary world. Because of

its importance, I should like to address some issues which the interactions among natural science, philosophy, and theology present to the Church and to human society in general.

The Church and the Academy engage one another as two very different but major institutions within human civilization and world culture. We bear before God enormous responsibilities for the human condition because historically we have had and continue to have a major influence on the development of ideas and values and on the course of human action. We both have histories stretching back over thousands of years: the learned, academic community dating back to the origins of culture, to the city and the library

...Each discipline should continue to enrich, nourish and challenge the other to be more fully what it can be and to contribute to our vision of who we are and who we are becoming.  
**Pope John Paul II**

and the school, and the Church with her historical roots in ancient Israel. We have come into contact often during these centuries, sometimes in mutual support, at other times in those needless conflicts which have marred both



*Above* As the feast of St. Ignatius Loyola, the founder of the Jesuit order, occurs on July 31 while the Pope is in residence in Castel Gandolfo, it is not unusual for the Popes to invite members of the Jesuit community to celebrate Mass with him on that day. Present here with His Holiness in 1994, were (from left) Sabino Maffeo, Gary Menard, José Funes, and Richard Boyle. At that time, Meynard and Funes were scholastics, not yet ordained. Today, Fr. Meynard is assistant headmaster at the Arrupe Jesuit High School in Denver, Colorado and Fr. Funes is now director of the Vatican Observatory.



our histories. In your conference we met again, and it was altogether fitting that as we approach the close of this millennium we initiated a series of reflections together upon the world as we touch it and as it shapes and challenges our actions.

So much of our world seems to be in fragments, in disjointed pieces. So much of human life is passed in isolation or in hostility. The division between rich nations and poor nations continues to grow; the contrast between northern and southern regions of our planet becomes ever more marked and intolerable. The antagonism between races and religions splits countries into warring camps; historical animosities show no signs of abating. Even within the academic community, the separation between truth and values persists, and the isolation of their several cultures – scientific, humanistic and religious – makes common discourse difficult if not at times impossible.

But at the same time we see in large sectors of the human community a growing critical openness towards people of different cultures and backgrounds, different competencies and

viewpoints. More and more frequently, people are seeking intellectual coherence and collaboration, and are discovering values and experiences they have in common even within their diversities. This openness, this dynamic interchange, is a notable feature of the international scientific communities themselves, and is based on common interests, common goals and a common enterprise, along with a deep awareness that the insights and attainments of one are often important for the progress of the other. In a similar but more subtle way this has occurred and is continuing to occur among more diverse group – among the communities that make up the Church, and even between the scientific community and the Church herself. This drive is essentially a movement towards the kind of unity which resists homogenization and relishes diversity. Such community is determined by a common meaning and by a shared understanding that evokes a sense of mutual involvement. Two groups which may seem initially to have nothing in common can begin to enter into community with one another by discovering a common goal, and this in turn can lead to broader areas of

shared understanding and concern.

As never before in her history, the Church has entered into the movement for the union of all Christians, fostering common study, prayer, and discussions that “all may be one” (Jo. 17,20). She has attempted to rid herself of every vestige of antisemitism and to emphasize her origins in and her religious debt to Judaism. In reflection and prayer, she has reached out to the great world religions, recognizing the values we all hold in common and our universal and utter dependence upon God.

Within the Church herself, there is a growing sense of “world church”, so much in evidence at the last Ecumenical Council in which bishops native to every continent – no longer predominantly of European or even Western origin – assumed for the first time their common responsibility for the entire

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*Top* Present here with Pope John Paul II in on the feast of St. Ignatius in 1995 are Br. Guy Consolmagno, Fr. William Stoeger, Fr. Sabino Maffeo, and Mr. David Brown. Brown, then a scholastic in the early stages of his Jesuit studies, was only visiting the Specola that summer. He would finally join the Observatory full time upon completing his doctorate in astrophysics from Oxford in 2008.



Church. The documents from that Council and of the magisterium have reflected this new world-consciousness both in their content and in their attempt to address all people of good will. During this century, we have witnessed a dynamic tendency to reconciliation and unity that has taken many forms within the Church.

Nor should such a development be surprising. The Christian community in moving so emphatically in this direction is realizing in greater intensity the activity of Christ within her: "For God was in Christ, reconciling the world to himself" (2Cor. 5,19). We ourselves are called to be a continuation of the reconciliation of human beings, one with another and all with God. Our very nature as Church entails this commitment to unity.

