

DISCOURSES OF THE POPES
FROM
PIUS XI TO JOHN PAUL II
TO THE PONTIFICAL ACADEMY
OF SCIENCES
1936-1986



PONTIFICIA
ACADEMIA
SCIENTIARVM

EX AEDIBVS ACADEMICIS IN CIVITATE VATICANA

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INTRODUCTION

I have the honour of introducing the discourses addressed to the Pontifical Academy of Sciences by the Supreme Pontiffs Pius XI, Pius XII, John XXIII, Paul VI and John Paul II over the fifty years from 1936 to 1986.

With his discourse of 12 January 1936, Pius XI announced the forthcoming renewal of the Pontifical Academy "dei Nuovi Lincei", which would take the place of the ancient Academy "dei Lincei" founded by Federico Cesi in the Christmas of 1603. With the successive Motu proprio, In multis solaciis, of 28 October 1936, Pius XI instituted the Pontificia Academia Scientiarum and defined its rôle by assigning it the title of scientific Senate (Senatus scientificus) of the Holy See, recognising in it the legitimate autonomy of scientific research in its own field.

The discourses of the Popes given to the Pontifical Academy of Sciences on the various occasions of its Plenary Sessions, Study Weeks and Working Groups, express at the highest level the agreement which must exist between science and religion, between technology and morality. The Popes have taught that, in principle, there cannot exist a contradiction between religion and science; when this does in fact occur, it derives from a faulty reading of the book of nature or the book of Divine Revelation. Both books have been written by God and thus enjoy a perfect harmony which flows from their one infallible Author; but the human mind is weak when it does not enjoy special divine enlightenment in the reading of the Sacred Books.

The Pontifical discourses of Pius XI, Pius XII, John XXIII, Paul VI and John Paul II collected together in this volume, express in addition the need for a technology constantly dependent upon and related to a respect for the human person, for his dignity, for his fundamental rights. Both the most advanced methods of scientific research and all the possible practical applications of science must be at the service of man.

The Popes, experts in humanity and universally recognized as the highest guardians of moral principles and of their consequences, have enunciated in their discourses to the Pontifical Academy of Sciences the guidelines flowing from human reason illuminated by Divine Wisdom which must be respected by technocrats, by economic and political powers, so that science and technology may promote the true good of man, of each man and of all men.

The Popes, raising the conclusions of the Pontifical Academy of Sciences to the level of high moral teaching, have, on various occasions, given a particular interest to conditions in developing countries, to which the Academy has dedicated Study Weeks and Working Groups in the spheres of nutrition, health, ecology and energy.

A particular study has been dedicated by the Academy to the themes of war and peace. The Supreme Pontiffs, and in particular Pope John Paul II, have, during these last years of a growing threat of world conflict involving nuclear and conventional weapons, conferred a high prestige upon the initiatives of the Academy and have indicated to scientists the true and useful ways research may proceed, and indicated to governments the task of trusting collaboration for the peace of all peoples.

I would like to thank warmly the Bank Piccolo Credito Valtellinese for the generous contribution offered towards the publication of the present volume.

With the publication of the present discourses addressed to the entire scientific community, the Pontifical Academy of Sciences intends to express to the Supreme Pontiffs sentiments of the deepest gratitude and admiration.

CARLOS CHAGAS

President of the Pontifical Academy of Sciences

DISCOURSES
OF
HIS HOLINESS POPE PIUS XI



Discourse of His Holiness Pope Pius XI on 12 January 1936 given to inaugurate the Academic Year of the Pontifical Academy of Sciences "I Nuovi Lincei".

The Holy Father said that he was especially and doubly grateful and happy to be with his beloved sons from the Pontifical Academy of Sciences. Doubly pleased, he said, because he was not only inaugurating the new academic year but also, so to speak, the new President, Father Gemelli, who had, among other things, so opportunely called to mind the temporary but real merits of Mgr. Morano. Happy and grateful always to be among the members of his Academy for very important and profound reasons; it sufficed to say that while, by the hidden divine plan the Magisterium of Faith rested with him, the magisterium of science could be perceived, in a certain sense, as resting with these beloved sons.

For this reason, His Holiness was also very happy to see, so well and so worthily represented at one time and in a particularly solemn occasion, his Sacred College, the Sacred College of Cardinals, which—and this was very well said—is his Hierarchical Senate: he was also able to say that the Academy of Sciences is his Academic Senate: and many could easily guess among the intentions of the Supreme Pontiff—alongside the intentions and preoccupations of science and the services which it could give and does give to Faith and truth—one could well have guessed that the Pope wanted to place within the scope of his Magisterium, that is the Magisterium of Faith, also a particularly chosen and efficacious instrument for the spreading of the natural truths that Faith not only does not exclude, but manifestly supposes, requires and demands.

The Holy Father had mentioned the new President: thus by doing so he implicitly honoured the memory of the preceding deceased President, the dear Father Gianfranceschi, so favourably, so honourably, so justly noted and appreciated not only by all the Academicians, but by the whole world of those who study and know what constitutes hard and truly worthwhile work. Nor was it only the honoured and dear memory of Father Gianfranceschi that His Holiness wished to evoke; he also believed the moment had come to recall actively and effectively the legacy of the great religious to the Academy: that is his intellectual heritage—or better his academic heritage because in this case it is in regard to the Pontifical Academy of Sciences.

Many times in his life, the dear Father spoke with the Pope about

his almost fatherly ambitions concerning the beloved Academy; explaining how he would have liked it to be and how he would have shaped it and formed it according to those ideals of science and scientific culture which animated his whole spirit. And quite often too he explained his thoughts to the Pope and left these behind in his writings—which today are almost voices from the world beyond—so making his great hopes clearly understood, beginning with a hope for a larger and more comfortable home for the Academy. Beautiful, charming as dear Father Gemelli has described the Casina of Pius IV, but a little limited; so that it is right to say *dilatentur spatia* if not *charitatis* at least *veritatis*. His Holiness had immediately accepted that desire which was also his (perhaps in fact the wishes of the dear religious sprung from the desire of the Pope); and the present meeting hall, the room for many important gatherings, can, without a doubt be considered as the fulfilment of the first thought and desire of Father Gianfranceschi, fulfilled despite the proportions which the tyrannical poverty of space allowed.

But, Father Gianfranceschi's wishes went even further: and when, with all his refined filial piety he honoured, gladdened and consoled the Pope, he did not hesitate to imply that it would be a great, beautiful and useful thing if there were to be, so to speak, a spaciousness in financial means alongside the greater spaciousness of the new premises. And the Holy Father met with his wishes; he had thought of something which would help the financial condition of the Academy, if not the riches which it merited, then at least a reduction in its poverty, to allow it something greater in the scientific field of activity and above all in that very precious activity which consisted in stimulating the activity of others.

Yet all was not finished. Father Gianfranceschi worked out with particular care and with all delicacy that the scheme needed a new and more useful arrangement of the scientific personnel, of workers in this great task of science.

His Holiness was pleased to accept all these ideas and as he had already sought to accede to the wishes of the dear departed Father, so he also came to look—clearly with the advice and consultation of the new President—at the other and more important aspect, namely the rearrangement of the scientific personnel, of the scientific structure of the Academy. The Venerable Pontiff was happy to say that, with the help of Divine Providence and of good will, the Academy so dear to him seemed to be on a good road toward a definitive and complete reorganization. Certainly, that will be the task—as has already been said—of the new President, with those means and that assistance which his qualities put at his disposal; but also the Pope put himself at his disposal for such a useful and important

restructuring to give the finishing touch to the renewal of the beloved Academy. Without doubt, there would be difficulties, but there is no difficulty which good will cannot overcome. Clearly it would be up to him, the President, to regulate in the meantime, in the best possible way, the actual period of transition of the Academy until everything is supplied, finished and ready so that the Holy Father can usefully document what will be done. Probably therefore, it will be the role of the President not to call the next session for February in the normal way, but, at the right moment, newly to convene the Pontifical Academicians for the new meeting.

All this clearly stated to these beloved sons that thought of the Academy was not in the mind of the Pope only when he had the true joy of being among them, but he often thought about it and followed it and was directly involved in the Academy. It suffices to say that the Pope holds his solicitude for the Academy as perfectly justifiable as he regards it as the magisterium of science alongside the Magisterium of Faith, the senate of science alongside the Hierarchical Senate.

It then seemed to the Venerable Pontiff that one could not meet in such a serene atmosphere, about such peaceful matters, for those pleasures of the mind which science obtains, without thinking about the thick, black menacing clouds upon the horizon: the national horizon and the international horizon in the largest sense of the word. Those beloved sons already had in mind what their Father, the Pope, felt; it really seemed to him that being concerned so peacefully and joyfully with what all the participants in the auditorium had brought together, well demonstrated—and not just in a manner of speaking—that despite the climate of gloomy clouds and despite the dangers which menaced on all sides, the Pope preserved a calm area within his soul which these tumults of external threats could not reach; and this confirmed that—as he had earlier already stated more than once—he always kept a hope which was a little optimistic (but not blindly or unjustifiably so), that from some part of this gloomy and menacing sky, the light could re-emerge and the rainbow of peace could be born and rise up, that peace, even that plenitude of peace—as the divine word so well says—based on justice and truth, that truth for which this meeting was called and for which all must live and work.

This peace, this need for national and international reconciliation—it is obvious—is necessary also for the benefit of study and science, to return to it. It is science which seeks always to serve the truth. And the truth is the source of all good: truth will free us from every evil; *veritas liberabit vos*: and God is Truth. And it is precisely in this Name, God, that the Pope called together the participants; and it is in His Name

that he had given to them every true joy of the spirit: it is in His Name that the Holy Father wished to bless those present, their studies and all the persons and things dear to each one.

This blessing the Pope therefore wished to extend to all members of the great and truly noble family of scholars, from the greatest to the most humble of scientific workers; that science which expresses the most beautiful harmonies and the most magnificent wonders that can be imagined: there are no others which can race or compete with it save goodness and love.

Discourse of the Secretary of State, Eugenio Cardinal Pacelli, given on behalf of His Holiness Pope Pius XI on 1 June 1937.

Most Reverend Eminences, Excellencies,
Illustrious Members of the Academy,

No doubt you regret that the token and august dignitary, at this solemn inauguration of the Pontifical Academy of Sciences, is not the sovereign presence of the Supreme Pontiff. He was the one, who, in renewing the Old Institute of the New Lincei, conceived and accomplished so greatly and nobly this outstanding Academy. Greater, I say, than your regret, is my own amazement and confusion at finding myself in the midst of you to represent him. He deigned this morning to entrust to me, so great an honour and office, in order to transmit to you, that paternal and apostolic welcome and greeting, which his heart and his thought pondered. He did this, out of the high regard which he has of you, and in his ardour for the progress of the sciences, which he appreciates in you, such celebrated masters. To have seen you all present and assembled around him, his spirit would have exalted in a hymn of praise and thanksgiving to God, the giver of every good thing. But I know only too well, what the office committed to me by his august goodness arouses in your souls, which are inclined towards every nobility of affection. First of all there is the yearning, more than knowing, to have a new confirmation of what has already been authoritatively announced, namely, the reason why his Person is not present in the midst of you, this much revered Father and Founder of the Academy, in the fortunate moment of its awaited inauguration.

The Holy Father, as I myself had the honour and joy of verifying this morning in the customary Audience, is feeling well, better than before. Yesterday, he was able to celebrate the Holy Sacrifice of the Mass. But all things considered, and only at the last minute, did he consider it more prudent, not so as to spare himself this effort and trial, but rather to deprive himself of the greatest and most desired pleasure he would had in performing it.

His absence is, consequently, an act of violence, which the Holy Father has done to his heart, and to his burning desire to reply to your no less eager expectation. But his absence is at the same time, and please allow that he may say so, a respectful homage to science, to that science which delves into the secrets and hidden limits of the strengths of human nature, so as to ensure a precious health recovered and strengthened. It is a respectful homage, which is both an honour for you and your knowledge, while at the same time it is a witness of esteem to the dictates of a science, which he has, if you like, intended to live up to with the institution of this Academy. In doing this he is mindful of the precept of Sacred Scripture: "*Honora medicum propter necessitatem, etenim illum creavit Altissimus*" (Eccl. 38:1). God is the Lord of medicine too, and Lord of all the sciences; and the greatest example of this faith is the submission of a Pontiff. A Pontiff who wishes to live up to the word of he who watches over the precious life of the Common Father of the Christian people, so as to conserve his health. This is the good health, as has been restored to him by God, of an illustrious and sincere Watchman, who taxes his mind with his immense thoughtfulness for all the Churches, under the weight of his eighty years. He does not decline the work, and on the subject of work, he does not decline the pain, not even that pain of being unable to be with you himself, so sacrificing to God a yearning, whose accomplishment was so greatly desired and awaited by him. It was the desire to declare inaugurated this Scientific Senate, conceived and created by him, for the progress of science and human investigation, for the honour of the Apostolic See, that beacon of truth and salvation, for the knowledge and glory of that God, by the power of Whom all things were made, and without Whom nothing was made, of what has been made in heaven, on earth, and in the depths. It appeared to the Supreme Pontiff in all its brilliant light, as the powerful streams of the natural and rational sciences, and the great river of revealed wisdom springing forth from the same divine fount and descending to man. Since this latter wisdom springs from the deepest source, it is inaccessible to reason, but not to faith, and yet it is no less certain and true. When those sciences, wherever they may seek and meet the truth, from whatever part of the created universe, from the heavens, from the oceans, from the earthly abysses, are set free and shine upon the human genius, they may prepare and build the entrance hall of the temple of faith, the steps of the 'Sancta Sanctorum', behind the veil of which, the secrets of the divinity lie hidden and throb. All nature is ordained to man, and the end of celestial motion, affirms Saint Thomas, is ordered to man, as to an ultimate end in the genus of generable and mobile beings (*Contra Gentiles*, 3:22). But man

in his turn is ordained and orientated towards that image and likeness, which signifies in him the face of God, and towards that glory which the heavens proclaim; towards that truth which the hand of God left as a fingerprint when he created the world and every thing, towards that greater truth which exalts the human genius beyond the stars and remains forever.

The words themselves of the August Pontiff will be worth much more than the poor expressions, with which I had hoped to interpret his mind, and these I have the great honour of communicating to you. They are the very same words, which he would have wanted to speak to you, if he had been present here in person today. They are his words, in thought and heart, which will remain for all the days to come, with the solemn seal of apostolic authority and the foundation of the Pontifical Academy of Sciences.

His Holiness, would have no doubt recalled an often encountered passage, one of the most serious that are contained in the Divine Books, and which appropriately regards the men of the Church, which can easily mean pupils and teachers of the faith and in general of the truth: "*Quia tu scientiam repulisti, ego repellam te*" (*Hosea, 4:6*). The Holy Father would have added that, in this the summit of his life, in this fullness of years which God wished to concede to him, it seemed to him not inopportune and not alien from his office, to also give further proof of the weight, which he gives to those divine words, showing himself not only completely alien to the rejection of science, but careful in fact to call it to himself, and to possess it for himself. For this reason, His Holiness thought that an excellent way of achieving this aim, would be to call around himself, your most worthy persons, illustrious members of the Academy, you who so well represent so great a science, in, it could be said, a universal approval.

It is true, that there are some things in which science and faith seem to express irreconcilable difficulties and contrasts. But this apparent lack of reconciliation cannot be so in reality for the Holy Father, nor for the person who reflects for a little while on the fact that, science is the research of the truth as it is found in the natural revelation of the created world, and faith is the homage shown by the created intellect to the truth directly revealed by the Creator. So it is evident that this homage shown by the created intellect to the direct revelation of the Creator will never be more worthy of both creature and Creator, as when it is illuminated by the splendours of sciences. This conviction has inspired the Holy Father, and has greatly cheered his heart in the institution, or restitution which may be intended of this Academy, to which you, illustrious members of the

Academy, come to bring the contribution truly sought after, of your names, of your science, of your works.

The good Father Gemelli, among the many for whom the Holy Father is always most grateful, has seen to replacing the Academic insignia of each one of you, and his Holiness feels sure that you will not regret it. The August Pontiff was reserving for himself the pleasure of delivering with his own hand the so-called Annual Medal, which I now give to you through his precise mandate. It is by now, as is well-known, the traditional custom of the Holy See to dedicate in the special mint of the Pontifical Medal, the recollection of what is considered the most important event of the year. The Holy Father, for his part, has considered that his and your Academy—no less yours than his—was precisely the event which this year deserved such a dedication. You, yourselves, for your part have inspired the composition of it for him, personifying (as has already been said) science so worthily: You have recalled more vividly to his mind, the great images of those great spirits which truly seem sent by God the Creator, for revealing more amply the splendours of science, and likewise those upon whom it truly pleased Him to impress the most far-reaching foot-print of the Creator, His Spirit.

The Medal, which I am about to hand over to you in the name of the Holy Father, imparts everything to you and better than any one word could, presenting you with easily recognisable images, since they are historical: Volta, Michelangelo, Leonardo da Vinci. Their scientific contribution needs no reminder, since you are among the greatest knowers of it: Volta with the wonders of electricity, Leonardo with the universality of his scientific genius, Michelangelo, a master not only in literature, but also in true and proper science with the wonders of his sacred and profane, civil and military architecture. The Holy Father did not even wish to remind you of these things. He reserved rather for himself and for you, the satisfaction of recalling in the great Volta, the catechist of children in his parish at Como, in Michelangelo, the builder of Saint Peter's cupola, in Leonardo, the wonderful multiple scientific spirit who left in his will a legacy of Masses to be offered for his soul, the most concise, most comprehensive, most profound manner of professing even in detail all the truths of his catholic, dogmatic and practical faith.

Whereupon, the Holy Father thought he would end his words and the expression of all his satisfaction and paternal recognition for your presence, by indicating to you in these three great men, a great threefold warning, a magnificent threefold programme, and a most glorious threefold example.

Such is, O Illustrious Members of the Academy, the August Message. Allow me, therefore, to gather into a garland all the glory of your hard

work and your merits, and present them with you as an offering, to the heart of the Supreme Pontiff, so that he may find in them, along with the perfume of all his most joyful hope, the balsam of his missed presence, which is personified in his spirit and his will, which today gives perennial life to this Pontifical Academy.

And with this, in the name of the Holy Father, I declare the first academic year inaugurated and open.

*Discourse of His Holiness Pope Pius XI given on
30 January 1938 at the Solemn Audience granted
to the Plenary Session of the Academy.*

The Holy Father began his speech by heartily congratulating Prof. Bjerknæs for the magnificent things he had said, and for having come from such a distant place—from Oslo, where the Pontifical Academy also had a fellow. Although geographically speaking Oslo, in Norway, was far away, it was necessary to add at once that spiritually it was not far from the heart of the Pope, from the Vicar of Jesus Christ. Nor was it far scientifically speaking, as the illustrious professor had come specially from that extreme northern part of Europe to speak in the elect and solemn gathering. Thus, if only by his association with the subject of that meeting, he rendered his country very close.

The presence of Prof. Bjerknæs was truly valued. He was a scholar and a collaborator of Hertz who was, so to speak, one of the spiritual fathers of Marconi. Although dead after a short life, 37 years, Hertz had already followed a road to which he was very happy to be called and predestined. This was so because Hertz saw above and before himself Him who had called and chosen him: the God, that is, who rules nature, that God who has enclosed in nature and in his most secret beings the splendours of wonderful light. This was true also of Marconi. In the same manner did Marconi see the wonders of creation, as the late scientist had effectively shown very often. Also at the eve of his departure from this life, when the signs of death were already upon him, he repeated at a Pontifical Audience in Castel Gondolfo his gratitude to the Holy Father for having accepted his scientific work in service of the Holy See. Both scientists remind one of what the great German poet, Schiller, wrote: '*... soll das Werk den Meister loben—doch der Segen kommt von oben*': the work should praise the master, but the blessing comes from above. Truly we find ourselves here before two of the greatest works to which the human activity was ever called by the Creator—the blessing of God has descended on them so clearly and so manifestly, and is splendidly glorious and glorifying.

The August Pontiff was therefore extremely grateful to the Professor from Oslo who had given such a delightful and enjoyable hour, with such learned and authoritative words and with a comment so appropriate to the theme of that meeting. The Holy Father had always followed the work of Marconi in its developments, and had seen it unravel itself little by little. And the professor, furthermore, came precisely from those regions where the work of Marconi rendered inestimable service, not any more under the bright sun of Rome, nor under the warm skies of Italy, but in the middle of the ice, and in polar night, evidently useful even for the material salvation of those peoples trapped in the snares of a dangerous navigation at sea, useful in their situation with the means at their disposal.

His Holiness repeated his acknowledgements to prof. Bjercknes, turning to him and saying in German that he thanked him for having desired to be present despite the discomforts of the long journey. And together with a warm welcome he extended to him a special greeting for his country so that on his return the scientist could announce that the Pope, the old Pope, always thinks of the Norwegians, and despite his inability to do much, earnestly desires to contribute towards their well-being, and their life. Together with the greetings that the Supreme Pontiff sent to everyone, but particularly to the old and to the children the beloved academic could also assure his fellow citizens of the blessing of the Holy Father, who loved them dearly and prayed constantly to God for them.

Taking up again his Italian, the Holy Father said that he truly could not see what might be added to the beautiful and distinguished things already said, and for which he had been present. Indeed it all made one think that not only had the great spirit of Marconi returned in that meeting but that he had also gently fanned his ardour. The Supreme Pontiff was glad to be able to testify to it that to the beloved Marconi he owed the assurances and expressions of a fervent, of a particular, true, filial devotion; and also to his frank and sincere happiness at having been able to place the fruits of his research and of his scientific study at the service of the Holy See, which is to say at the service of truth in the highest, widest, most beneficent sense of the word. Nor could the Holy Father fail to repeat his acknowledgements for all the testimonies of profound devotion that the great scientist repeatedly sought to give to the Person of the Vicar of Jesus Christ.

What then should he say to those beloved Academicians from Italy and abroad who had gathered together to procure a true festival of intelligence and of sciences? What could he say which would return thanks to them, although he knew that everything which came from the mouth of the old Father was made lovable to them by their filial piety. He wanted first

to record that the presence of the beloved members and fellows of the Pontifical Academy of Sciences aroused in his spirit one of the most beautiful hours of his life. It should not seem out of place to recall that sublime hour since it is of hours such as these that the mercy of God had granted to him to spend before the grandiosity and majesty of nature by himself, as the great Hertz and Marconi had spent hours alone in which their genius was called to contemplate incomparable magnificence. The Holy Father wanted to recall an unforgettable night, spent at above 4600 m: a night full of light, true image of the luminous night that surrounds the created world and before which great minds alone, like Marconi and Hertz, invoke and will always invoke greater splendours of other firmaments: that light which, at least in part, evoked the mystery from creation.

Thus he found himself, as it were, in the middle of an assembly of giants: about him there were in fact more than ten peaks, all above 4000 m. They made one think of the inspired image of the prophet Habakkuk, since those great mountains like giants seemed to raise their arms to heaven, so seeming even higher: *Dedit abyssus vocem suam, altitudo manus suas levavit*. The Holy Father had never before seen the words of the prophet come true in such a real way: mountains amongst the greatest mountains which soared up with fresh impetus towards new summits, towards the abysses of the heavens.

His Holiness was sure that more than one of those present would not have found the recollection out of place: what a great school of sciences a high mountain is! To prescind from other teachings, the mountains say at once what great abundance of riches these rocky masses tear up from the depths of earth to launch themselves into the depths of heaven. It was all a complex of forces, of hidden and as it were secret actions in the immense workshop of nature, which prepare the verdant dowries of the hills and the beautiful waves of the waters. Certainly those beloved sons, those great scientists, are called to contemplate such singular wonders, and to an exceedingly beneficent end.

Apart from that recollection, the August Pontiff felt himself united to the beloved academics also for another reason. It had pleased the Lord of everything that he should have spent many days, and among them the most beautiful of his life, in libraries. These long stays had given him a certain familiarity with their names. From their works it had seemed to him many times that their intelligence, their genius, the researches of their studies seemed to flame out just like those peaks to which he had referred, which lift up their arms to heaven. How many of the beloved participants at that meeting were often with the Pope, with the old Librarian, on his daily journey along the long rows of library shelves which stretched

for kilometres about him! They, the scientists with their respective works, their famous names, their vast researches with which they honour the sciences and the activities of their various countries! And how many could remember in that moment, on the other hand, that the Pope of today is the old friend of books, of the writers and creators of books, and of those who are and who want to be workers for the development of the human sciences!

These recollections gave a way to reflect on a splendid passage of the gospel, which recalls an exalted mission and responsibility. It was a passage that the Sacred Liturgy proposes very often and which had been read only a few days before. In it is the Lord Jesus, God Himself, who speaks first, as is easily understood, to His Apostles and to their successors: to the agents therefore not of science, but of faith. Nevertheless, those divine words can be applied, after the men of faith, to those of the sciences because they come from God, the Lord of the sciences: *Deus scientiarum Dominus*. God does not want a separated faith and science, and even less that they should be in conflict. Rather through their own essential unity, He wants them working for the good of souls, for the good of intelligences.

Faith and sciences. To faith belongs that word which the Divine Master says and repeats: *Vos estis lux mundi: ... neque accedunt lucernam, et ponunt eam sub modio, sed super candelabrum ut luceat omnibus, qui in domo sunt*. You are the light of the world: ... and a lamp is not lit to put it under a bushel but on the lampstand, so that it might give light to everyone in the house. These words, His Holiness repeated, are directed above all to giving the command, the preaching, the teaching of faith: the teaching of those truths which are indispensable for everyone, even to those to whom to speak of the necessities of science becomes cruel derision because they do not have, nor will have the predisposition for it. And yet they have need of truth, of that essential truth which Hertz and Marconi, and all those who through the created world see the work of the Creator. The truth which releases the mystery from the created world, the truth of faith. But equally these words can be applied to those who dedicate themselves to those other truths that come as subsidiaries, in help and in service to the Faith itself. Therefore, these word can also be applied to the Academics, to the men of sciences: *Vos estis lux mundi*. Indeed the hand of God has not lit the light of sciences in all, as it has in them, nor has it given the intellect of all a far-sighted gaze. They have received the privilege of such an outstanding light, and for this reason, they must use it for the good of the world.

It is true that all the discoveries of sciences up to now, before the immense vision of the created world, are slight. Thus one could repeat

with the great scientist Golgi, speaking of the present, and alluding precisely to the discoveries already made: *ignoramus*, and giving a glance to the future: *ignorabimus*. But the contemplation of the created world is nevertheless a delight. Scientific research of its treasures, up to yesterday only descriptive, one might say, and more than ever mechanical, has today become a true unceasing investigation dealing with all the created world. It is clear therefore that God has given us the ability to investigate not just matter, its structure and composition, but also the nature, the mystery of the created world, with the research of such splendours to which sciences arrives little by little, and at the heart of which is at last the splendour of the Truth.

Concerning this, the great Christian poet Alessandro Manzoni saw two categories in the created world: that of the most useful things, whose usefulness is immediately obvious, and the other of things which seem superfluous, but which nonetheless concur to celebrate the glory of that Truth. He described the first saying:

“To Him who is hidden in every plant of the earth
from which is made every thread of your clothes
and which provides chemical substances
that makes pine strong against the wind,
that makes the willow pliable
that makes the larch and alder waterproof”.

And then he continues with the second category:

“If you are haughty, ask Him why,
on a deserted beach, swept by savage breezes,
there should grow a silent flower,
which explains before Him alone the glories of His canvas,
and which releases the incense of its perfume,
from the deserts up to the heavens, and then it dies”.

There are therefore created things whose usefulness is so evident, so clear that they do not need explanation: to that category belong the high intelligences of the scientists which, for this reason, must spread beneficial light around them. On the other hand, there are other created things which, one might say, have been made just for the pleasure of making them, of seeing them, of saying of them that which the great poet has said so effectively with insuperably beautiful verses, inviting people to perceive the work of God.

It is with good reason that those illustrious academics, who more directly cultivate the research of truth, belong to the first category. So it can be seen why that which the Gospel said of the Apostles can be applied also to them: *Luceat lux vestra*. They in their search for the ultimate reason, in their creation, in their very being in the world, must always be a light, a great light, for all.

The Holy Father had already alluded to this elevated idea, this magnificent observation. He intended to apply it firstly to himself, and to all those who share with him the apostolate of Faith: we are in this world, he said, to be the light which saves, the supernatural light of Faith which surpasses all others. A light which does not contradict but aids the light of sciences, helping it in a unique and indescribable way to explain the universe. Thus to him and to those who with him inherit this apostolate of Faith apply above all the divine words: *Vos estis lux mundi*. But next he insisted upon applying them also to those scientists of his Academy, which the hand of God has called to investigate the splendours of the created world, giving the light of scientific truth which concurs to unveil in ever greater visions and reflections the uncreated Truth. Thus the Word of God is also valid for them: *Vos estis lux mundi*. There shines in them that true light of scientific research which continually brings great benefit to humanity, but then rises to the source of all those truths. It is in fact the hand of God which has arranged these studies, the same hand that lit the geniuses of Marconi and Hertz. It awakens the energies of the beloved Pontifical Academicians so that they be a light to those who do not dwell in the Father's House. Therefore so that the terrible vision the Apostle to the Gentiles had, if only for a moment, be not realized for any of them, every great intelligence such as theirs, needs to thrill in the research of the full truth, lest there be an intelligence created by God, illuminated by God, which stops at the created and does not rise to the Creator. To such an intelligence would be applicable that grave and logical penalty alluded to by the Apostle himself with the fearful words: *ita ut sint inexcusabiles*, as if to say that they cannot have an excuse for not having known the Artificer, the Creator, after having known the work, the creature. It is true that the limits of excusability and inexcusability are among the most difficult to comprehend in this area of the unknown, of the inscrutable, even for the greatest intelligences. Only that God who is Truth, who is all Truth, who calls all creatures to truth, who gives them the means for following truth, only that God sees these limits with certainty, even if the Apostle has spoken of inexcusability.

After these reflections, the Holy Father added that he had wanted above all to say something useful for himself and for the souls of all those who work for the apostolate of faith. But then he wanted also to rejoice with all those present in that great hour, that great gift which God had granted him: an hour of light, an hour of truth. It was an exquisite gift, one of the greatest genuine participations of his own perfections, because God is Truth. *Ego sum veritas*. In these words is contained everything that the August Pontiff wanted to and could say to exalt the beloved Academics' opportunity of having received from God such riches, such light of truth, such zeal for the search for truth. And since *Deus veritas est*, the most intimate, most supreme, most beneficent, most extensive participation to which God could elevate, is the constant quest for truth.

With these thoughts His Holiness went on to impart his blessing to all those present, wishing that it remain with them and with their intentions in that moment and always.

*Discourse of His Holiness Pope Pius XI given on
18 December 1938 at the Solemn Audience granted
to the Plenary Session of the Academy.*

The Holy Father began his speech by saying that he intended to address not only a word of blessing to the participants but also, as was to be expected of a father, to express an affectionate greeting to the eminent and elect sons he had about him—the honourable members of the Sacred College and the delegation of Cardinals, and also those others recommended to him for various reasons, but for the most part on account of scientific knowledge which owed so much to their work. They themselves—he did not hesitate to say—owed much to their subject because of the pure, worthy, truly elevated joys which only science, the study of truth, can give. It was this point which led His Holiness to address a special speech to the cultivators of science, to scientists of such great merit and distinction.

The Holy Father continued saying that we are in an era in which it is difficult to avoid the influence of the age: *Dies mali sunt*—they are not favourable towards serene things. However, all should be grateful to the Church, the great Mother and Teacher who suggested and presented a special subject for that meeting, itself called to illuminate and make sweeter our spiritual horizon. She had even almost prepared it by a happy combination of time and place (and we know Who it is that ordains these coincidences!). All ought to be grateful to the Church that the meeting was taking place towards the end of Advent, that is, towards the Vigil of Christmas—the great and beloved solemnity, itself a source of sweetness, joy and teaching for all, including scientists. The Sacred Birth which is about to be celebrated is the scientist's great feast, it is the particular solemnity of the cultivators of science. There were good reasons for it being so and, having around him such illustrious scholars, the Holy Father wished to recommend it as such.

What exactly is science? What is the object of this science to which they dedicate themselves with such success? The complex object of science, of all the sciences is the reality of the created universe. Whether we are considering the depths of space, the reaches of the sea or the

gigantic mountains, or whether we work with invisible dust, the most miniscule and impalpable organism, we are always in the sphere of the created, the ambit of the universe. The birth of Jesus Christ is, as the Church remembers it with her affection and in her continuous worship, the Birth of the Divine Word made flesh and appeared amongst us: *Verbum caro factum est et habitavit in nobis*. See how these beloved sons come to meet the Creator of the object of their sciences. He it is Who has prepared for each and every one of them the object of their studies in all the minute and varied characteristics of the various branches of the diverse disciplines. In a special way at this time the Church opportunely recalls every day in the Sacred Liturgy all over the world, this great and grandiose truth: the great truth which returns in all its immense richness on the occasion of the Christmas Mystery. Christmas is the birth of the Incarnate Word, the Divine Word, of Whom the Evangelist has spoken so effectively. The human eye has truly never seen so far, closed if you like to the natural light, but open to the supernatural and divine light. The Apostle John wrote the stupendous words "*In principio erat Verbum, et Verbum erat apud Deum, et Deus erat Verbum. In ipso vita erat*". The human mind has certainly never been raised so high in its thought. Never have human words expressed such exalted concepts. With such an expression it seems, so to speak, as if the widest possible edge is lifted off on the Mystery of the Divinity, the mystery of the Intimate Being itself of the Divinity.

In principio erat Verbum: words which at once express the thought—and what would words be without thought? We distinguish the mental word, the spoken word, the verbal word—in *principio erat Verbum*. The word was in the heart of the divinity, He was Himself the Divinity, He enjoyed all the Divinity. The thinking Divinity, the thought Divinity, as our poor and feeble way of speaking would say. The Word which tells God its essence, its being. *In ipso vita erat*: behold the procession of life, of thought, of affection; behold the Holy Spirit, that Spirit in which, through which, God—as our great poet said "*loves Himself and smiles*": *O luce eterna che sola in te sidi – sola t'intendi, e da te intelletta – e intendente, te ami e arridi!*

God concedes to all of us to see something of such sublime splendours: *O luce eterna che sola in te sidi!* Does the Mystery perhaps vanish before this inundation of light? No, the Mystery remains! But when mistaken notions are refuted what beauty and what things take their place. The idea, for example, of those who argue that God needed to create the world to remove Himself from the tremendous solitude of His eternity. It is rather a matter of a most beautiful eternity: The Father, The Son and

The Holy Spirit: a divine infinity of life in a threefold infinity of reality, of personality.