Turning to the relationship between religion and science, there has been a definite, though still fragile and provisional, movement towards a new and more nuanced interchange. We have begun to talk to one another on deeper levels than before, and with greater openness towards one another's perspectives. We have begun to search together for a more thorough understanding of one another's disciplines, with their competencies and their limitations, and especially for areas of common ground. In doing so we have uncovered important questions which concern both of us, and which are vital to the larger human communi-

ty we both serve. It is crucial that this common search based on critical openness and interchange should not only continue but also grow and deepen in its quality and scope.

For the impact each has, and will continue to have, on the course of civilization and on the world itself, cannot be overestimated, and there is so much that each can offer the other. There is, of course, the vision of the unity of all things and all peoples in Christ, who is active and present with us in our daily lives – in our struggles, our sufferings, our joys and in our searchings – and who is the focus of the Church's life and witness. This vision carries with it into the larger community a deep reverence for all that is, a hope and assurance that the fragile goodness, beauty and life we see in the universe is moving towards a completion and fulfilment which will not be overwhelmed by the forces of dissolution and death. This vision also provides a strong support for the values which are emerging both from our knowledge and appreciation of creation and of ourselves as the products, knowers and stewards of creation.

The scientific disciplines too, as is obvious, are endowing us with an understanding and appreciation of our universe as a whole and of the incredibly rich variety of intricately related processes and structures which constitute its animate and inanimate components. This knowledge has given us a more thorough understanding of ourselves and of our humble yet unique role within creation. Through technology it also has given us the capacity to travel, to communicate, to build, to cure, and to probe in ways which would have been almost unimaginable to our ancestors. Such knowledge and power, as we have discovered, can be used greatly to enhance and improve our lives or they

can be exploited to diminish and destroy human life and the environment even on a global scale.

The unity we perceive in creation on the basis of our faith in Jesus Christ as Lord of the universe, and the correlative unity for which we strive in our human communities, seems to be reflected and even reinforced in what contemporary science is revealing to us. As we behold the incredible development of scientific research we detect an underlying movement towards the discovery of

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and its own conclusions.  
Pope John Paul II*

levels  
of law and  
process which unify  
created reality and which at the same  
time have given rise to the vast diversity of structures and organisms which constitute the physical and biological, and even the psychological and sociological, worlds.



Contemporary physics furnishes a striking example. The quest for the unification of all four fundamental physical forces – gravitation, electromagnetism, the strong and weak nuclear interactions – has met with increasing success. This unification may well combine discoveries from the sub-atomic and the cosmological domains and shed light both on the origin of the universe and, eventually, on the origin of the laws and constants which govern its evolution. Physicists possess a detailed though incomplete and provisional knowledge of elementary particles and of the fundamental forces through which they interact at low and intermediate energies. They now have an acceptable theory unifying the electromagnetic and weak nuclear forces, along with much less adequate but still promising grand unified field theories which attempt to incorporate the strong nuclear interaction as well. Further in the fine of this same development, there are already several detailed suggestions for the final stage, superunification, that is, the unification of all four fundamental forces, including gravity. Is it not important for us to note that in a world of such detailed specialization as contemporary physics there exists this drive towards convergence?

In the life sciences, too, something similar has happened. Molecular biologists have probed the structure of living material, its functions and its processes of replication. They have discovered that the same underlying constituents serve in the make-up of all living organisms on earth and constitute both the genes and the proteins which these genes code. This is another impressive manifestation of the unity of nature.

By encouraging openness between the Church and the scientific communities, we are not envisioning a disciplinary unity between theology and science like that which exists within a given scientific field or within theology

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Pope John Paul II*

proper. As dialogue and common searching continue, there will be growth towards mutual understanding and a gradual uncovering of common concerns which will provide the basis for further research and discussion. Exactly what form that will take must be left to the future. What is important, as we have already stressed, is that the dialogue should continue and grow in depth and scope. In the process we must overcome every regressive tendency to a unilateral reductionism, to fear, and to self-imposed isolation. What is critically important is that each discipline should continue to enrich, nourish and challenge the other to be more fully what it can be and to contribute to our vision of who we are and who we are becoming.

We might ask whether or not we are ready for this crucial endeavor. Is the community of world religions, including the Church, ready to enter into a more thorough-going dialogue with the scientific community, a dialogue in which the integrity of both religion and science is supported and the advance of each is fostered? Is the scientific community now prepared to open itself to Christianity, and indeed to all the great world religions, working with us all to build a culture that is more humane and in that way more divine? Do we dare to risk the honesty and the courage that this task demands? We must ask ourselves whether both science and religion will contribute to the

integration of human culture or to its fragmentation. It is a single choice and it confronts us all.

For a simple neutrality is no longer acceptable. If they are to grow and mature, peoples cannot continue to live in separate compartments, pursuing totally divergent interests from which they evaluate and judge their world. A divided community fosters a fragmented vision of the world; a community of interchange encourages its members to expand their partial perspectives and form a new unified vision.

Yet the unity that we seek, as we have already stressed, is not identity. The Church does not propose that science should become religion or religion science. On the contrary, unity always presupposes the diversity and the integrity of its elements. Each of these members should become not less itself but more itself in a dynamic interchange, for a unity in which one of the elements is reduced to the other is destructive, false in its promises of harmony, and ruinous of the integrity of its components. We are asked to become one. We are not asked to become each other.

To be more specific, both religion and science must preserve their autonomy and their distinctiveness. Religion is not founded on science nor is science an extension of religion. Each should possess its own principles, its pattern of procedures, its diversities of interpretation and its own conclusions. Christianity possesses the source of its justification within itself and does not expect science to constitute its primary apologetic. Science must bear witness to its own worth. While each can and should support the other as distinct dimensions of a common human culture, neither ought to assume that it forms a necessary premise for the other. The unprecedented opportunity we have today is for a common interactive relationship in which each discipline re-

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tains its integrity and yet is radically open to the discoveries and insights of the other.

But why is critical openness and mutual interchange a value for both of us? Unity involves the drive of the human mind towards understanding and the desire of the human spirit for love. When human beings seek to understand the multiplicities that surround them, when they seek to make sense of experience, they do so by bringing many factors into a common vision. Understanding is achieved when many data are unified by a common structure. The one illuminates the many: it makes sense of the whole. Simple multiplicity is chaos; an insight, a single model, can give that chaos structure and draw it into intelligibility. We move towards unity as we move towards meaning in our lives. Unity is also the consequence of love. If love is genuine, it moves not towards the assimilation of the other but towards union with the other. Human community begins in desire when that union has not been achieved, and it is completed in joy when those who have been apart are now united.

In the Church's earliest documents, the realization of community, in the radical sense of that word, was seen as the promise and goal of the Gospel: "That which we have seen and heard we proclaim also to you, so that you may have fellowship with us; and our fellowship is with the Father and

with his Son Jesus Christ. And we are writing this that our joy may be complete" (1Jo. 1,3-4). Later the Church reached out to the sciences and to the arts, founding great universities and building monuments of surpassing beauty so that all things might be recapitulated in Christ (Cfr. Eph. 1,10).

What, then, does the Church encourage in this relational unity between science and religion? First and foremost that they should come to understand one another. For too long a time they have been at arm's length. Theology has been defined as an effort of faith to achieve understanding, as *fides quaerens intellectum*. As such, it must be in vital interchange today with science just as it always has been with philosophy and other forms of learning. Theology will have to call on the findings of science to one degree or another as it pursues its primary concern for the human person, the reaches of freedom, the possibilities of Christian community, the nature of belief and the intelligibility of nature and history. The vitality and significance of theology for humanity will in a profound way be reflected in its ability to incorporate these findings.

Now this is a point of delicate importance, and it has to be carefully qualified. Theology is not to incorporate indifferently each new philosophical or scientific theory. As these findings become part of the intellectual culture of the time, however, theologians must understand them and test their value in bringing out from Christian belief some of the possibilities which have not yet been realized. The

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**Pope John Paul II**



*Right Faculty and students  
of the 2007 Vatican Observatory Summer School  
in audience with His Holiness Pope Benedict XVI.*



hylomorphism of Aristotelian natural philosophy, for example, was adopted by the medieval theologians to help them explore the nature of the sacraments and the hypostatic union. This did not mean that the Church adjudicated the truth or falsity of the Aristotelian insight, since that is not her concern. It did mean that this was one of the rich insights offered by Greek culture, that it needed to be understood and taken seriously and tested

for its value in illuminating various areas of theology. Theologians might well ask, with respect to contemporary science, philosophy and the other areas of human knowing, if they have accomplished this extraordinarily difficult process as well as did these medieval masters.