If that might seem a digression it was on the contrary fully within the theme originally proposed, and the Holy Father was pleased to explain it with gracious stress. *Et Deus erat Verbum*, he continued, *omnia per ipsum facta sunt*. All this universe was made by Him, through Him: therefore everything was made through this Word, the expression of a mental word of a thought which was never considered so luminous, profound, extensive. It is a divine thought: it is God Who thinks Himself: *O luce eterna che sola in te sidi – sola t'intendi, e da te intelletta – e intendente, te ami e arridi*.

Everything was made through the Word, through the great Artificer of the universe. No force or beauty can be added to this expression, but it is not surprising that elsewhere the same Divine Word explaining the immense beauty of creation says of God: "*Omnia fecit in pondere, numero et mensura*". It is like going into an immense laboratory of chemistry, of physics, of astronomy! Few indeed can admire the profound beauty of such words as well as those who make sciences their profession.

In pondere: you who weigh the stars—His Holiness explained—and calculate the specific weight of bodies and even of atoms; *in numero*, you who number tiny microscopic things, and count the years of light; *in mensura*, you who, as you weigh the stars, so you measure the astronomic intervals between them, and the oceanic distances. No one can understand better than you the exactness of these words: that everything is made by God *in pondere, numero et mensura*.

Because the origin of the world in this Divine Word, through whom everything was made (*per quem omnia facta sunt*), is not reflection on such a sublime truth worthy not just of the most diligent attention, but also real devotion from the men of science? Here there is not involved just the common piety of each individual Christian: No! To be a scientist, to be one who sees beyond the material surface of things is enough to elevate oneself to incomparable heights, and to approach such magnificence.

Omnia per ipsum facta sunt ... in ipso vita erat. It was something the August Pontiff did not believe superfluous for his beloved sons to hear: even if they were not his own words he had recalled them hoping that in this way he might respond to the pleasing thoughts they had expressed. Something which would be accepted and adapted to their intelligences, and find its proper place in their daily studies in which the universe reveals itself and points to this Word *per quem omnia facta sunt*.

He then returned to the other phrase of Sacred Scripture that concerned the work of the Word of God through all that is created: everything was

made in *pondere, numero et mensura*. The created world receives weight, number and measure through the hands of God. This is true for everything: for the greatest as much as for the smallest. But furthermore, Sacred Scripture also takes care to describe to us everything in the world which is of consolation and delight. In the book of Wisdom the Word of God is spoken of again. It takes its very name from the divine Wisdom and is described to us as the *Verbum mentis*, the 'thought word'. It is identified in the omnipotent work of creation, about which wisdom itself is pleased to raise up incomparable praises.

It is a delightful passage.

Ab aeterno ordinata sum: from all eternity I have been constituted. This is the first point of contact with the expression of John: *In principio erat Verbum*. Thus also, "*Nondum erant abyssi et ego iam concepta eram*": I had already been generated even before the abysses existed. The Divinity thought itself and the Divine Wisdom was conceived and generated. *Necdum fontes aquarum eruperant*: and the springs of water had not yet gushed forth; *necdum montes gravi mole constiterant*: nor had the mountains risen in their great mass; *adhuc terram non fecerat et flumina, et cardines orbis terrae*: He had not yet made the earth, nor the rivers, nor the foundations of the world: before all things and before everything I existed.

After this introduction, the Holy Book continues with a style which is both wonderful narration and admirable poetry. When the hand of God was forming the whole creation, I, His Wisdom, was there. *Quando praeparabat caelos aderam; quando certa lege, et gyro vallabat abyssos*: when He prepared the heavens, when He fixed the depths in the regular pattern of their limits, I was present. *Quando aethera firmabat sursum, et librabat fontes aquarum*: when He set the atmospheres above and arranged the springs of water; *quando circumdabat mari terminum suum, et legem ponebat aquis, ne transirent fines suos; quando appendebat fundamenta terrae*: when He surrounded the sea with its boundary, and set a law for the waters so that they would not pass beyond their limits; when He fixed the foundations of the earth; – *cum eo eram cuncta compones*: with Him I was arranging all things.

The Poet was surely thinking of this when, comparing the earth to a ship safe on its anchors, he exclaimed: "*... dei celi – nei lucidi porti – la terra si celi attenda sull'ancora – il cenno divino – per novo cammino*".

See how much the Holy Bible tells us with regard to this divine uncreated Wisdom of the Word *per quem omnia facta sunt!* How could we approach such an inspired passage without a profound sense of admira-

tion? And not that here only the visible universe is mentioned. There is besides the supernatural universe which is not seen, but which exists with all its sublime realities. Nevertheless at the simple consideration of the basic fact of the visible universe one is spontaneously brought to celebrate the latter, the time beyond life and death, and the glories of its Author and Creator, to arrive at that radiant end justly referred to by the same poet as: "*Veggenti e non veggenti – unica notte involve; e d'altri fermenti – esce l'alba, che solve – del creato il mistero – e ci posa nel vero*".

A most consoling reality, the Holy Father explained, which causes a hymn to the Divine Wisdom to spring up in our soul. A hymn to the Divine Word for these intimate relations of the Divine Being with the divine work. *In principio erat Verbum ... et Deus erat Verbum ... omnia per ipsum facta sunt: ... in ipso vita erat.* What light is shed by such thoughts. What splendours which make the soul rise up from the created world to higher, vaster, more incommensurable realities!

The Holy Father himself, the old priest and old mountain climber, remembering some episodes from his youth, was pleased to recall that right on the highest peak he had reached he had fully understood the meaning of some texts of Sacred Scripture. On one occasion at 4630 m. amid other summits of similar size, the inspired image of the prophet Habakkuk appeared to him in all its brilliance. These enormous heights like giants, seemed to lift their arms up to heaven thus seeming still bigger and still higher: *Dedit abyssus vocem suam: altitudo manus suas levavit.* The Holy Father had never before seen the words of the prophet realized in such a vivid way: mountains among the greatest mountains seeming to soar up as if alive, with a self-renewing force, towards new more daring heights, towards the depths of the heavens.

The August Pontiff was pleased to mention these elevated considerations. He knew how the beloved sons about him would have shared with him the great spiritual delight that followed. He wished that the Lord would make the interior life and the life of study of each one to enjoy some abundant rays of that *luce intellettuale piena d'amore; – amor di vero ben, pien di letizia; – letizia che trascende ogni dolore.* It is true, the Holy Father continued, that love and supernatural light were spoken of here, but it is also true that one arrived at it by lingering a little at the marvellous concept of the visible universe. The Holy Church herself, teacher of faith and truth, invites us to this. It is precisely with that faith, with that truth, that we can come closer to the infinite light of God: *O luce eterna, che sola in te sidi – sola t'intendi, e da te intelletta – ed intendente, te ami e arridi!*

With these thoughts the Holy Father renewed his wishes that the participants have a Holy Christmas, and that they might enjoy it as they merited. In the ineffable presence of the great Mystery of the Incarnation of the Word of God he wished to repeat all his other paternal desires for each and everyone. He hoped that from it an intense and beneficent light might break forth and spread into all the areas they wanted, with many good gifts for everyone and everything they had in their minds and hearts at that moment.

DISCOURSES
OF
HIS HOLINESS POPE PIUS XII



*Discourse of His Holiness Pope Pius XII given on
3rd December 1939 at the Solemn Audience
granted to the Plenary Session of the Academy.*

It is with great joy that we are here amongst so many eminent Cardinals, members of the diplomatic corps, distinguished teachers, scientists, and mathematicians in order to open the new academic year at the Pontifical Academy of Sciences. It was in a similar meeting held in this very hall on a different occasion that you heard us convey to you the message of our incomparable predecessor Pius XI, when he was unable to come in person due to ill health. His glorious name is now written in indelible letters both in the annals of history as well as in the start of the life of this academy of sciences which he founded. While her structures and name may sound new, in her nature, her intentions, and her aim, this academy reminds us and brings to a more modern and universally scientific level the old and illustrious Accademia dei Lincei, which had already been renovated by Pope Pius XI, our illustrious predecessor.

It is to Pius XI, who was present in this very hall a year ago—a hall which now contains his venerable portrait—that our thoughts, containing both sadness and reverence, now turn. We greatly admired in his mind and heart those powerful and daring elevations of the spirit, of thoughts concerning the past, present and future. They cloaked his throne with the splendour of the highest piety, self-sacrifice, and kindness and with a great expansion of faith, ecclesiastical knowledge and the results of scientific investigations. This academy—entrusted by him to the care of the distinguished President, Father Gemelli is his greatest achievement. For him, it represents the conquering of a pinnacle surrounded by the great mountain range of the sciences, where truth raises high her brow above the valleys and plains which divide the various countries: where Truth, which ascends from the chasms of the earth and sea and descends from the skies so as to assemble illustrious scientists, your great researchers and their voice of wisdom, to sing the hymn of human reason to the signs left in the universe by the Creator when heaven and earth were completed with all their array (*Gn* 2:1-2). As Saint Augustine tells us, God, having created the universe, did not abandon the world (S. AUG.,

De Genesi ad Litteram I, IV, c. 12, n. 22; MIGNE, *PL*, t. 34 col. 304) 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 (*Eccl* 1:11). God has given fallen man this task of understanding this great enigma (*Eccl* 1:13); the enigma of the unknown God working in creation, to which Paul the Apostle pointed when addressing the epicurian 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 far from any of us (*Acts* 17:18-27).

The enigma of creation has for centuries stretched the intellect of all peoples; the various solutions proffered have filled the schools of the Academy; the 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 labours, these lessons, these volumes, these battles are nothing other than the searchings for the truth hidden deep in the enigma itself. Whatever else, asks the Genius of Hippo, whatever else does the human soul desire if not the truth? (S. AUG., *In Ioannis Evangelium*, tract. XXVI, n. 5; MIGNE, *PL*, t. 35, col. 1609).

Yes, your souls, illustrious Academicians, crave and search for the truth, which throbs in all we see, hear, smell, taste, touch and feel in all its many ways, and follow in our thought through the maze of weights, of numbers, of measures, in the visible and invisible movements, where she stirs, transforms herself and where she both shows and conceals herself; it is here that truth challenges our acumen, our machines, our experiences and where she often threatens to elude our instruments and devices which are the marvellous product of our human resources. Such is the vigour, the allurement, the beauty and the impalpable life of truth, that she breaks free from the appearance of that immense reality which surrounds us.

Reality speaks to us and communicates her word to us through the wonderful senses 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. We are not the measure of the truth of the world, nor of ourselves, nor of the high destiny to which we are called to participate. 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. When our intellect does not conform to the reality of things or is deaf to the voice of nature, it raves in the illusions of dreams. How well did the greatest Italian poet put this:

Nature takes her course from the sublime intellect and its art ... there shalt thou discern how your art, as it best can, follows her like a pupil with his master; we may call this art of yours God's grandchild, as it were (*Inferno*, Canto XI, 99-105).

But not only is our art God's grandchild but so is truth with regard to our intellect. Since in the ladder of the known truth it finds itself, so to speak, down here on the third descending step under nature and under God. One can find nature situated between God and us. One cannot separate the truth of nature from the infallible mind of the Creator who sustains it both in its being and in its actions and so it is able to measure the truth of things in reality. What is accidental both to nature and to things is the truth which our weak intellects attribute to them as a result of our contemplations and investigations; our minds do not, as some people once believed, possess innate ideas at birth; it is through the senses that one begins to gain knowledge of those things perceived in their external sensible accidents and qualities; so that through these external phenomena our intellect can come to an internal knowledge of things, even of those whose accidents are completely perceived through the senses (*Contra Gent.*, I. IV., Chap. 1). And so man's genius, when it is not blurred through prejudice and error, comes to understand that, in the same way that nature, whose truth is measured in the Divine mind, is the daughter of God, so too is the truth of our sciences, arrived at in our own minds, the grandchild of God.

Do not then be surprised if we discourage you, who are the scrutinisers of nature and of sensible things, who bring out the hidden truths lying latent in nature, according to the great principles of the Stagirite, that *cognitio nostra incipit a sensu*; it is this principle which allows us to understand the following stanza given by God to that stranger called man; a stranger to the most beautiful of created things and to the face which looks at the sky while looking after it; a stranger to the

hand which feels all and holds all, which solidifies through art, and, with boldness and readiness, raises cities and knocks down mountains;

a stranger too to the spirit, image of the eternal; a spirit which each of you who knows her admirable prison of muscles and bones, nerves and veins, blood and fibre, must recognise in himself that nobility and grandeur and be able to exclaim before every fallen son of Adam that, amongst the tumult of sufferings, he still conserves the traces of his former self:

Still from the summits of the divine origin do I recognise the signs in you; still beautiful and great despite your downfall
(MONTI, *La Bellezza dell'Universo*).

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

Such then is the joy of knowing and learning, even a little, of the measureless sea of truth which surrounds us, we who are vagabonds in the little ship which is our life and whose only compass is our intellect. But in this intellectual cruise:

Worse than in vain does any quit this shore to fish for truth, the fisher's art unknowing—He'll not return the same man he was before (*Paradiso*, Canto XIII, 121).

With the joy of knowledge, you, elected geniuses add the art of the search of truth, and then return to your studies and laboratories, rich in the thought which is the result of having conquered an enigma, so as to add to the admirable treasure-store of science. This is the way of human progress, a difficult avenue to take, marked by the footprints of the most audacious heroes of research from Talete, Aristotle, Archimedes, Ptolemy, from Galileo to Bacon, to Leonardo da Vinci, to Copernicus, to Kepler, Newton, Voltaire, Pasteur, Curie, Hertz, Edison, Marconi and one hundred more names that one could add; and to you who, having received the flame of investigation and knowledge, will pass it on with greater brilliance to even younger heroes, who are not afraid of the stumbling blocks and the risks of the way nor are they fearful of the funereal monuments erected to the glorious souls who have died along its path. Training is father to research: "With a small spark one achieves a great flame". To the discoveries of your predecessors one can add, and thereby amplify and correct, the new fruits of current researchers, prodigies of the physical sciences and of pure and applied Mathematics,

which have the effect of both astonishing and altering our present day world, a taste of more prodigious wonders to come. The mysteries of truth, which for centuries have been hidden and buried in the universe, are gradually unfolded by you; you hasten to penetrate the very atom in an attempt to penetrate, in a more intimate way, our knowledge of the constitution of bodies; you both awaken and reveal forces, unknown to our ancestors, and then both capture these forces and then channel them where you desire; you then spread the news throughout the world and, together with the world, you prepare yourselves to show us the true image of our brothers and the world; you challenge eagles for the kingdom of the winds and beat them in flight and height gained.

We believe that this marvellous ascension of man to the skies above city, valley, and the mountains of the world was granted by God to the genius of man in our century so as to remind him one more time that from the threshing floor, whereon fierce deeds are done (*Paradiso*, Canto XXII, 115) man can ascend to God by that same way down which things descend. In this way, just as all the perfections of things descend in an orderly fashion from God, the supreme head of all beings, so, with man, starting from inferior things and then climbing step by step, he can advance in his knowledge of God, the First Cause, always greater and more noble than any of His effects. The truth which inferior things communicate to you in all their variety and diversity, is not that which *odium parit*, but is the truth which rises above the divisions and disagreements of souls, and unites geniuses in fraternal accord and in a love of the truth. A truth loves another truth and, like sisters, daughters of the same mother, Divine Truth, they embrace in the presence of God. In you, perspicacious investigators of nature, our predecessor of venerable memory recognised the great friends of truth; you are bound in fraternal affection by your love of science and this makes you, in the midst of all the battles that fill the earth with blood, an important sign of that union of peaceful intentions which does not threaten the frontiers of the mountains, rivers, seas, nor oceans.

As a friend of truth, the Church both admires and encourages the advance of knowledge, together with that of the arts and of all things, and sees it as a beautiful and good thing to exalt the spirit and to promote good. Is not the Church herself the cause of divine progress in the world and the mother of the highest intellectual and moral progress of humanity and of the civilised life of the nations? She advances throughout the centuries, master of truth and virtue, fighting against errors, and not against those who err, not tearing down but building up, planting roses and lilies without uprooting olive and laurel trees. She looks after and

often sanctifies both monuments and temples of Roman and Greek paganism. If in her museums there no longer exist admirers of Mars and Minerva, in her monasteries and libraries they speak still of Homer and Virgil, Demosthenes and Tullio; nor does she disdain to recognise that alongside the eagle from Hippo and the son from Aquino stand Plato and Aristotle. The pursuit of the sciences is encouraged in the universities founded by her; she calls on mathematics and astronomy to correct the ancient methods of measuring time; she calls on all the arts which are marked with the splendid sign of truth to emulate in honour of Christ the basilicas of the Caesar and to go beyond them with vertiginous domes, ornaments, pictures, and with images which will render eternal the names of their creators.

Every form of art and every type of science serves God because God is "*scientiarum dominus*" and "*docet hominem scientiam*" (Ps 93:10). Man has in his greatest school only two books. In the book of the universe the human mind searches for the truth of the good things created by God; in the book of the bible and of the Gospels the human intellect, together with his will, search for a truth which is beyond reason, sublime as is the intimate mystery of God and only known to Himself. At the school of God philosophy meets with theology, the divine word with the science of palaeontology; light is separated from darkness, the earth (*Ecll* 1:4) during its orbit around the sun eternally fixes upon the gaze of God and of man. The goodness of God, as that of a mother, almost approximates a human language (*1 Th* 2:7) so as to remind man of the sublimity which He manifests to him in a school of sister truths which exalt him and make him, in the study of nature and of faith, a disciple of God. Such a school is also created by the Church in her magisterium. Is not reason the servant of faith., which renders to her "*rationabile obsequium*" (*Rm* 12:1) as a foundation and defence, which emanates from the mark of the divine likeness in order that she may be made more beautiful. And faith, in her turn, does she not exalt reason and nature, inviting all the multifarious creatures of the universe to bless the Lord, from the skies to the earth, with the canticle of the three children in the flames of Babylon? And you see the Church in her ceremonies blessing the work of human reasoning and intellect, the literary activities and libraries, the schools and laboratories, the telegraphs and railways, the sources of electricity and aeroplanes, the trucks and ships, furnaces and bridges and all that the human mind and his ability for creation renders to the truthful and healthy progress of life and of human society.

No, it needs to be stated that the honour paid to faith does not humiliate reason but renders it honour and sublimity, since it is the

greatest boast of the progress of human civilisation to facilitate the spreading of the faith throughout the world. Faith is not arrogant, she is not the tyrant of reason, nor does she contradict her; the stamp of truth is placed by God both on faith and reason. In fact each aids the other, since right reasoning demonstrates the basis of our faith, and, through her light, clarifies her terms, and faith defends reason from error and teaches her many things. So we have little doubt that it will only honour this Pontifical Academy of Sciences if we recall what the great Vatican Council defined when it stated:

It is therefore far remote from the truth to say that the Church opposes the study of human arts and sciences; on the contrary, she supports and promotes them in many ways. She does not ignore or despise the benefits that human life derives from them. Indeed, she confesses: as they have their origin from God who is the Lord of knowledge (cf. *1 Sam.* 2.3), so too, if rightly pursued, they lead to God with His grace.

To you, however, noble champions of the various disciplines of the human arts, the Church recognises your freedom of method adopted or research undertaken, a freedom upon which our immortal predecessor, Pius XI, founded this academy, knowing fully well that the same council went on to add:

Nor does the Church in any way forbid that these sciences, each in its sphere, should make use of their own principles and of the method proper to them. While, however, acknowledging this just freedom, she seriously warns lest they fall into error by going contrary to the divine doctrine, or, stepping beyond their own limits, they enter into the sphere of faith and create confusion. (VATICAN COUNCIL, Sess. III, C. 4).

In these words of the universal sacred senate of the Catholic Church is to be found all your rightful scientific freedoms and the highest promise for the advantages which you have brought to the life of society which the Church herself uses for her mission in the world. It is praiseworthy of the sciences and of their admirable inventions if the herald of Christ anticipates the seasons, foretells whirlwinds and storms, flies over valleys and mountains, visits both hot and cold countries at great speed, shortens the length of trips, and becomes both doctor and healer of bodies so as to give new life to souls. It is fitting praise to your incomparable colleague, the late lamented Marconi, that our paternal word

and blessing is able to be heard beyond seas and oceans, bringing both our affection and hopes to distant peoples. Is therefore not science worthy of all our respect and honour?

It is this admirable and legitimate bond of the sciences with faith, this vestibule which the sciences and the arts erect at the entrance of the temple of faith, an image which already for centuries has amazed the world in the Vatican Hall of the Segnatura where science and faith face and illuminate one another in the sublime light of the thought and paint brush of the incomparable painter Raphael from Urbino. You will certainly have paused to admire the scene named after the school at Athens. In those people, you will have recognised your oldest predecessors in the investigation of both matter and spirit, in the contemplation and the measurement of the skies, in the study of nature and of man, in the mathematical calculations and the learned discourses. The search for truth both animates and gives colour to those countenances and they seem to speak one to another of the many speculative and practical sciences, of their many late nights in study; their faces betray a certain concentration of thought debating with itself and concluding with the realisation of how little actual truth is surrounded by so much which was believed to be true so as to create a number of different worlds, not all of which could become reality. And you see Plato in that temple of science pointing to the sky as the source of knowledge and Aristotle, on earth, the two debating among themselves and not totally satisfied with their high conclusions. They know that the infinite thirst of the human intellect to embrace everything is never satisfied; they feel that beyond our nature here below there exists and reigns a supreme power of a non-visible world. They recognise within themselves an immortal spirit which pushes them higher but they are not aware of the Spirit which vivified and which would grant them the wings to ascend.

Before this scene and assembly of "great spirits" which great art has been able to offer us, we bow our heads and remain perturbed, remembering how bitter is the path of science and how dearly all of science pays for the hopes and longings of the human spirit. We are immortal beings created for another world, for a world not manifested to reason but to a world represented in the picture entitled the "Dispute of the Sacraments" which hangs opposite to the "School of Athens" painting. It would seem as if in the painting of the two life-like pictures the genius of Thomas Aquinas helped to guide the hand of Raphael, pointing out to him the three steps of knowledge which lead to God; the first is represented by the pursuit of the sciences through which man ascends from creatures to God with only the light of reason as an aid; the second,

symbolised in the altar of the Blessed Sacrament, is both a synthesis and centre of a divine truth which transcends the human intellect and descends to us on earth through revelation; the third is revealed in the apparition of the celestial court, gathered around God, to the human mind which is raised in order to be capable of perfectly understanding the content of revelation (*Contra Gent.*, 1. 4, c. 1). From science to faith; from faith to the intuitive vision of the First and most important Truth, Source of all Truth.

It is through these schools, one higher than the other, through which, step by step, one reaches the fullest satisfaction of the human intellect. In the school of nature, whilst the skies speak of the glory of God, corporal things on earth become our teachers. They may at first conceal what is their ultimate cause but through their shape and motion they in fact reveal it to our senses; mere matter which cannot even be conscious of its need to reveal itself to us. They speak to us with their beauty, with their order and with their strength and immensity. If you were to interrogate the stars, the sun, the moon, the earth, the sea, the chasms and all living things that move, they would answer you with the words of Augustine: we are not your God; seek beyond us "*Non sumus Deus tuus; quaere super nos*" (*Conf.*, 1. X, C. 6, n. 9). Oh man, lost before the world, listen to Divine wisdom and do not make some mere material left-over into an idol which needs to be secured to a wall so that it will not fall down (*Wisdom* 13:1516); do not pray to a lifeless object for the health of a sick person, or for the life of someone dead; do not call on something which cannot even walk, to safeguard a journey (*Wisdom* 13:18).

Above the school of nature one finds the school of faith wherein one discovers the infallible teacher of the God who is both present and hidden in the Blessed Sacrament; an incarnation of Divine wisdom, Word of God, whose omnipotent voice teaches both ancient and modern philosophers the origin of the universe from a void; similarly this omnipotent voice sends the Apostles to teach all peoples a science which is beyond human reasoning and which cannot be refuted by any who challenge it (*Luke* 21:15). It is this Word of the Father Who makes alongside the great Roman Pontiffs and the assembly of Fathers and Doctors of the Church, disciples of the greatest geniuses of poetry, of the sciences and of the arts and of the princes of the earth, the prayerful souls of the simple people of God. In that monstrosity, one finds concentrated the whole of the Christian faith; therein lies present the very same God, the Truth and the Life who is pointed to in the skies by the Doctor with his arm raised near the altar.

And in the skies Raphael sublimates his own faith by attempting, with his brush, to create a Christ who resides over and beyond the clouds of faith and is found instead in the open splendour of the eternal and living light, sitting on the throne of the celestial amphitheatre surrounded by a crown of saints and angels, together with the Father and the Holy Spirit.

That sky is the sublime divine school; that throne is the chair of the Teacher of teachers "*in quo sunt omnes thesauri sapientiae et scientiae absconditi*" (Col 2:3). He is the wisdom of all things and of every divine mystery; He is the science of all created things, because all things were created for the Word and nothing was created that was not through Him (John 1:3). Oh, when will we be allowed to reach those heights and become disciples of such a Teacher, to contemplate and listen to Him; and be present at His ineffable school and bathed in His divine light, with the eye of the soul, to come to know His teaching and art, cause and effects, matter, the formation and order of all that is in the sky and on earth, of all that comprises the world and nature; and, in the volume of the infinite and eternal ideas of the Divine Word, to be able to understand at one glance more than could be understood after one thousand years of study; to achieve this better than if we possessed the acumen of all the greatest geniuses of the earth and more perfectly than if we were able to see things as they are in themselves. "Quando veniam et apparebo ante faciam Dei?" (Ps 51:2).

Up there, in that most sublime and beatifying school, in the knowledge, through God, of all the human and divine sciences, man's insatiable longings to know and understand all the genera, the species and the virtues and the order of the universe will be satisfied. There the perfection of our physical nature will be combined with the perfection of our spiritual nature; in that house of Wisdom and science, which is inexhaustable and perpetual, one loses all the errors made in one's past life: as Vicar of Christ and Father to you all, we pray to God that we will all one day ascend to heaven and be granted the reward of our earthly labours. In that hall of supreme glory we will even forget the lofty depiction of Raphael's which was but a mere mortal dream and all our desires will finally be satiated. And, with the divine vision of Dante Alighieri, in his journey beyond the world to the empyrean and entering with eyes on "that exalted light wherein, as in itself, the truth is known", we will see

in that abyss how love held bound into one volume all the leaves whose flight is scattered through the universe around (*Paradiso*, Canto XXXIII, 85-88).

*Discourse of His Holiness Pope Pius XII given on
30th November 1941 at the Solemn Audience
granted to the Plenary Session of the Academy.*

It is with great joy that we return to this hall of the Pontifical Academy of Sciences, amongst this distinguished gathering of Eminent Cardinals, illustrious diplomats and teachers of the highest repute. To be amongst you, Pontifical Academicians, worthy investigators of nature, of its many manifestations and of its history, who have been called together by our wise predecessor, Pius XI, to establish this important scientific institute. He had the wisest admiration for the progress of the physical sciences and the great depths which they are able to reach, greater in fact than the deepest crags which he was able to contemplate from the summits of the Alps. It is important to pay the greatest tribute to him which will only then render and amplify the honour paid to you, since he held you in the highest esteem and had a great appreciation of your academic worth. It was with the intention of rendering you honour that it was decided to grant you the title of 'Excellency'; a title which is nothing but a recognition of the scientific excellency which you possess and which exalts you in the eyes of the world. The honour and the greeting which we give to you are first and foremost destined to your well-deserving and indefatigable President but they extend also to those Academicians who have not been able to leave their countries and be present here due to the difficulties which we are all experiencing during this period. The joy which we feel at being present amongst such a learned gathering goes some way to dispel the bitterness experienced as a result of this conflict between nations, all of whom are dear to us; our greater debt for such comfort is due to God, to whom we daily raise our trusting hopes; being wise and good, and by giving us His light, and granting us health and forgiveness, He steers all things towards that end where His infinite compassion triumphs over His justice.

Our Lord, Omniscient God, Creator of the Universe and Man

It is to Him that we must raise our thoughts and hearts even here in this hall of science; because it is the same God who sustains the universe, the passage of time, the good and bad experiences of nations

and remains at the same time the all-knowing God; *Deus Scientiarum, Dominus* (1 *Reg.*, 2:3). His infinite wisdom makes Him Master of both sky and earth, of angels and men; in Him, creator of the universe, one finds hidden all the treasures of wisdom and science (*Col* 2:3). It is in Him that one finds the ineffable knowledge of Himself and the infinite imitability of His life and beauty; in Him one finds the knowledge of birth and rebirth, of grace and health; in Him are to be found the archetypes of the admirable dances of the plants around the sun, of the suns in their constellations, of the constellations in the labyrinth of the firmament right up to the last islands in the sea of the universe. He moved from the centre of the inaccessible light of his eternal throne so as to create both earth and sky and, alongside Him, was to be found the Divine Wisdom, delighting in the role of architect (*Prov* 8:30); He addressed the void from the threshold of eternity with the power of His voice; and the void was overwhelmed and conquered with the appearance of the sky and the earth accompanied with the thunder of that all-powerful voice. *Ex nihilo nihil fit* is applicable and true concerning everything from the hand of man to every living creature, but it cannot be applied with regards to the voice of God; *ipse dixit, et facta sunt* (*Ps* 32:9). And in the same way as both sky and earth were created, the earth began as a formless void and God's Spirit hovering over the water (*Gen* 1:1-2); so, too, was man fashioned out of dust from the soil and God breathed into his nostrils a breath of life and thus man became a living being (*Gen* 2:7). Such then is the *macrocosm*, the universe of worlds, before the *microcosm* which is man (S. TH., p. 1, q. 91, art. 1 in corp.); little man, a minuscule world of spirit, surrounds and covers, like an arc filled with light, the immense empyrean of mass matter which is beneath man because of its lack of spirit.

God, Teacher of man

That day in which God formed man and crowned his head with His own image and likeness, making of him the ruler of all living things in the sea, in the sky and on earth (*Gen* 1:26), the Omniscient Lord God became his teacher. He taught him agriculture, to cultivate and look after the delightful garden in which he had been placed (*Gen* 2:15); He drew to man all the animals from the field and all the birds of the air to see what he would call them and so man gave names to all the cattle, all the birds, all the wild beasts (*Gen* 2:19-20); but, despite being in the midst of so many living things, man felt sad and lonely and attempted in vain to find a face which looked like him and which would

contain a ray of that Divine Image which shines out of the eyes of every son of Adam. Only from man could there come another man who would then call him father and ancestor; and the helpmate given by God to the first man came from man himself and is flesh from his flesh, made into a woman and called such because she came from man (*Gen 2:23*). At the summit of the ladder of all that lives, man, endowed with a spiritual soul, was made by God to be a prince and sovereign over the animal kingdom. The multiple research, be it palaeontology or of biology and morphology, on the problems concerning the origins of man have not, as yet, ascertained anything with great clarity and certainty. We must leave it to the future to answer the question, if indeed science will one day be able, enlightened and guided by revelation, to give certain and definitive results concerning a topic of such importance.

Man's greatness

Do not marvel if, in front of you, you who have with so much acumen studied, researched, anatomised and compared man's brain with that of irrational animals, we exalt man whose face is bathed with that intelligence which is his exclusive inheritance. True science never lowers or humiliates man in his origins, rather it exalts and elevates him since it sees, compares and admires in each member of the human family the traces of the Divine Image.

Man is truly great. The progress made by him in the physical and natural sciences, in pure and applied mathematics, render him even more eager to secure greater and more certain advances. What is this progress if not the effect of the domination, even if limited and won at great experience, which he still exercises over inferior nature? And has the past ever witnessed a greater study, scrutiny and penetration of nature than the present? A constant research so as to understand nature's forces and forms so as to be able to dominate them, subdue them with his instruments and then utilise them for his own benefit.

Man is truly great, but he was of an even greater stature at his origin. If he fell from his original greatness by rebelling against his Creator and left, an exile, from the garden of Eden, in order that the sweat from his brow would drop on his bread, food from the earth amongst brambles and thistles (*Gen 3:18-19*); if the sky and sun, cold and heat, shelters and forests, if countless other labours, discomforts of abode and conditions of life would humiliate his face and body; if the remains of that empire granted to him over the animals are nothing more than a faint reminder of his former power and a small fragment of his throne; it is still true

that he remains great amongst his ruins because of that Divine image and likeness which he carries in his soul and because of which God continues to express His satisfaction in mankind, the last achievement of His creative hand. God did not cease to love nor to abandon fallen man and then, in order to raise him up once more, He himself 'became as men are and being as all men are and knowing our weakness and temptations, He did away with sin' (*Phil 2:7; Hebr 4:15*).

Man, the investigator of the universe and his achievements

Two gifts which raise man high amongst the world of celestial spirits and the world of corporeal beings, render man great despite his fallen nature. Firstly his *intellect*, whose eye spans the created universe and crosses the skies, eager to contemplate God; secondly his *will*, endowed with a freedom to act and decide, servant and master of man's intellect, which, to differing degrees, allows him to become the master of his own thoughts and actions before himself, before others and before God. Are these not the two magnificent wings which allow you to ascend to the firmament, O scanners of the skies, and which, throughout the night, keep you from sleep as you count the suns and stars, measure their movements, seek to discern their colours and discover their flights, meetings and collisions? You truly assume the stature of giants; with the broad vision of your telescopes you measure the number of the stars and you divide the spectrums, you pursue the vortices and the flashes of the nebulae and give them a name; but it is necessary for you to bow to Divine science, which is better able than you to fix the number of stars which exists and give each one its proper name, *numerat multitudinem stellarum, et omnibus eis nomina vocat* (*Ps 146:4*). The skies made of crystal have disappeared. The genius of Kepler and that of Newton was able to recognise in the sky the mechanical actions found on earth; in the flame and light of those revolving worlds you were able to discover elements to be found on our own globe; and by binding in marriage sky and earth you were able to extend the Empire of physics which was already rich in her pure and applied mathematical experiments, and in her genius, investigations and courageous acts and which had the effect of promoting nuclear and atomic physics.