If the cosmologies of the ancient Near Eastern world could be purified and assimilated into the first chapters of Genesis, might not contemporary

cosmology have something to offer to our reflections upon creation? Does an evolutionary perspective bring any light to bear upon theological anthropology, the meaning of the human person as the *imago Dei*, the problem of Christology – and even upon the development of doctrine itself? What, if any, are the eschatological implications of contemporary cosmology, especially in light of the vast future of our universe? Can theological method fruitful-





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long ago recognized the importance of such links by establishing the Pontifical Academy of Sciences, in which some of the world's leading scientists meet together regularly to discuss their researches and to convey to the larger community where the directions of discovery are tending. But much more is needed.

*Galileo  
saw nature  
as a book  
whose author is God  
in the same way  
that Scripture  
has God  
as its author.  
Pope Benedict XVI*

ly appropriate insights from scientific methodology and the philosophy of science?

Questions of this kind can be suggested in abundance. Pursuing them further would require the sort of intense dialogue with contemporary science that has, on the whole, been lacking among those engaged in theological research and teaching. It would entail that some theologians, at least, should be sufficiently well-versed in the sciences to make authentic and creative use of the resources that the best-established theories may offer them. Such an expertise would prevent them from making uncritical and overhasty use for apologetic purposes of such recent theories as that of the "Big Bang" in cosmology. Yet it would equally keep them from discounting altogether the potential relevance of such theories to the deepening of understanding in traditional areas of theological inquiry.

In this process of mutual learning, those members of the Church who are themselves either active scientists or, in some special cases, both scientists and theologians could serve as a key resource. They can also provide a much-needed ministry to others struggling to integrate the worlds of science and religion in their own intellectual and spiritual lives, as well as to those who face difficult moral decisions in matters of technological research and application. Such bridging ministries must be nurtured and encouraged. The Church

The matter is urgent. Contemporary developments in science challenge theology far more deeply than did the introduction of Aristotle into Western Europe in the thirteenth century. Yet these developments also offer to theology a potentially important resource. Just as Aristotelian philosophy, through the ministry of such great scholars as St Thomas Aquinas, ultimately came to shape some of the most profound expressions of theological doctrine, so can we not hope that the sciences of today, along with all forms of human knowing, may invigorate and inform those parts of the theological enterprise that bear on the relation of nature, humanity and God?

Can science also benefit from this interchange? It would seem that it should. For science develops best when its concepts and conclusions are integrated into the broader human culture and its concerns for ultimate meaning and value. Scientists cannot, therefore, hold themselves entirely aloof from the sorts of issues dealt with by philoso-

*Right* Fernando Comerón, an expert on star formation and brown dwarfs at the European Southern Observatory, was an alumnus of the 1990 Vatican Observatory Summer School and one of the instructors at the 2007 school. Here he introduces his daughter Ines to His Holiness Pope Benedict XVI at the Pope's audience with the 2007 school.



phers and theologians. By devoting to these issues something of the energy and care they give to their research in science, they can help others realize more fully the human potentialities of their discoveries. They can also come to appreciate for themselves that these discoveries cannot be a genuine substitute for knowledge of the truly ultimate. Science can purify religion from error and superstition; religion can purify science from idolatry and false ab-

solutes. Each can draw the other into a wider world, a world in which both can flourish.

For the truth of the matter is that the Church and the scientific community will inevitably interact; their options do not include isolation. Christians will inevitably assimilate the prevailing ideas about the world, and today these are deeply shaped by science. The only question is whether they will do this critically or unreflectively, with depth and nuance or with a shallowness that debases the Gospel and leaves us ashamed before history. Scientists, like all human beings, will make decisions upon what ultimately gives meaning and value to their lives and to their work. This they will do well or poorly, with the reflective depth that theological wisdom can help them attain, or with an unconsidered absolutizing of their results beyond their reasonable and proper limits.

Both the Church and the scientific community are faced with such inescapable alternatives. We shall make our choices much better if we live in a collaborative interaction in which we are called continually to be more. Only a dynamic relationship between theology and science can reveal those limits which support the integrity of either discipline, so that theology does not profess a pseudo-science and science does not become an unconscious theology. Our knowledge of each other can lead us to be more authentically ourselves. No one can read the history of the past century and not realize that crisis is upon us both. The uses of science have on more than one occasion





ADDRESS TO THE 2007  
VATICAN OBSERVATORY  
SUMMER SCHOOL  
(POPE BENEDICT XVI)

Pope Benedict XVI addressed these comments to the students of the 11th Vatican Observatory Summer School in Astrophysics in June, 2007. While aimed primarily for those twenty six students from around the world, they also express his devotion to our work and the hopes that come with the participation of the Vatican in the wider world of astronomy.

proved massively destructive, and the reflections of religion have too often been sterile. We need each other to be what we must be, what we are called to be.

And so on this occasion of the Newton Tercentennial, the Church speaking through my ministry calls upon herself and the scientific community to intensify their constructive relations of interchange through unity. You are called to learn from one another, to renew the context in which science is done and to nourish the inculturation which vital theology demands. Each of you has everything to gain from such an interaction, and the human community which we both serve has a right to demand it from us.

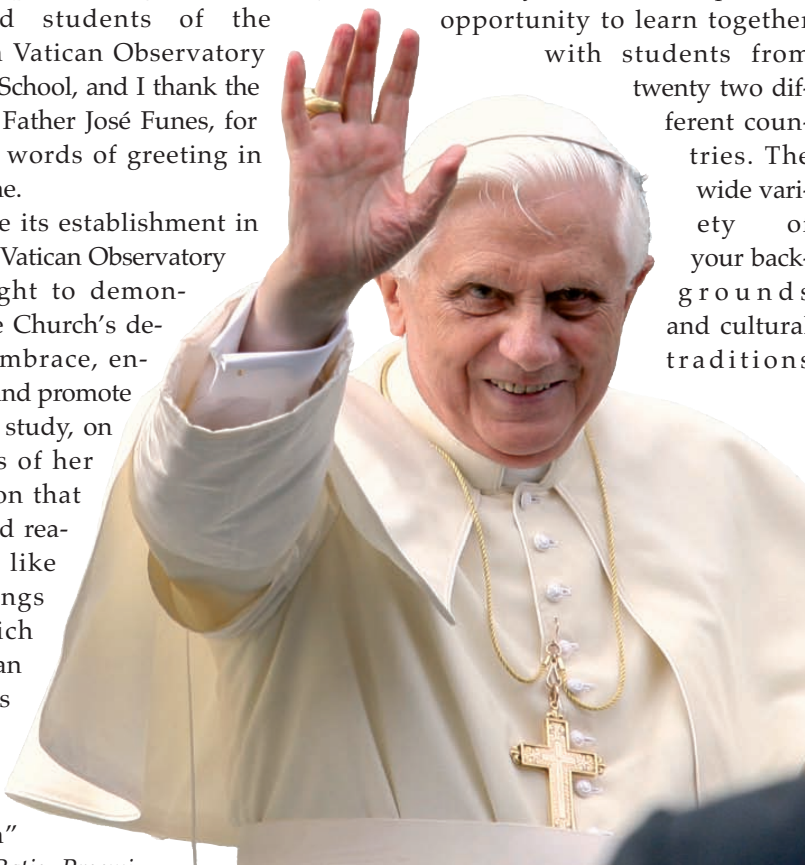
Upon all who participated in the Study Week sponsored by the Holy See and upon all who will read and study the papers herein published I invoke wisdom and peace in our Lord Jesus Christ and cordially impart my Apostolic Blessing.

*From the Vatican, 1 June, 1988.  
Joannes Paulus P.P. II*

I am pleased to greet the faculty and students of the Eleventh Vatican Observatory Summer School, and I thank the Director, Father José Funes, for his kind words of greeting in your name.

Since its establishment in 1891, the Vatican Observatory has sought to demonstrate the Church's desire to embrace, encourage and promote scientific study, on the basis of her conviction that "faith and reason are like two wings on which the human spirit rises to the contemplation of truth" (*Fides et Ratio, Proemium*). The Jesuit Fathers and Brothers who staff the Observatory are not only involved in astronomical research, but are also committed to offering educational opportunities for the next generation of astronomers. The Vatican Observatory Summer School is a concrete sign of that commitment.

Your program this month is devoted to the study of Extrasolar Planets. In addition to your demanding research, however, you will have a precious opportunity to learn together with students from twenty two different countries. The wide variety of your backgrounds and cultural traditions



can be a source of great enrichment to you all. I encourage you to make the most of this experience, and I offer my prayerful good wishes that your small international community may become a promising sign of greater scientific collaboration for the benefit of the entire human family.

In the days to come, may you find spiritual consolation in the study of the stars that “shine to delight their Creator” (Bar 3:35). Upon you and your families I cordially invoke God’s blessings of wisdom, joy and peace.