From the infinitely big to the infinitely small

In the depths of the firmament you are able to discover, during your 'astronomical nights', those 'supergalaxies' or 'nebular groups or masses' which—as one of your distinguished colleagues pointed out—'go to make

up a most prodigious phenomenon which helps us to make certain observations whose immensity goes beyond all intellects and imaginations' (ARMELLINI, *Trattato di astronomia siderale*, Bologna 1936, Vol. III, page 318): colossal families, each one formed by millions of 'galaxies', each one in itself an immense astral system which has a diameter of many thousands of light years and holds within itself millions of suns. Many of you are eagerly awaiting the non too distant inauguration of the huge reflector which is five meters in diameter and which stands on Mount Palomar in California. With this instrument the sphere of the exploration of the universe will be able to expand to a thousand million light years.

But from this infinitely big realm of research you also descend to explore the infinitely small. Who could have been able to imagine, one hundred years or so ago, the nature of those enigmas which are trapped in those minute particles which we call chemical atoms whose width is in the order of a tenth of a millionth of a millimeter. At that time one considered the atom to be a homogenous globule. The latest physics sees it rather in terms of a microcosm in the real sense of the word, in which one finds hidden the most profound mysteries. Despite the most sophisticated experiments and the employment of the most modern mathematical instruments, current research still remains today at only the start of its conquests in the knowledge of the structure of the atom and of the elementary laws which regulate its energies and movements. So, at present, the continual mutation and transformation of all material things appears more than ever to be the case, even when concerning the chemical atom which, for a long time, has been considered to be unchangeable and imperishable. Only one being is immutable and eternal: God. *Ipsi (caeli) peribunt, tu autem permanes; et omnes sicut vestimentum veterascent. Et sicut opertorium mutabis eos, et mutabuntur; tu autem idem ipse es, et anni tui non deficient.* (Ps 101:27-28). 'The heavens ... pass away but You remain; they all wear out like a garment, like outworn clothes You change them; but You never alter, and Your years never end'.

In such a manner you seek, in the immense fields of experience, laws concerning matter and phenomena which create the unity, variety and the beauty of the universe.

The order of the universe revealing God's hand at work

Is the universe perhaps dumb when she presents herself to you? Does she not have something to tell you so as to satisfy the powerful inclinations of your intellects for a grand synthesis of the sciences? For a synthesis which is in accord with the order of the universe? The most important

matter concerning the universe is the order which it manifests and which, in its entirety, both distinguishes and unifies it, runs right through it and links it in her various parts and natures which love and hate each other, repel and embrace one another, flee and then seek one another, combine and then separate from one another, and then conspire to steal the flash of lightning, the thunder and the clouds from the sky. During these very difficult times we are experiencing with a feeling of terror precisely such disturbances of the earth, sky and sea. It remains a thing to be wondered at that you know how each of these natures and elements in both organic and inorganic chemistry operates according to a different instinct owing to its own inclination and depends upon a principle without being conscious of the fact and conspires to achieve a particular goal without wanting necessarily to do so; in like manner the corporeal world, though it lacks a soul to inform and unify it, and also lacking understanding to govern and guide it, yet it is moved by reason as though it were something living and acts in a meaningful way as if this were its aim. Is this not the most evident demonstration of the fact that the world contains within itself the guiding hand of that invisible teacher which manifests itself in His work, He Who is the omniscient God, the God who orders the world with the greatest perfection? (Cf. BARTOLI, *Delle Grandezze di Cristo*, Ch., 2). You search for the truth and the laws that sustain the synthesis of nature and creation, and of these laws you seek the reasons for them, rapt in wonder and lost for words before the movements of nature; in your hands and in your chains she tosses and turns and, at times, menaces you with an indomitable force which does not have its origin in you.

Neither the genius, nor the will, nor the action of man, with his many machines and implements, can disturb the order in nature; he can reveal it, as indeed doctors and surgeons continually do with the use of a scalpel which reveals the heart and the brain, muscles and veins; the most intimate secrets of the human body are discovered, the ways of life and those of death, so as to help life to repel death. Let us illustrious Academicians, lift our thoughts to the Master of the sciences; a Teacher not of a knowledge learned from somebody else but belonging properly to Him, creator of the very same matter which He puts before man so that his genius may contemplate and study it. Is there perhaps a contradiction between the investigation of physical nature and the human intellect? Between science and philosophy? There certainly exists a tension between those sciences which do not recognise the hand of God at work in nature and that philosophy which sees in the laws of this nature a manifestation of Divine reason which takes care of all and governs the universe. Does philosophy seek to be an ideal dream which confuses God and nature,

which gazes longingly upon visions and illusions of idols drawn from the imagination? Is not philosophy rather the very discipline which keeps us firmly rooted in the reality of the things that we see and touch, and the search for the deepest and highest causes of nature and of the universe? Does not all our knowledge stem from our senses? Where do laws come from? Let us for a moment consider our life in society: do not all domestic servants working for one head of the family have a certain hierarchy amongst themselves while still remaining directly responsible to him? And the head of the family and all the other citizens, do they not also maintain a certain order amongst themselves and are they not also directly responsible to the head of the city; he then, in turn, and alongside other heads of the cities in a country, is responsible to the king or to the head of the state. The universe—as was already judged by Aristotle when recalling the thoughts of Homer (*Illyad*, 2:204)—does not wish to be ruled arbitrarily. A great number of different people all issuing different commands is not a good thing; there should only be one commander; *ouk agathon polukoiranin eis koiranos esto, eis basileus* (ARISTOTLE, *Metaphysicorum* I, XI, Chapter X).

God the only commander and legislator of the universe. The order to be found in the multiplicity and in the diversity of created things

God is the unique commander and legislator of the universe. He is a Sun diffusing and multiplying the rays of His infinite light into all of creation; but no single image in creation can equal His. Similarly, when a man finds it difficult adequately to express a concept in his mind he solves the problem by using many words. So, in the multiplicity of creatures and in their very many natures one finds the different remains of the one divine image, differing in quality to the degree to which they are able to draw near to God. You who carefully study the nature of things, have you not perhaps found that their differences is one of gradations? From the geological strata, that of minerals and inanimate bodies you then move on to plants and from plants to irrational creatures and, finally, from irrational animals to man. Does not the very fact of such diversity dictate a certain inequality between things and that all should be graded in an ascending order? In this order and in these grades we see nature and her different forms brought forward according to their perfections and strengths. They are ordered according to their actions and their purposes, their reactions and their compositions, their substance and quality. From these we find their properties, their differing agents with their concomitant impressions and differing effects; they differ because

God has made them such, determined and steered towards a particular goal and a particular action (Cf. *Contra Gent.*, 1, III, Ch., 97). In this inherent necessity of things, which is nothing other than part of the Divine Plan to bring all things to particular end, in the same manner as an archer might direct his arrow to the appropriate goal, in this necessity lies the law of the nature of physical bodies, a law which is part of their very nature (S. TH., P. I, q. 103, art. 1 ad 3). In the same way as a man may imprint a certain manner of acting onto another man through the issue of a command, so too does God imprint all of nature with the principle of her actions (S. TH., I^a II^{ae}, q. 39, art. 5). So that—in accordance with the teaching of the great Doctor of the church, Thomas Aquinas—when someone asks the reasons for a particular natural effect, we are able to offer the explanation that the cause was due to the natural property of the thing even though all is brought back ultimately to the will of God as first cause, wise teacher of all of nature. So if a person is asked for the reason explaining why fire gives off heat and answers that this is because it is part of God's will, he would in fact be answering correctly if he wished to discuss the issue in terms of first cause, he would, however, have answered badly if he intended to exclude all the intervening causes (*Contra Gent.*, 1, II, Ch. 97).

All men are brothers attending the same Divine school

As God's creatures, the first cause also imprinted a sacred law within us, a sublime instinct, particular to man, which enables us to gain an immediate knowledge of God; desire 'which is a spiritual movement, and never rests until the object of its love makes it rejoice' (*Purgatorio*, Canto XVIII, 32-33). If our flesh comes from the dust of the earth and is destined to return to it, then our spirit is immortal and, coming from God, it attempts once more to climb to God on the ladder of science but never actually managing to satiate its thirst for truth. The world is the Divine school, teacher of every science; when this school passes away we shall all remain face to face before God the Teacher. Let us then bow down before His wisdom since we can never overcome all the obstacles to a full knowledge of His wisdom; let us bow because of His great gift of this vast school-room which is filled with marvels and surrounded by even greater and immeasurable wonders; which were seen to be good once God had created them (*Gen* 1:31). You yourselves have no doubts about it; you who have a better appreciation of the vastness of creation, the way and degree of perfection, the diversity and the beauty of the vast number of individual grades and the way in which their

different weights determine their appropriate functions and operations; you who both love and magisterially promote the world of sciences. Is not also your science a brilliant reflection of divine science which one glimpses, at times clearly and at times obscurely, in the centre of things as they are in themselves? And yet, in the hands of men, science can become a two edged sword which can either bring health or death. Cast a glance at the blood-filled fields and seas and then ask yourselves whether it was for this that our provident and omniscient God made in His own image, redeemed him from his guilt and gave him new life with many graces from heaven; ask yourselves if God created such a developed intellect and warm heart so that man could then treat his brother as an enemy.

In the Divine school we are all brothers; brothers in our contemplation, in our study and employment of nature; brothers in life and in death; we pray before the crib of Our Lord, an infant who continues to love in silence, observes and then judges mankind which is tearing itself apart, that all men become brothers once more in love and in the victory of good in justice and peace over evil.

In this solemn assembly, honoured by the presence of Lord Cardinals, Distinguished Diplomats, persons of high rank, and men noted for their devotion to knowledge, Our eye, once again, turns to you, Most Excellent Members of the Academy, wise and untiring investigators of the universe. No doubt you never cease to admire the universe, if it is true what Plato puts in the mouth of Socrates and taught to his disciple Aristotle, that the feeling of wonder is most appropriate for the lover of wisdom, since without it, philosophy has no other beginning, whatever way it may be understood. (In the *Theaitetos*, no. XI). You admire this universe from the outermost limits of the starry sky to the tiniest structure of the atom; and in the grandiose magnificence of the created world, you see the temple of order and of divine power. You know, you admire the immeasurable greatness of this universal machine. At the very least, the immensity of its boundaries, the multitude of its bodies and elements, the velocity of its movements, and the variety and beauty of its parts are to be appreciated. While—as We already observed in Our last discourse in this Academy—the most wonderful thing to be considered is the disposition of order, which distinguishes and unites all, interweaves and links together, and harmonises the very same discordant irrational natures with so much fidelity and mutual bond. Although each is operating according to the different instinct of its own inclination, they all conspire to an end without wishing it, from a beginning without knowing it (Cf. BARTOLI, *Delle grandezze di Cristo*, Ch. 2). You contemplate, measure, study such a universal order: it is not, nor can it be, the fruit of absolute blind necessity, and neither can it be even of chance or luck: chance is a part of fantasy, and luck, the dream of human ignorance. In order, you seek a reason which intrinsically governs it, an arrangement of reason in a world which, even without life, moves itself as if it lived, and works by design as if it intended. In a word, you seek the law, which is precisely an arrangement of reason of One Who governs the universe and has fixed it in nature, and in the movements of its unconscious instinct.

Importance of the Question

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

Changes in the concept of the Physical Law - Dynamic and Statistical Laws

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

goddess on the altar of science, and at its absolute dominion come to yield not only the world of matter, but also the kingdom of life and spirit, subject and liege to the birth of materialistic monism. The universe therefore, was not different from the unmeasured empire of movement; and according to one such conception, as Du Bois-Reymond exposes synthetically in his discourse *Über die Grenzen des Naturerkennens*, (Leipzig 1907), a universal mechanical formula had to exist, knowing which, a universal genius or 'Laplacian' mind, would be able to understand fully everything that happens in the present. Nothing then would be uncertain for him, with both the buried past and the furthest future presenting themselves clearly at his glance. This concept was also expressed by the great French mathematician Henri Poincaré, when he wrote: "*Tout phénomène, si minime qu'il soit, a une cause, et un esprit infiniment puissant, infiniment bien informé de lois de la nature, aurait pu le prévoir dès le commencement des siècles*" (*Science et méthode*, p. 65). The postulate on "closed physical causality" consequently would not allow any exception, nor any intervention in the course of physical activities, for example, the case of a miracle. But this postulate equals the old saying in which, given the cause, even a sufficient one, the effect comes about necessarily. The great Doctor, Saint Thomas Aquinas, with Aristotle, demonstrated this saying as false, because not every cause is such, even when it is sufficient, that its effect is not possible to prevent itself, at least for free human action. In other words: every effect necessarily has a cause, but not always a cause operating necessarily, there being also causes which act freely. (Cf. *In libros Peri hermeneias*, 1. Ch. IX Lect. XIV, no. 11.).

And yet a man of Virchow's ability uttered these serious words at the 47th annual assembly of German scientists and doctors: "A presumption of natural science is uncertain, unless we affirm that natural laws are absolutely effective in all circumstances, and are not liable to suspension at any time". But Virchow had not seen all the circumstances of past events nor those to come; and his words were truly a presumption, as the scientific unfolding of the last ten years allows us easily to recognise. The crass materialism of the past has shown itself untenable, or has been transformed into that dark angel of light, (Cf. *Eph* 6:12; *2 Cor* 11:14), which is cloaked with spirit or with pantheism. The affirmation of natural laws, not tolerating any exception, has been shaken to such an extent by the progress of exact science, that nowadays one falls into the other extreme of speaking only of intermediate rules, of statistical norms and laws of probability. Such thought is legitimate insofar as many laws of the sensible world or

macrocosm show a statistical character—since they do not express the mode of behaviour of every single being, but the average process of an immense number of similar beings—and so they lend themselves to be treated by means of probability calculations.

But the will to see only statistical laws in the world is an error of our times, as one alienated from the nature of human genius, who

*with his senses only, learns what
he later will do in the light of reason* (Par. IV, 41-42)

— it is the assertion that it could do completely without the old, rigidly dynamic conception of the natural law, and that it may have become empty of sense. In fact, the recent positivism riding in tandem with conventionalism, has gone so far that it even puts in doubt the value of the causal law.

What is science?

This positivistic thought is now rejected with good reason by sound philosophy. What indeed is science, if not the certain knowledge of things? And how is it possible to acquire this knowledge, if the principles and the causes of things are not investigated, from which proceeds the demonstration of their existence, and of their nature and action? You observe, research, study and experiment with nature in order to understand its principles and intrinsic causes, so as to penetrate the governing laws of its constitution and action, to set in order the process of such laws, and to deduce from it a science with principles, causes and conclusions following through logical consequence. Consequently, you seek the regularity and order in the various kingdoms of creation; and which the investigating spirit of man has discovered in its great richness!

The system of natural laws

A) In the inorganic world

Behold indeed, even only because of hints, in the macrocosm of purely physical-chemical phenomena, the numerous particular laws of mechanics of solid, liquid, and gaseous bodies; the laws of acoustics and of heat, of electricity, of magnetism and of light; the laws of the progress of chemical reactions, and of chemical equilibria in organic and inorganic chemistry. These particular laws are often elevated to higher and more

general norms, so groups of natural phenomena, which at first glance seemed devoid of every internal relation, may be understood and recognised in greater number, as consequences of a superior law. Behold the laws of planetary motion to be connected to the universal law of gravitation. Have not the famous equations of Maxwell built a bridge between optical and electrical phenomena, and are not all natural phenomena in the inorganic world subordinate to the law of constancy and entropy? If until recently two constant laws were known—that of the conservation of mass and that of the conservation of energy—the most recent research has proved with ever more convincing facts and arguments that every mass is equivalent to a determined quantity of energy and vice versa. Therefore, the two ancient laws of conservation are, in effect, special applications of a more general higher law, which says: In a closed system, despite all changes, even where there is a considerable transformation of mass into energy or vice versa, the sum of both remains constant. This higher law of constancy is one of the keys the atomic physicist uses today to penetrate the mysteries of the atomic nucleus.

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

And these intimate processes of the investigation of the atom will appear as really surprising to us, not only because they open up before our eyes a world hitherto unknown, whose richness, multiplicity, and regularity seem somehow to vie with the sublime grandeur of the firmament, but also for the unpredictably grandiose effects that technology itself can expect from them. In this connection We cannot abstain from mentioning an astonishing phenomenon about which the Nestor of theoretical physics, Max Planck, Our Academician, has written in a recent article of his, *Sinn und Grenzen der exakten Wissenschaft* (In *Europäische Revue*, Februar 1942). The curious transformations of the atom have for many years occupied only research workers in pure science. The

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

B) In the spheres of vegetative and sensitive life

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

life, too, is regulated by natural laws, for the most part of such a quality that to define them precisely becomes more difficult the higher they stand in the order of being.

Objective reality of knowledge

This admirable and ordered system of qualitative and quantitative, particular and general laws of the macrocosm and the microcosm, is today largely unveiled in its intricacy to the scientist's eyes. And why do we say unveiled? Because it is not projected or constructed by us into nature, thanks to some innate subjective form of consciousness or of the human intellect, nor is it created purposely on behalf and for the use of such an economy of thought and study, that is, to facilitate our knowledge of things; nor is it finally, the fruit or the conclusion of agreements or understandings among scientists studying nature. Natural laws exist, so to speak, incarnate and secretly operative within nature, and we, by observation and experiment, look for them and discover them.