Pope Benedict XVI,  
11 June, 2007

ADDRESS  
TO THE PONTIFICAL  
ACADEMY OF SCIENCES, 2008  
(POPE BENEDICT XVI)

Pope Benedict touched on a number of issues involving both biology and astronomy in his address to the plenary session of the PAS in October, 2008. In the following address, three points are notable. First, in much the same way expressed in Fr. Stoeger’s article about Creation and the Big Bang, the Pope draws a clear distinction between God as primary cause in the realm of the life sciences, and the function of those sciences to describe “not creation, but rather a mutation or transformation” of that which has been created. (One also hears an echo of his comments on the role of mathematics in Fr. Whitman’s chapter.) Of course, the basic theology can be found in Aquinas – hearkening back to the very first essay in this chapter, from Pope Leo XIII. Second, it is interesting to see how Pope Benedict XVI quotes Galileo as an authority on the nature of the relationship between faith and science. And finally, note how the trend discussed at the beginning of this chapter has become complete. Where, a hundred years ago, the Church viewed science as an apologetic tool supporting well-established doctrine, now with Pope Benedict XVI we also see the scientific understanding of Creation as itself providing the knowledge to enrich our theological understanding of the Creator.

*The laws  
of nature...  
are a great incentive  
to contemplate  
the works  
of the Lord  
with gratitude.*  
Pope Benedict XVI

In choosing the topic Scientific Insight into the Evolution of the Universe and of Life, you seek to focus on an area of enquiry which elicits much interest. In fact, many of our contemporaries today wish to reflect upon the ultimate origin of beings, their cause and their end, and the meaning of human history and the universe.

In this context, questions concerning the relationship between science’s reading of the world and the reading offered by Christian Revelation naturally arise. My predecessors Pope Pius XII and Pope John Paul II noted that there is no opposition between faith’s understanding of creation and the evidence of the empirical sciences. Philosophy in its early stages had proposed images to explain the origin of the cosmos on the basis of one or more elements of the material world. This genesis was not seen as a creation, but rather a mutation or transformation; it involved a somewhat horizontal interpretation of the origin of the world. A decisive advance in understanding the origin of the cosmos was the consideration of being *qua* being and the concern of metaphysics with the most basic question of the first or transcendent origin of participated being. In order to develop and evolve, the world must first be, and thus have come from nothing into being. It must be created, in other words, by the first Being who is such by essence.

To state that the foundation of the

cosmos and its developments is the provident wisdom of the Creator is not to say that creation has only to do with the beginning of the history of the world and of life. It implies, rather, that the Creator founds these developments and supports them, underpins them and sustains them continuously. Thomas Aquinas taught that the notion of creation must transcend the horizontal origin of the unfolding of events, which is history, and consequently all our purely naturalistic ways of thinking and speaking about the evolution of the world. Thomas observed that creation is neither a movement nor a mutation. It is instead the foundational and continuing relationship that links the creature to the Creator, for he is the cause of every being and all becoming (cf. *Summa Theologiae*, I, q.45, a. 3).

To “evolve” literally means “to unroll a scroll”, that is, to read a book. The imagery of nature as a book has its roots in Christianity and has been held dear by many scientists. Galileo saw nature as a book whose author is God in the same way that Scripture has God as its author. It is a book whose history, whose evolution, whose “writing” and meaning, we “read” according to the different approaches of the sciences, while all the time presupposing the foundational presence of the author who has wished to reveal himself therein. This image also helps us to understand that the world, far from originating out of chaos, resembles an ordered book; it is a cosmos. Notwithstanding elements of the irrational, chaotic and the destructive in the long processes of change in the cosmos, matter as such is “legible”. It has an in-built “mathematics”. The human mind therefore can engage not only in a “cosmography” studying measurable phenomena but also in a “cosmology” discerning the visible inner logic of the cosmos. We may not at first be able to see the harmony both of the whole and of the relations of the individual parts,



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2003: “scientific truth, which is itself a participation in divine Truth, can help philosophy and theology to understand ever more fully the human person and God’s Revelation about man, a Revelation that is completed and perfected in Jesus Christ. For this important mutual enrichment in the search for the truth and the benefit of mankind, I am, with the

*There is  
a special  
concept  
of the cosmos  
in Christianity.  
Pope Benedict XVI*

or their relationship to the whole. Yet, there always remains a broad range of intelligible events, and the process is rational in that it reveals an order of evident correspondences and undeniable finalities: in the inorganic world, between microstructure and macrostructure; in the organic and animal world, between structure and function; and in the spiritual world, between knowledge of the truth and the aspiration to freedom. Experimental and philosophical inquiry gradually discovers these orders; it perceives them working to maintain themselves in being, defending themselves against imbalances, and overcoming obstacles. And thanks to the natural sciences we have greatly increased our understanding of the uniqueness of humanity’s place in the cosmos.