It cannot be said that matter is not a reality, but an abstraction fashioned by physics; that nature is in itself unintelligible and that the world that can be apprehended by the senses is a world apart, where the phenomenon, which is appearance of the exterior world, gives us a vague notion only of the reality of the things it hides. No: nature is reality, recognisable reality. If things seem to be and are mute, they have, however, a language that speaks to us, that emerges from their bosom, like water from a perennial spring. This language is their causality which reaches our senses with the sight of colours and movement, with the sound of metals, the roar of whirlwinds, and the cries of animals, with the sweetness and the bitterness of honey and gall, with the scent of flowers, with the weight and temperature of their material substance, impressing upon us an image or likeness which is the vehicle for our intellect to lead us to the reality of things. Hence we speak not of the image or likeness of our intellect, but of the things themselves; and we can distinguish the phenomenon of the world of the senses from the substance of things, the appearance of gold from the gold itself, as the appearance of bread from bread itself, from whose substance we make food in order to assimilate it and identify it with the substance of the body itself. The movement of things toward us calls forth an image in us; without an image there can be no conformity of our intellect with real things, and without an image knowledge becomes impossible; and we cannot call anything true unless it has some equivalent in our intellect. The things from which our mind takes its knowledge

provide measurements to our mind and to the laws we find in them and take from them; but they, in turn, are measured by that eternal divine intellect which embraces all things created, as the mind of the craftsman embraces every work of his art. (Cf. ST. THOMAS AQUINAS, *De veritate*, q. 1 a 2). What do the hand and the brain of the scientist do? They discover them, reveal them, distinguish them, and classify them, not like one who follows flying birds, but like one who is in possession of them, and is investigating their nature and intrinsic properties.

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

Confutation of phenomenalism

But do not be mistaken, like those philosophers and scientists who thought that our cognitive faculties know only their own mutations and sensations, so that they were induced to say that our intellect arrived at knowledge only from the images of things, and, therefore, that only the images of things, and not the things themselves, were the object of our science and of the laws we formulate with respect to nature. A manifest error! Are they not in all probability the same things, both those things which you interpret, and those things of which your science speaks, reasons, and discusses? Are We speaking to you yourselves, or to the images that are formed in Our eye from seeing you present here? If consequently what you interpret and know were only the images

of your sensations, it would follow that all your physical sciences, from the stars to the atom, from the sun to the electric lamp, from the minerals to the cedars of Lebanon, from microbes to man and to the medicines for his infectious diseases, would not deal with things that are outside of your mind, but only with those intelligible similarities which you contemplate inside your mind perhaps dreaming. Science, exalted by a Copernicus and a Galileo, a Kepler and a Newton, a Volta and a Marconi, and other famous and distinguished investigators of the physical world that surrounds us externally, would accordingly amount to a beautiful creation of day dreaming and a beautiful phantasm of physical knowledge; appearance would take the place of the reality and truth of things; and it would be just as true to assert as to deny the same thing. But no; science knows not dreams or images of things, but the things themselves through the images we receive from them, because, as the Angelic Doctor, following Aristotle, has taught a stone cannot be in our mind, but the image or figure of the stone can—the image which it produces, a true likeness, in our senses and then in our intellect, so that by this likeness it can be, and is, in our mind and in our study and make us return to it and to reality. Even the recent research in experimental psychology testifies, or rather confirms, that these likenesses are not the mere product of autonomous, subjective activity, but psychic reactions to stimuli independent of the subject, coming from the things themselves; reactions in conformity with the different qualities and properties of things, which vary with the variation of the stimulus.

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

Conclusion

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

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

Speculative sciences and practical sciences

As we are here with you, illustrious members of the Academy, to inaugurate the new year of this Pontifical Academy of Sciences, Our thought cannot but return once again to Our unforgettable and incomparable Predecessor, the founder of this most noble scientific Institute, and remember him in those white vestments to which the white snow of the alps seemed a prelude and a greeting of paternal stature—the snow being pressed down one day with his bold and confident steps, risking dangers, abysses and storms, intent upon reaching not only the peaks of the mountains of nature, but also the summits of speculative and practical truth. As he climbed is seemed as if the mountains were rising with him and the fields were descending with him: *ascenderunt montes, descenderunt valles*, (Ps 103:8),—the mountains rose, the valleys sank down—and when he descended, he marvelled again at the whiteness of the Cathedral of his Milan, which was like a brilliant alpine mountain with spectacular peaks rising in the middle of the Lombard plains. You too have climbed the mountains of knowledge, of the speculative sciences, of calculation, of astronomy, of the vortices of the stars, and of the nebulae; and you have descended to the plains of the practical sciences using the thousands of forms of art, technology and experiment; for it is the great power of the human speculative intellect to be able to put its hand into practice and become a practical intellect, making the immutable laws and the materials of nature a guide and support for its actions, which are always regulated and sustained by the government and the providence of God.

Conception and objective value of natural laws

But on our globe, under our eyes, man appears master and potent above all the natural living creatures—man, to whom God assigned the duty to multiply and to populate the earth and procure the bread on which he lives; therefore, it is not astonishing that the great philosopher Aristotle should compare the human soul to the hand, the organ before all other organs. Everything, in fact, we owe to the hand: cities and fortresses

monuments, books of knowledge, of science, of art and poetry, the inheritance and the patrimony of libraries and of human civilization. Similarly, the soul has been given to man, one might say, in place of all sorts of things so that he might procure, in some way, all these things, inasmuch as our souls can receive through the senses and intellect all the shapes or images of the things themselves. Realise then that We admire the hands and the intellects of the disciples of nature, which you are, in your schools, in your laboratories, in your offices, in your workshops, in your arsenals. But you are at the same time teachers, and you teach and project beyond yourselves, not the physical and intellectual forms of your souls, but by means of these, that which nature has caused and projected in your cognitive faculties. In your imaginations and in your minds you form, invent and construct wonderful images and plans of devices, of instruments, of telescopes, microscopes and spectroscopes, and of thousands of other means available nowadays to tame, harness and to direct the natural forces; however your art does not create the material which is in your hands, but only modifies it with cognitive skill, and rules its action according to the laws which you have discovered for yourselves, combining and matching your practical and technical knowledge of the reality of things with your speculative knowledge of the same real things.

Thus the general law of nature which the scientist formulates with patient observation and diligence in his laboratory is much more and better than a mere description or intellectual calculation, which considers only phenomena and not the real substances with their properties. It does not stop at, nor is it satisfied by, the appearance and the image of senses, but penetrates into the depths of reality, searches and discovers the intimate, hidden forces of the phenomena, manifests their activity and relationships. It is therefore easy to understand that the knowledge of the laws of nature makes it possible for man to dominate the natural forces and place them at his service in the highly advanced modern technology. Only in this way can human thought elevate itself to understand how the regular order of the spectroscopic lines, which the physicist observes and distinguishes today in his laboratory, will disclose perhaps tomorrow to the astrophysicist a deeper vision and knowledge of the mysteries of the composition and development of the celestial bodies.

Thus from the foundation of the law of nature, with the active help of modern technological means, and by the positive and true knowledge of the internal tendencies of the elements and of their effects in the natural phenomena, the scientist proceeds, against all difficulties and obstacles, to further discoveries, pursuing his research with constancy and perseverance.

The Atomic Era

The most grandiose example of the results of such intense activity seems to be found in the fact that man's relentless efforts have finally succeeded in reaching a deeper knowledge of the laws which concern the formation and disintegration of the atom, and in that way to master experimentally, up to a certain point, the release of the powerful energy which emanates from many such processes, and all this not in submicroscopic quantity, but in truly gigantic measure. The use of a great part of the internal energy of the nucleus of uranium, about which we spoke in Our speech in this Academy on the 21st of February 1943, referring to a work by the great physicist Max Planck (who died recently), has become a reality and has had its application in the making of the "atom bomb" or "nuclear energy bomb", the most terrible weapon which the human mind has conceived up to date.

In this state of affairs We cannot refrain from expressing a thought which constantly weighs upon Our soul, as well as upon that of all who have a true sense of humanity; and in this connection We recall the words of St. Augustine in his treatise *De Civitate Dei*, where he talks about the horrors of war, even of a just war: "Of which evils"—he writes—"if I were to narrate, as it should be, the many and manifold devastations, the harsh and cruel sufferings, although it would be impossible to do justice to the subject, when would we reach the end of the long dispute? Whoever considers with sorrow these horrible and fatal evils must confess their misery; but whoever endures them and thinks of them without anguish in his soul, much more miserably believes himself to be happy, because he has also lost human feeling" (*Lc 19, c. 7*). But if the wars of that period already justify such a severe judgment of the Great Doctor, with what words should We judge at present those which struck our generations and bent to the service of their work of destruction and extermination a technology incomparably more advanced? What misfortunes should humanity expect from a future conflict, if it should prove impossible to arrest or curb the use of ever newer and ever more surprising scientific inventions?

But putting aside, for the moment, the use of atomic energy in war, and in the confident hope that it will be directed instead solely to projects of peace, it must be considered a truly inspired investigation and application of those laws of nature which regulate the intimate essence and activity of inorganic matter.

In truth, properly speaking, this involves only one single great law of nature, which manifests itself above all in the so-called "periodic

system of the elements". Lothar Meyer and Demetrius Mendeleev in 1869, on the basis of the scanty chemical data known at the time, cleverly suggested it and gave that system its first provisory form. It had, however, many lacunae and incoherences; its profound meaning was still obscure; nevertheless it suggested an intimate affinity between the chemical elements and a uniform structure of their atoms from equal subatomic particles. Later, the picture became clearer year after year, the defects and the imperfections disappeared, and the profound meaning was revealed. We restrict Ourselves here to remembering briefly some of the more important stages in this quest: the discovery of radioactive elements by the Curies; the atomic model of Rutherford, and the laws governing it as proposed for the first time by Bohr; the discovery of isotopes through the work of Francis William Aston; the first fragmentations of nuclei by means of natural alpha rays, and a short while later the synthesis of new heavy nuclei by bombardment with slow neutrons; the discovery of the transuranics proposed by Fermi, and the production of transuranic elements in large quantities, and among these first of all of plutonium, which constitutes the active part of the bomb, and is obtained in the gigantic "Uranium Piles"; in a word, a coherent development and improvement of the natural system of the chemical elements in fulness and in profundity!

If therefore we embrace in one glance the result of this marvellous work, we see that it represents not so much a conclusion as the access to new knowledge and the principle of what has been called the "Atomic Era". Up to a short time ago, science and technology had been interested almost exclusively in the problems regarding the synthesis and analysis of molecules and chemical compounds; now, instead, the interest is concentrated on the analysis and synthesis of the atom and of its nucleus. Above all, furthermore, the work of scientists will have no rest until it finds an easy and sure way to govern the process of splitting the atomic nucleus, in order to make its very rich sources of energy serve the progress of civilisation.

How amazing are the conquests of the human intellect, which scrutinizes and investigates the laws of nature, carrying humanity with it along new paths! Could one envisage a more exalted concept?

The law of nature participating in the eternal law of God

But law means order; and universal law means order in great things as well as small. It is an order deriving immediately from the intimate tendencies innate in natural things; an order that nothing can create by

itself or give of itself to itself, as no being can give itself to itself; an order that signifies the Order of Reason in a Spirit which has created the universe and on which "depend Heaven and the whole of nature"; an order which those tendencies and energies received as they came into being and through which both collaborate for a well-ordered world. This marvellous assemblage of natural laws, which the human spirit, with tireless observation and accurate study, discovered, adding victories upon victories over the occult resistances of the forces of nature, what else is it but an image, through pale and imperfect, of the great idea and of the great divine design, which in the mind of God the Creator is conceived as a law of this universe since the days of His eternity? Then, in the inexhaustible thinking of His wisdom, He prepared the heavens and the earth, and then, creating the light on the abysses of chaos, cradle of the universe also created by Him, He gave a beginning to motion and to the flight of time and of centuries, and called into being, into life and activity, all things according to their species and their kind, to the most imponderable atom. How rightly every intellect which contemplates and penetrates the heavens and weighs the stars and earth should exclaim, turning to God: "*Omnia in mensura et numero et pondere disposuisti*" (*Wis 11:21*). (You have disposed everything in measure and number and weight). Do you not feel, within your souls, that the firmament which enwraps us and the globe which we tread narrate together with your telescopes, with your microscopes, with your scales, with your rules, with your multiform devices, the glory of God, and reflect, as you look, a ray of that uncreated wisdom which "*attingit a fine usque ad finem fortiter, et disponit omnia suaviter*"? (*Wis 8:1*). (Reaches mightily from one end of the earth to the other and disposes all things well).

From this comes the closed unity of natural laws

The scientist almost feels the palpitation of this eternal wisdom, when his research reveals to him that the universe is formed as in one casting in the boundless foundry of time and space. Not only the starry heavens shine, composed of the same elements, but they even obey the same great and fundamental cosmic laws, always and wherever they appear, in their internal and external action. The same laws of gravitation and of the pressure of radiation determine the quantity of mass for the formation of the solar bodies in the immensity of the universe up to the farthest nebulous spirals; the same mysterious laws of the atomic nuclear regulate, through atomic composition and disintegration, the economy of the energy of all fixed stars.

This absolute unity of design and government which manifest itself in the inorganic world you find no less grandiose in the living organisms. What else does a simple look at the universal and common structure of the organisms and at the most recent discoveries and conclusions of anatomy and comparative physiology show you? Take the construction of a skeleton of a higher living being with analogous organs, and especially the disposition and function of sensitive organs—for instance, of the eye from the simplest forms to the very perfect visual organ of man; take, in the whole realm of living creatures, the fundamental laws of assimilation, metabolism, and generation. Does not all this indeed show a general and magnificent unified concept, realized and resplendent in various forms and in very many different ways? Is this not perhaps the closed and absolutely fixed unity of natural laws?

Yes; it is a unity closed with the key of that universal order of things against which, inasmuch as it depends on the first Cause of a Creative God, God himself cannot act; because, if He should do so, He would operate against His own prescience or His will or His goodness; now, in Him “there is no change, nor the shadow of variation” (*Jas* 1:17). But if this order is considered dependent on secondary causes, God possesses its key and can leave it closed, or open it and operate beyond it. Could it be that God, in creating the universe, made Himself subject to the order of secondary inferior causes? Is not this order subject, indeed, to Him, emanating from Him, not as necessity of nature, but from arbitrary will? Hence He can act beyond the instituted order when He pleases; for instance, by working the effects of secondary causes without recourse to them, or producing other effects, to which they do not extend. Thus the Great Doctor St. Augustine wrote: “*Contra naturam non incongrue dicimus aliquid Deum facere, quod facit contra id quod novimus in natura ... Contra illam vero summam naturae legem ... tam Deus nullo modo facit, quam contra se ipsum non facit*” (*Contra Faustum*, 1. 26, c. 3) (it is not incongruous to say that God acts contrary to nature in as far as it is contrary to that which we knew in nature ... But just as He does not act against Himself, so in no way does He act contrary to that truly supreme law of nature). What works then are these? They are works of which God alone holds the key to their secret and which He reserved for Himself in the passage of time amid the particular order of subordinated causes, “subsequent works”, as the Divine Poet sang, “to which nature never heated the iron, nor beat the anvil” (*Par* 24:101). Before such works, extraordinary either because of the substance of the fact itself, or because of the person in which they manifest themselves, or because of the

manner and order in which they are accomplished, people and scientists stand astonished. The miracle is born when the effects are manifest and the cause concealed. But the ignorance of the hidden cause, which astonishes the unbeliever, sharpens the eyes of the faithful and of the learned, who, within certain limits, know and measure how far the work of nature, with its laws and forces, reaches; beyond that point they see the work of a superior, hidden and omnipotent hand, that hand which created the universal order of things, and in the process of the particular orders of cause and effect marked the moment and circumstances of its marvellous intervention.

Such a conception fills the scientist with enthusiasm ...

This divine government of the universe certainly cannot but arouse a feeling of admiration and enthusiasm in the scientist, who in his research discovers and recognizes the traces of the wisdom of the Creator and supreme Legislator of Heaven and earth, Who with the hand of an invisible pilot guides all the creatures "to different ports—through the great sea of being—each one endowed with the instinct which carries it" (*Par* 1:112-114). Yet what are the tremendous laws of nature if not a shadow and mere idea of the depth and immensity of the divine design in the grandiose temple of the universe? "The supreme privilege of the scientist", wrote Kepler, "is to recognize the spirit and retrace the thought of God". Often—we have to confess our human weakness—before the vision of things and the images of our senses, that thought becomes dim and retreats; but if the thought of God enters the work of the scientist, he does not confuse it which the movements or images he sees within or outside himself; and that disposition of soul to search for and recognise God gives him, in his laborious study, the proper enthusiasm and copious compensation for all the labours endured in the interest of research and discovery, and, far from making him proud and conceited, teaches him humility and modesty.

... but also with humility

Certainly, the more deeply the cultivator of knowledge and sciences pushes his research into the wonders of nature, the more he feels his insufficiency to penetrate and exhaust the wealth of the design of the divine construction and of the laws and norms which govern it; and you have heard the great Newton saying with incomparable beauty and emphasis: "I do not know how I appear to the world, but to myself I appear like a child, who plays on the shore of the sea and rejoices,

because he finds every now and then a smoother pebble and a less well-known shell than usual, while the great ocean lies before him unexplored". These words of Newton, today, after three centuries, in the modern ferment of the physical and natural sciences, sound more than ever true. Of Laplace we hear that, while he was lying ill and the friends who were around him were remembering his great discovery, he replied, smiling bitterly: "that which we know is small, but that of which we are ignorant is immense". No less acutely did the illustrious Werner von Siemens, who discovered the principle of the self-excitation of the dynamo, attest at the 59th reunion of German scientists and doctors: "The more intimately we penetrate into the harmonious order of the forces of nature, regulated by eternal, immutable Laws—and nevertheless profoundly veiled from our knowledge, so much so that we feel the more spurred to a humble modesty—the more restricted the sphere of our cognition appears to us, the more alive becomes our effort to attain more and more from this inexhaustible source of knowledge and power, and the higher grows our wonder before the infinite ordaining wisdom, which permeates all of creation".

In truth our knowledge of nature is modest in extension and often imperfect in content. In a treatment of the electromagnetic theory of light one could read the words: "Could it be that a God wrote these formulae?". Certainly Maxwell's equations are clever; and they, like every similar advancement in theoretical physics, suppose and imply, so to speak, a simplification and idealization of concrete reality, without which a fruitful mathematical treatment is impossible. So often today can one propose only rules instead of laws, or only partial solutions instead of general solutions! Wherever a regular behaviour appears in the cooperation, at first sight without any rule, of innumerable particular phenomena, the scientist has to be satisfied with assigning the character and the form of the behaviour of the masses according to considerations of probability, and, ignorant of the dynamic basis for the particular, to formulate statistical laws.

The progress of science is incessant. It is true that the successive stages of its progress have not always followed the path which from first observations and discoveries leads directly to the hypothesis, from the hypothesis to the theory, and finally to the certain and unquestionable attainment of the truth. There are instead cases where the investigation follows a sort of curve; cases, in other words, in which theories that seemed to have already conquered the world and reached the apex of undisputed doctrines, acceptance of which brought esteem in the realm

of sciences, fall again to the level of hypotheses, to remain perhaps, later, completely abandoned.

Notwithstanding, however, the inevitable uncertainties and deviations that any human effort brings with it, the progress of sciences knows no pauses nor leaps, while the researchers of truth pass on from one to the other the investigating torch, to illuminate and develop the pages of the book of nature, thick with enigmas. Just as in things which develop naturally, notes the Angelic Doctor St. Thomas, the perfect is reached little by little from the imperfect, so it happens to men concerning the cognition of truth. In fact, from the beginning they have conquered a little of the truth, and then step by step they have arrived at a fuller measure of it, not attributing the origin of the world and things in general to chance or to fortune; but intuiting the truth with more careful perspicacity, they deduced from the available indications and from reason that natural things are ordered by a providence. Indeed, how would one find the invariant and certain path in the motion of the sky and the stars and in the other effects of nature, if all this were not governed by a super-eminent intellect?

Through new and broader avenues, humanity is advancing, but always like a pilgrim, towards a deeper knowledge of the laws of the unexplored universe, as it is spurred on by the natural thirst for truth; however, even after thousands of years, human knowledge of the internal principles of the moving forces of the growth and processes of the world, and even more of the design and divine impulse which penetrates, moves, and directs everything, will be and will remain an imperfect and pale image of the divine conception. In the face of the prodigies of eternal wisdom which, in the sea of the living, governs everything with undeviating order and directs all things towards hidden harbours, the investigating thoughts of the scientist are blind and mute, and give way to that humble, admiring adoration that sees before it the marvel of creation, in which his hand was not present and which he cannot imitate, but in which his eye can discern a sudden flash of the power of God. Before the many inscrutable enigmas of the order and concatenation of the laws of the immensely great and immensely small cosmos, the human mind must repeat the exclamation: "*O altitudo divitiarum sapientiae et scientiae Dei: quam incomprehensibilia sunt iudicia eius et investigabiles viae eius!*" (Rom 11:33) (O the depth of the riches, of the wisdom, and of the knowledge of God! How incomprehensible are His judgments, and how inscrutable His ways!). The scientist is fortunate, if in passing through the vast celestial and terrestrial fields, he knows how to read in the great book of nature and listen to the

cry of its word, making manifest to men the footprint left by the divine step in creation and in the history of the universe! The footprints and the syllables written by the finger of God are indelible: footprints and syllables are the facts from which the divine is released into all minds; and the words of the Doctor of the peoples seem to be written especially for wise, investigating intellects: "*Quod notum est Dei, manifestum est in illis: Deus enim illis manifestavit. Invisibilia enim ipsius a creatura mundi, per ea quae facta sunt, intellecta conspiciuntur, sempiterna quoque eius virtus et divinitas*" (Rom 1:19-20) (What can be known about God is plain to them, because God has shown it to them. Ever since the creation of the world His invisible nature, namely, His eternal power and deity, has been clearly perceived in the things that have been made!). In one of the inscriptions which decorated the tomb of the great astronomer Angelo Secchi on the day of his funeral it read: "*A caeli conspectu ad Deum via brevis*" (it is a short way from observing the sky to God).

Looking from this higher observatory at the world and the universe which are at the feet of God, it is not hard to understand how natural things act so unavoidably, and conform without exception to the tendencies of their various natures, but which no natural tendency can oppose to the supreme Creator, Preserver, and Governor Who stands above the things sanctioned by Him and given to creatures, while He remains free for His own wise reasons to impede or change the effects and activities of such tendencies in a different direction for particular cases. In the presence of the marvellous reality of the cosmos, which the scientist contemplates, studies and scrutinizes, the universal spirit devised by Laplace, with his formula which, at least according to the concept of materialists, should also include events dependent on thought and on free will, appears as a utopian fiction; instead, infinitely real truth is that divine Wisdom which knows and measures every smallest atom with its energy, and assigns to it its place in the framework of the created world, that supreme Wisdom whose glory penetrates throughout the whole of the universe and shines with the greatest light in heaven.

Discourse of His Holiness Pope Pius XII given on 7th June 1949 at the Solemn Audience granted to the Plenary Session of the Academy and to the Study Week on the theme "The Biological Problem of Cancer".

If the especially heavy duties which weigh upon Our shoulders, particularly at the present time, deprive Us, to Our great regret, distinguished scholars and teachers, of the satisfaction of speaking to you at leisure, We cannot, however, resist the desire to welcome you and to tell you of the very friendly interest We take in your work. Because of its objectives it is a work of capital importance and it will surely be fruitful, thanks to your incomparable competence and to the methods of this academy.

Your work is concerned this year with the "biological problem of cancer", that horrible scourge whose very name terrifies us, which incessantly ravages a notable portion of humanity; a dreadful scourge where surgical or radiological treatment in too many cases only postpones the fatal outcome. And until the end, what physical suffering, what moral anguish! In its internal forms, mysteriously hidden, cancer does not ordinarily show its presence until its progress has already made it nearly incurable. Little by little, it silently eats away at vital organs, in many cases rendering difficult or impossible any absorption or assimilation of food for which, moreover, it sometimes causes an insurmountable repugnance. And it pursues its work of destruction until all is consumed.

In other forms it openly devours the flesh of its victims; it disfigures them, mutilates them in so frightful a fashion that those who, moved by the tenderness of their affection or by the heroism of their charity, approach them, if they can overcome the natural repugnance they feel, are not always able to hide their reactions from the invalid. Those suffering from cancer even seek out the miserable loneliness from which they frequently suffer, by voluntarily shutting themselves up for fear of letting themselves be seen as they are. Deprived by this very isolation from any human consolation, their sadness sometimes leads them to the last extreme of despair, to the temptation of ending a life which only a firm faith in another life of eternal happiness helps them to bear with patience.

This evil appears all the more frightful when one is faced, as he is at least up to now, with the feeling that he is helpless, or nearly so. When from time to time someone imprudently announces news of a sensational discovery which will finally bring about a radical and definitive victory over this pitiless destroyer, there only follows, alas, for those who allow themselves to be deceived, or even ask to be deluded, a crueler and more profound disappointment than the many others that have preceded it.

How much more modest and, therefore, how much higher and surer is your ambition, gentlemen! In reality, a great many hypotheses have been brought forth and many theories have been timidly built up and discreetly proposed. They are certainly not to be belittled because, even if they are not verified, they open the door to new and more effective research. They mark, therefore, some progress, doubtless valuable, but of necessity very slow. You, who have applied yourselves for many years to the conscientious study of cancer, of its manifestations and symptoms, of its nature and its causes or, at least, of the conditions of its origin and development, aspire, each in his own specialty but in constant contact with each other, to continue your advance step by step toward the light which will enable you to seek more easily and to find, first, a remedy which prevents or which alleviates and, finally, one that cures cancer.

Observations carefully made, diligently collected and compared, even if they are not conclusive, nevertheless suggest useful reflections on the nature and possible action of various agents, cancerous, physical or chemical, on the role of the atmosphere, the sun, a man's profession or heredity in the appearance and growth of tumours and in the evolution of a cell from a normal to a malignant state.

These observations, experiments and investigations you know how to pursue assiduously and patiently, and of which the general public often takes little account. They will not, perhaps, give you noisy publicity, but you will merit, as your conscience tells you, the gratitude of generations to come.

It pleases Us to praise here the initiative of Our Pontifical Academy, under whose auspices you have begun your Study Week. Always eager to serve the progress of science for the greater good of humanity, it asks you to specify, following its standard methods, "the points on which agreement has been reached, the points on which agreement could not be reached, the reasons why agreement could not be reached, and suggestions concerning the research that appears most likely to resolve the

difficulties". Your proper intentions and spirit could not, We think, be better expressed.

These are surely the things, distinguished scholars, that ought to encourage you to pursue your work with the confidence that it is not undertaken in vain. For your work tends, as your programme states with modest assurance, "to open up, on a scientific basis perspectives looking towards a biological cure for malignant tumours".

We wish for you, in your mutual work, happy and fruitful results, asking with all Our heart for God's light and blessing on it.

Discourse of His Holiness Pope Pius XII on 22 November 1951 at the Solemn Audience granted to the Plenary Session of the Academy and to the Study Week on "The Question of Microseisms".

We are grateful to the Almighty for an 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 investigating and unveiling the secrets of nature and teaching men to direct their energies for their good, at the same time you preach, in the language of numbers, formulae and discoveries, the ineffable harmonies of the all-wise God.

Contrary to rash statements in the past, the more true science advances, the more it discovers God, almost as though He were standing, vigilant and waiting, behind every door which science opens. Furthermore, We wish to say that not only does the philosophical thinker benefit from this progressive discovery of God, achieved in the increase of knowledge—and how could he do otherwise?—but those also profit who participate in the new discoveries or who make them the object of their considerations. The genuine philosophers especially benefit from it, since, by using the scientific advances as a springboard for their rational speculations, they can achieve greater security in their conclusions, clearer illustrations in possible obscurity, more convincing support in finding ever more satisfactory answers to difficulties and objections.

Nature and basis of proofs for the existence of God

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

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

But if the primitive experience of the ancients was able to offer sufficient arguments to reason to demonstrate the existence of God, now, with the amplification and deepening of the field of experience itself, the imprint of the Eternal upon the visible world is all the more splendid and radiantly visible. It seems profitable, therefore, to re-examine the classical proofs of St Thomas on the basis of the new scientific discoveries especially those based upon the movement and order of the universe (S. TH., I p., q. 2, art. 3); to consider, that is, if and to what extent the more profound knowledge of the structure of the macrocosm and the microcosm contributes to the reinforcement of philosophic arguments. On the other hand, it is not unprofitable to see if and to what point these arguments, as is not infrequently affirmed, have been shaken by the fact that modern physics has formulated new fundamental principles, abolished or modified ancient concepts, whose meaning was perhaps in the past adjudged fixed and definite, as, for example, time, space, movement, causality, substance, concepts of the greatest importance for the question that now holds our attention. Rather than a revision of the philosophic proof, it is a question of scrutinizing the physical bases from which those arguments derive—and We must necessarily limit Ourselves to only a few for reasons of space. But there is no fear of surprises: science itself remains firmly grounded in that world which today, as yesterday, presents itself in those five ‘modes of being’ from which the philosophic demonstration of the existence of God takes its motives and force.

Two essential hallmarks of the cosmos

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

- 1° The *mutability of things*, including their beginning and their end.
- 2° The *order of finality* which shines in every corner of the cosmos.

The contribution made by the sciences to the two philosophical demonstrations is truly notable; and upon them hinge and are constituted

the first and fifth ways. Physics especially has contributed to the first an inexhaustible mine of experience, revealing the fact of mutability in the profound recesses of nature, where before now no human mind could ever even suspect its existence and amplitude, and furnishing a multiplicity of empirical facts which gave highly valid support to the philosophical reasoning.

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

With equal richness, the sciences, especially astronomy and biology, have recently supplied to the argument of order such a wealth of knowledge and such an intoxicating vision, as it were, of the conceptual unity which animates the cosmos, and of the finality which directs its march, as to give to modern man in advance that joy which Dante imagined in the empyrean Heaven when he saw how 'all that is dispersed through the universe is united by love in the mind of God'. (*Par*, 33:85-87).

Providence has disposed that the idea of God, so essential to the life of each man, while it can be easily grasped by a simple glance at the world so that not to comprehend the voice of nature is sheer foolishness (*Wisdom* 13:1-2), shall receive confirmation from every deepening of the understanding and progress in the field of scientific knowledge.

We wish, therefore, to give a few rapid examples of the precious service which modern sciences render to the demonstration of the existence of God. We limit Ourselves first to the fact of mutations, revealing principally the amplitude, the vastness, and, as it were, the totality which modern physics meets with in the inanimate cosmos. Then we shall pause for a look at the significance of their direction, which has been also ascertained. It will be as though one listened to a concerto within the immense universe, which sings 'the glory of Him Who moves all things' (*Par*, 1:1).

A) *The mutability of the cosmos*

a) in the macrocosm

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

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

b) in the microcosm

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

Mutability in the electronic sphere

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

Mutability in the nucleus

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

At the same time, it has been discovered that such processes have the greatest importance in the economy of the energy of the fixed stars. At the centre of our sun, for example, according to Bethe, a temperature which averages around twenty million degrees centigrade is reached, a recurring chain reaction in itself in which four nuclei of hydrogen are joined to a nucleus of helium. The energy which is thus freed com-

pensates for the loss due to the irradiation of the sun itself. In modern physics laboratories also, it is possible to bring about transformations of nuclei by means of a bombardment with particles furnished with great energy, and with neutrons. This has been accomplished with the uranium atom, for example. In this connection, the effects of cosmic radiation should be mentioned, which can split the heaviest atoms, not infrequently giving off entire swarms of subatomic particles.

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

The eternally immutable

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

As in a painting in chiaroscuro the figures stand out from the dark background, obtaining in this manner alone the full effect of modelling and of life, so the image of the eternally immutable emerges clear and resplendent from the torrent that carries away with it all the material things in the macro- and microcosms and whirls them into an intrinsic mutability which never stops. The scientist who stands on the edge of this immense torrent finds relief in that cry of truth with which God defines Himself (*Exodus* 3:14): 'I am Who am', and Whom the Apostle praises as '*Pater luminum, apud quem non est transmutatio neque vicissitudinis obumbratio*—the Father of lights, with whom there is no change nor shadow of alteration' (*James* 1:17).

B) *The direction of the transformations*

a) in the macrocosmos: the law of entropy

But modern science has not only enlarged and deepened our knowledge of the reality and magnitude of the mutability of the cosmos; it has also offered us valuable indications concerning the direction according to which the processes of nature are carried out. While a hundred years ago, especially after the discovery of the law of constants, it was thought that the natural processes were reversible and therefore, according to the principles of strict causality—or, rather, determination—an ever-

recurring renewal and rejuvenation of the cosmos was considered possible. With the law of entropy, discovered by Rudolf Clausius, it became known that the spontaneous natural processes are always related to a diminution of the free and utilizable energy, which in a closed material system must finally lead to a cessation of the processes on the macroscopic scale.

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

b) in the microcosm

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

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

C) *The universe and its development*

— in the future

If, then, the scientist turns his gaze from the present state of the universe to the future, however far off, he will be forced to 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 utilizable energy and matter approaches, to speak figuratively, the state of a spent and wasted volcano. And the thought presents itself inescapably: if the present cosmos, today so pulsating with rhythm and life, is not sufficient to account for its existence, as we have seen, how much less will it be the case for that cosmos once the shadow of death shall have passed over it.

— in the past

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

Two questions spontaneously come to mind:

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

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

D) *The beginning in time*

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

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

The examination of numerous spiral nebulae, carried out especially by Edwin E. Hubble at Mount Wilson Observatory, has demonstrated the significant result—though tempered by reserve—that these far-off

systems of galaxies tend to rush away from one another at such speed that the space between two such spiral nebulae doubles in the period of about 1300 million years. If one looks back across the period of this process of the 'Expanding Universe' the conclusion is that from one to ten billion years ago the matter of all the spiral nebulae was compressed into a relatively narrow space, at the time of the beginning of the cosmic processes.

2. The age of the solid crust of the earth

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

3. The age of meteorites

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

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

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

Although these figures are astonishing, nevertheless, even the simplest believer would not take them as unheard of and differing from those derived from the first words of Genesis, 'In the beginning ...', which signify the beginning of things in time. These words take on a concrete and almost mathematical expression, and new comfort is given to those who share with the Apostle an esteem for that Scripture, divinely inspired, which is always useful '*ad docendum, ad arguendum, ad corripiendum, ad erudiendum*—to teach, to prove, to correct, to educate' (2 Timothy 3:16).