The distinction between a simple living being and a spiritual being that is *capax Dei*, points to the existence of the intellectual soul of a free transcendent subject. Thus the Magisterium of the Church has constantly affirmed that “every spiritual soul is created immediately by God – it is not ‘produced’ by the parents – and also that it is immortal” (Catechism of the Catholic Church, 366). This points to the distinctiveness of anthropology, and invites exploration of it by modern thought.

Distinguished Academicians, I wish to conclude by recalling the words addressed to you by my predecessor Pope John Paul II in November



whole Church, profoundly grateful”.

Upon you and your families, and all those associated with the work of the Pontifical Academy of Sciences, I cordially invoke God’s blessings of wisdom and peace.

31 October 2008

Pope Benedict XVI became one of the first world leaders to salute the International Year of Astronomy. Speaking at his weekly prayer of the Angelus at St. Peter’s Square on the winter solstice, 2008, he summarized the long history of astronomy and the Popes:

from: ADDRESS  
AT THE WEEKLY ANGELUS  
(POPE BENEDICT XVI)

Beyond its historical dimension, this mystery of salvation also has a cosmic dimension: Christ is the sun of grace who, with his life, “transfigures and enflames the expectant universe” (cf. Liturgy). The Christmas festivity is placed within and linked to the winter solstice when, in the northern

hemisphere, the days begin once again to lengthen. In this regard perhaps not everyone knows that in St Peter’s Square there is also a meridian; in fact, the great obelisk casts its shadow in a line that runs along the paving stones toward the fountain beneath this window and in these days, the shadow is at its longest of the year. This reminds us of the role of astronomy in setting the times of prayer. The Angelus, for example, is recited in the morning, at noon and in the evening, and clocks were regulated by the meridian which in ancient times made it possible to know the “exact midday”.

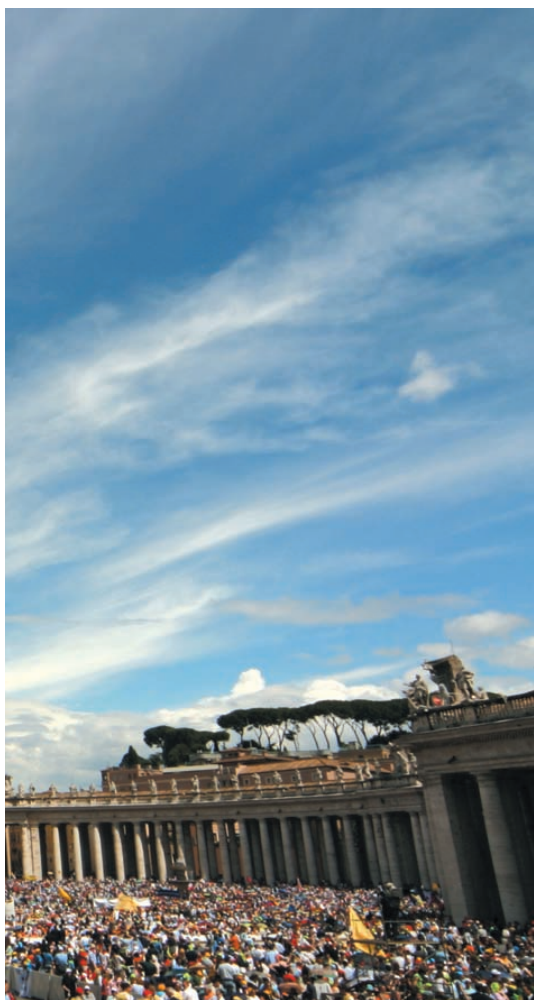
The fact that the winter solstice occurs exactly today, 21 December, and at this very time, offers me the opportunity to greet all those who will be taking part in various capacities in the initiatives for the World Year of Astronomy, 2009, established on the fourth centenary of Galileo Galilei’s first observations by telescope. Among my Predecessors of venerable memory there were some who studied this science, such as Sylvester II who taught it, Gregory XIII to whom we owe our calendar, and St Pius X who knew how to build sundials. If the heavens, according to the Psalmist’s beautiful words, “are telling the glory of God” (Ps 19[18]:1), the laws of nature which over the course of centuries many men and women of science have enabled us to understand better are a great incentive to contemplate the works of the Lord with gratitude.

*St Peter’s Square  
Fourth Sunday of Advent,  
21 December 2008*

from:  
HOMILY ON THE SOLEMNITY  
OF THE EPIPHANY  
OF THE LORD  
(POPE BENEDICT XVI)

*In his address to the Pontifical Academy of Sciences, above, Pope Benedict quoted his predecessor John Paul II that “scientific truth... can help philosophy and theology to understand ever more fully the human person and God’s Revelation about man.” Two months after that address, in his homily on the feast of the Wise Men, he showed how this can be done. Here, theology and astronomy are woven together into a beautiful image of the Incarnation:*

In this year 2009, which has been dedicated in a special way to astronomy to mark the fourth centenary of Galileo Galilei’s first observations with the telescope, we cannot fail to pay particular attention to the symbol of the star that is so important in the Gospel account of the Magi (cf. Mt 2:1-12). In all likelihood the Wise Men were astronomers. From their observation point, situated in the East compared to Palestine, perhaps in Mesopotamia, they had noticed the appearance of a new star and had interpreted this celestial phenomenon as the announcement of the birth of a king, specifically that in accordance with the Sacred Scriptures of the King of the Jews (cf. Nm 24:17). The Fathers of the Church also saw this unique episode recounted by St Matthew as a sort of cosmic “revolution” caused by the Son of God’s entry into the world. For example, St John Chrysostom writes: “The star, when it stood over the young Child, stayed its course again: which thing itself was of a greater power than belongs to a star, now to hide itself, now to appear, and having appeared to stand still” (Homily on the Gospel of Matthew 7, 3). St Gregory of





Nazianzen states that the birth of Christ gave the stars new orbits (cf. *Dogmatic Poems*, v, 53-64: PG 37, 428-429). This is clearly to be understood in a symbolic and theological sense. In effect, while pagan theology divinized the elements and forces of the cosmos, the Christian faith, in bringing the biblical Revelation to fulfillment, contemplates only one God, Creator and Lord of the whole universe.

The divine and universal law of creation is divine love, incarnate in Christ. However, this should not be understood in a poetic but in a real sense. Moreover, this is what Dante himself meant when, in the sublime verse that concludes the *Paradiso* and the entire *Divina Commedia*, he describes God as “the Love which moves the sun and the other stars” (*Paradiso*, XXXIII, 145). This means that the stars, planets and the whole universe are not governed by a blind force, they do not obey the dynamics of matter alone. Therefore, it is not the cosmic elements that should be divinized. Indeed, on the contrary, within everything and at the same time above everything there is a personal will, the Spirit of God, who in Christ has revealed himself as Love (cf. Encyclical *Spe Salvi*, 5). If this is the case, then as St Paul wrote to the Colossians people are not slaves of the “elemental spirits of the universe” (cf. Col 2:8) but are free, that is, capable of relating to the creative freedom of God. God is at the origin of all things and

governs all things, not as a cold and anonymous engine but rather as Father, Husband, Friend, Brother and as the Logos, “Word-Reason” who was united with our mortal flesh once and for all and fully shared our condition, showing the superabundant power of his grace. Thus there is a special concept of the cosmos in Christianity which found its loftiest expression in medieval philosophy and theology. In our day too, it shows interesting signs of a new flourishing,

thanks to the enthusiasm and faith of many scientists who following in Galileo’s footsteps renounce neither reason nor faith; instead they develop both in their reciprocal fruitfulness.

Christian thought compares the cosmos to a “book” the same Galileo said this as well considering it as the work of an Author who expresses himself in the “symphony” of the Creation. In this symphony is found, at a certain point, what might be called in musical terminology a “solo”, a theme given to a single instrument or voice; and it is so important that the significance of the entire work depends on it. This “solo” is Jesus, who is accompanied by a royal sign: the appearance of a new star in the firmament. Jesus is compared by ancient Christian writers to a new sun. According to current astrophysical knowledge, we should compare it with a star that is even more central, not only for the solar system but also for the entire known universe. Within this mysterious design simultaneously physical and metaphysical, which led to the appearance of the human being as the crowning of Cre-

ation’s elements Jesus came into the world: “born of woman” (Gal 4:4), as St Paul writes. The Son of man himself epitomizes the earth and Heaven, the Creation and the Creator, the flesh and the Spirit. He is the centre of the cosmos and of history, for in him the Author and his work are united without being confused with each other.

St Peter’s Basilica  
Tuesday, 6 January 2009

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Pope Benedict XVI*

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*Texts of the Papal speeches to the PAS reprinted here  
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