E) *The state and nature of original matter*

With equal earnestness and freedom of investigation and verification, learned men, in addition to the question of the age of the cosmos, have

applied their audacious talents to another question which we have already mentioned and which is certainly much more difficult, and that is the problem concerning the state and quality of primitive matter. According to the theories which are taken as a basis, the relative calculations differ considerably one from the other. Nevertheless, the scientists agree in holding that not only the mass but also the density, the pressure, and the temperature must have attained degrees of enormous intensity, as can be seen in the recent work of A. Unsöld, director of the Observatory in Kiel. 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 investigation and confirmation, and theories founded upon them have need of new developments and proofs, in order to offer a secure basis to a line of reasoning which is, of itself, outside the sphere of the natural sciences.

Notwithstanding this, it is worth noting that modern exponents of the natural sciences consider the idea of the creation of the universe entirely reconcilable with their scientific conception, and indeed they are spontaneously brought to it by their researches, though only a few decades ago such a 'hypothesis' was rejected as absolutely irreconcilable with the present status of science. As late as 1911, the celebrated physicist Svante Arrhenius declared that 'the opinion that something can proceed from nothing is in contrast with the present status of science, according to which matter is immutable' Similar to this is Plato'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 immutable by nature. Further, it has followed the course and the direction of cosmic developments, and just as it has envisioned the fatal termination, so it has indicated their beginning in time at a period about five billion years ago, confirming with the concreteness of physical proofs the contingency of the universe and the well-founded deduction that about that time the cosmos issued from the hand of the Creator.

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

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

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

This conviction, which takes into account the deepest movements of science, is crowned by faith which, the more it is rooted in the consciousness of peoples, the more it can really lead to a fundamental progress for 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 decidat*"—light for our life in time, light for eternal life (Hymn for None).

Discourse of His Holiness Pope Pius XII given on 24 April 1955 at the Solemn Audience granted to the Plenary Session of the Academy and to the Study Week on the theme "The Question of Oligoelements in Plant and Animal Life".

As We bid you welcome in this house, whose doors have always been opened wide to those who cultivate the arts and sciences, We desire also to express to Your Excellencies, Members of Our Academy, Our lively satisfaction.

Your life, consecrated as is to the study of natural phenomena, enables you to observe every day more closely and to interpret the wonders which the Most High has inscribed on the reality of things. In very truth, the created world is a manifestation of the wisdom and goodness of God, for all things have received their existence from Him and reflect His grandeur. Each of them is, as it were, one of His words, and bears the mark of what We might call the fundamental alphabet, namely those natural and universal laws derived from yet higher laws and harmonies, which the labour of thought strives to discover in all their amplitude and their absolute character.

Created things are words of truth. In themselves, in their being, there is neither contradiction nor confusion. Rather, they always cohere one with the other. Sometimes they are difficult to understand because of their depth, but always, when clearly known, they are seen to be in conformity with the superior exigencies of reason. Nature opens up before you like a mysterious but astonishing book, which must be turned page by page and read in an orderly manner, with the aim in mind of progressing ceaselessly. In this manner, every forward step is a continuation of the preceding ones, corrects them, and climbs continually toward the light of a deeper understanding.

The mission confided to you, therefore, ranks among the most noble, for you should be, in a sense, the discoverers of the intentions of God. It pertains you to interpret the book of nature, to describe its contents, and to draw the consequences therefrom for the good of all.

First of all, you are the interpreters of the book of nature. It is, then, necessary that you fix your gaze on each line, and be ever most

careful not to pass over any detail. Set aside all personal bias, and accomodate yourselves with docility to every indication of truth which comes to light.

We are aware of the exceptional importance of the epoch through which science is passing at this time, an importance which not all succeed in appreciating. In fact, there exist, in regard to scientific problems, three different attitudes. Some, and they are the majority, are content to admire the extraordinary results obtained in the technical realm and, it would seem, believe that these results constitute the sole, or a least the principal, aim pursued by science.

Others, better informed, are capable of appreciating the method and efforts required by scientific research. They can thus follow and understand its remarkable advances, its successes and checks. They observe with interest the ceaseless perfecting of mathematical methods, of experimental procedure, of instrumentation. They follow passionately the working out of hypotheses, the establishment of conclusions, the intellectual labour of harmonizing data, schematically modifying previous considerations, formulating new theories that will be subjected to verification. These multiple aspects are well understood by all those who, for various motives, interest themselves in the work of scientists.

As for the most essential problems of scientific knowledge, or those whose amplitude embraces its entire realm, the minds which perceive them are, it seems to Us, relatively few in number, and We rejoice at the thought that you are among them. Has not science arrived at the point of demanding that our vision should penetrate readily the most profound realities and rise to a complete and harmonious view of these in their wholeness?

1. A little more than a century and a half ago, by starting from rational bases, the first hypotheses were formulated concerning the discontinuous structure of matter and the existence of very minute particles, which were considered the final constituents of all bodies. From that time until our day, molecules have been counted, weighed and analyzed. Then the atom, at first considered indivisible, was split into its elements. It was examined and attacked in its innermost structure. The elementary electrical charge was determined, as well as the mass of the proton. The neutron, the mesons, the positron and many other elementary particles were identified and their characteristics determined. Means were found to guide these particles, to accelerate them, to shoot them into atomic nuclei. But it was especially by utilizing neutrons that man succeeded in producing artificial radio-

activity, nuclear fission, the transformation of one element into other elements, the production of enormous quantities of energy.

Theories and ingenious representations of the world have appeared; new mathematical methods and new geometries have been created. We can only mention here the special theory of relativity and the general theory of relativity, quanta, wave mechanics, quantum mechanics, recent ideas on the nature of nuclear forces, theories on the origin of cosmic rays, hypotheses concerning the source of stellar energy.

All this permits us to glimpse the depths into which science has moved, and one readily realizes the problems of an intellectual nature which will arise. It should be taken into consideration, moreover, that, while the bold band of conquerors ever opens new breaches in the citadel of nature, the rest of the army is spread over numberless other fields of knowledge: and this is the point of view of extension, which must be added to that of depth. One would wish to be able, like the bold climber arriving at the summit of the mountain, to take in the entire spread of the panorama with a single glance.

If it were possible for Us, We should like to show you the most advanced position in the various sectors of science, so that there might appear before your eyes a general view of the present situation.

See how astronomy, by means of instruments recently placed at its service, succeeds in unveiling entirely new mysteries in the heavens and, with the help of the physical sciences, has set out on the road which will perhaps lead it to elucidate the source of stellar energy. See how geology determines the absolute age of rocks by means of radioactivity and isotopic correlations:—a beginning has even been made towards determining the age of the earth!

In mineralogy, crystalline structures are yielding up their secrets to powerful analyses using radiations of very short wave-length. Inorganic and organic chemistry is solving the complex problems of the structure of macromolecules: it is successfully building huge molecular chains and, by the resultant applications, is transforming whole sectors of industry. Radio technique has succeeded in producing electromagnetic waves which approach the limits of luminous radiation of greatest wave-length. The earth is delved into so that its hidden treasures may be discovered, the highest strata of the atmosphere are being explored, genetics is bringing to light, in certain particular cellular complexes, new aspects of the power of life.

Physiology and biology, starting from bases achieved by chemistry, physical chemistry and physics, daily encounter unsuspected marvels and daily interpret, explain, forecast new facts and bring them to realization.

The domain of the virus is giving way to the assault of the electronic microscope and of the electronic diffraction technique. The mass spectrograph, Geiger counters, radioactive isotopes, all such instruments facilitate the progress of science as it faces the greatest enigma of all visible creation: namely, the problem of life.

In synthesizing all this knowledge it is philosophy which, with its broad concepts, states precisely the distinctive traits of vital factors, the necessary character of the underlying principle of unification, the internal source of action, of growth, of multiplication, the true unity of the living being. It shows, too, what matter, in some of its fundamental aspects, must be in order that there may be realized in the living being the characteristic properties which constitute it.

These are, without doubt, the domains that will give most work to the science of tomorrow.

2. But the feeling of elation engendered in one's soul by results like these is dampened by an impression of confusion and anguish existing among those who, with a sense of their responsibility, are following the unfolding of the facts. This anguish and confusion are to be understood in the most elevated sense, as sign of an aspiration toward an ever greater clearness in perspectives. For the triumphs of science are themselves at the origin of the two requirements to which We alluded above.

a) The first task is to penetrate the intimate structure of material beings and to consider the problems connected with the substantial foundation of their being and of their action. The question then arises: "Can experimental science solve these problems by itself? Do they belong to its domain? Do they come within the field where its research methods can be applied?". One must answer in the negative. The method of science is to take as its starting point sensations, which are external by their very nature. Though them, by the process of intelligence, it descends ever more deeply into the hidden recesses of things. But it must halt at a certain point, when questions arise which cannot be settled by means of sense observation.

When the scientist is interpreting experimental data and applying himself to explain phenomena that belong to material nature as such, he needs a light which proceeds in the inverse direction, from the absolute to the relative, from the necessary to the contingent; a light which is capable of revealing to him the truth which science is unable to attain by its own methods. This light is philosophy, namely, the science of general laws which apply to all being and therefore are appli-

cable in the domain of the natural sciences, above and beyond the laws discerned empirically.

b) The second requirement springs from the very nature of the human soul, which seeks a coherent and unified view of truth. If one is satisfied with a juxtaposition of the various subjects of study and their ramifications, as in a kind of mosaic, one gets an anatomical composition of knowledge from which life seems to have departed. Man demands that a breath of living unity enliven the knowledge acquired. It is in this way that science becomes fruitful and culture begets an organic doctrine.

This raises a second question: "Can science with the means which are characteristic of it, effect this universal synthesis of thought? And in any case, since knowledge is split up into innumerable sectors, which one, out of so many sciences, is the one capable of realizing this synthesis?". Here again We believe that the nature of science will not allow it to accomplish so universal a synthesis.

This synthesis requires a solid and very deep foundation, from which it derives its unity and which serves as a basis for the most general truths. The various parts of the edifice thus unified must find in that foundation the elements that make up their essence. A superior force is required for this: unifying by its universality, clear in its depth solid by its character of absoluteness, efficacious by its necessity. Once again that force is philosophy.

3. Unfortunately for some time past, science and philosophy have been separated. It would be difficult to establish the causes and responsibilities for a fact so detrimental. Certainly the cause of the separation must not be sought in the nature of these two ways, each of which can lead to truth. Rather, it must be sought in historical contingencies and in persons who did not always possess the necessary goodwill and competence.

At one time men of science thought that natural philosophy was a useless weight, and they refused to allow themselves to be guided by it. On the other hand, philosophers ceased to follow the progress of science, and they halted in certain formal positions which they could have abandoned. But when, as We have shown, there arose the inevitable necessity of a serious work of interpretation, as also of the elaboration of a unifying synthesis, scientists fell under the influence of the philosophies which the circumstances of the time placed at their disposal. Many of them, perhaps, were not even clearly aware that their scientific investigations were being influenced by particular philosophical trends.

Thus, for example, mechanistic thought guided for a long time the scientific interpretations of the phenomena observed. Those who followed that philosophical trend believed that every natural phenomenon was reducible to an ensemble of physical, chemical and mechanical forces, in which change and action were solely the result of a different disposition of particles in space and of the forces or displacements, to which each of them was subject. It followed that, in theory, one could foresee with certainty any future effect whatsoever, provided one knew beforehand the geometrical and mechanical data. According to that doctrine, the world was merely an enormous machine, composed of an innumerable series of other machines joined together.

Further progress in experimental research showed, however, the inexactitude of those hypotheses. Mechanics, deduced from the facts of the macrocosm, cannot explain or interpret all the phenomena of the microcosm: other elements come into play which defy any explanation of a mechanistic nature.

Take, for example, the history of the theories of the structure of the atom. At the beginning they were based essentially on a mechanistic interpretation, which represented the atom as a minute planetary system, made up of electrons circling around the nucleus according to laws entirely analogous with those of astronomy. Quantum theory later imposed a complete revision of these concepts and produced interpretations which were ingenious, certainly, but also unquestionably strange. In effect, there was conceived a type of atom which, without eliminating the mechanistic aspect, made the quantum aspect more prominent.

The mode of behaviour of the corpuscles was thus explained in different ways: electrons which, although revolving about a nucleus, did not radiate energy when, according to the laws of electrodynamics, they should have been radiating it; orbits which could not change continuously, but only in jumps; the emission of energy which occurred only when the electron passed from one quantum state to another, producing photons of a definite frequency determined by the differences in energy levels.

These hypotheses, as points of departure, were later stated precisely after the birth of wave mechanics, which fitted them into a more general and coherent mathematical and intellectual framework from which the traditional mechanistic ideas have vanished.

Then, spontaneously, the question arises: "How can it be that the macroscopic world, although composed of elements which all belong to the microscopic world, nevertheless obeys different law?". Science answers, first of all, with the following observation: when the number of elements in question is very great (billions upon billions of particles),

then the statistical laws deriving from the behaviour of these different elements taken in their entirety, are considered to hold strictly in the world directly observable by us.

But if the statistical method is satisfactory for the purposes of science, it reveals also how false were certain philosophical hypotheses which were limited to external evidences perceptible to the senses and then extended arbitrarily to the entire cosmos.

Confirmation of this is found in the theories of modern nuclear physics. In reality, the forces which hold together the nuclei are different from those which are discovered when studying the macrocosm. To understand them it is also necessary to change the customary manner of conceiving the corpuscular particle, the wave, the exact value of energy and the rigorously precise localization of a corpuscle, as also the foreseeable character of a future event.

The failure of the mechanistic theory has led thinkers to hypotheses entirely different—characterized rather by a kind of scientific idealism—wherein the consideration of the active subject performs the principle role. For example, quantum mechanics and its fundamental principle of indeterminism with the challenge to the principle of causality which it supposes, appear as scientific hypotheses influenced by currents of philosophical thought.

But because these hypotheses themselves do not satisfy the desire for complete clarity, many illustrious thinkers have been brought to skepticism when confronted with the problems of the philosophy of science. These claim that it is necessary to be satisfied with the simple verifying of facts and striving to have these included in formal presentations—synthetic and simple—in order to foresee the possible developments of a physical system from a given initial state.

This state of mind results in the abandonment of that conceptual introspection and in the loss of all hope of producing grand universal syntheses. We do not, nevertheless, believe that such pessimism is justified. We rather think that the natural sciences, in permanent contact with a philosophy of critical realism, such as was always that of the *philosophia perennis* as exemplified by the most eminent of its representatives, can arrive at an all-embracing view of the visible world which would, to some extent, satisfy the quest and the ardent desire for truth.

But it is necessary to emphasize another point. If science has the duty of striving for coherence and of seeking inspiration from sound philosophy, philosophy itself should never attempt to define truths which are drawn solely from observation, and from the use of scientific methods. An infinite variety of entities and laws of matter is possible. Only

observation or experiment, understood in their very broadest sense, can point out which among these the Creator, in fact, desired to make into reality.

Authorized interpreters of nature, be you also the teachers who explain to their brothers the wonders which are unfolded in the universe, and which you, better than others, see assembled as in a single book. Indeed, the majority of men can scarcely devote themselves to the contemplation of nature. They deduce from the facts they perceive only superficial impressions. Become, you who interpret creation, teachers eager to reveal its beauty, its power and its perfection so that they may be enjoyed by others.

Teach others to behold, to understand and to love the created world so that the admiration of splendours so sublime may cause the knee to bend and invite the minds of men to adoration.

Never betray these aspirations, this trust. Woe to them who make use of falsely taught sciences to make men leave the right path! They are likened to stones maliciously placed in the path of the human race. They are the obstacles on which men stumble in their search for truth.

You have in your hands a powerful instrument with which to do good. Take into account the unutterable happiness that you procure for others when you disclose to them the mysteries of nature and bring them to understand its harmonious secrets. The hearts and the gaze of those who listen to you are, as it were, hanging on your every word, ready to chant a hymn of praise and thanksgiving.

Discourse of His Holiness Pope Pius XII given on 20th May 1957 at the Solemn Audience granted to the Plenary Session of the Academy and to the Study Week on "The Problem of Stellar Populations".

Like the other physical sciences, whose prodigious development we of the present day contemplate with admiration, astronomy is now passing through a period of extremely fruitful researches and discoveries. Thus We are particularly glad to welcome to-day, with the elect group of astronomers taking part in the conference convened at the Vatican Observatory, also the members of Our Pontifical Academy of Sciences. In the midst of this assembly of distinguished scientists and tireless investigators of the wonders of creation, We feel an ardent desire to repeat the hymn that the Creator puts on the lips of all those who receive gratefully from Him the gift of life, of intelligence and of love: "*Caeli enarrant gloriam Dei et opus manuum eius annuntiat firmamentum*" (Ps 18).

In order to know better this starry firmament which speaks to you, by its immensity and its order, of the power and the wisdom of its Author, the conference convened under Our auspices proposes to debate in free and friendly discussion questions of great interest, which are absorbing the attention of specialists, and also of all those who are interested in one way or another in our knowledge of the physical universe. When the Congress of the International Astronomical Union was held in Rome in 1952, We took the opportunity of congratulating its members on the marvellous conquests that their science had accomplished during recent years. We then retraced the salient steps which enabled astronomers to form a more precise idea of the galactic system and of the position that the Sun occupies within it; and then to determine the real nature of spiral nebulae, recognizing in them other galaxies analogous to ours and containing thousands of millions of stars. Beyond the worlds already known, one could suspect the existence of others, which would soon reveal themselves with the aid of giant telescopes. At this very time moreover there was published Baade's discovery that the hitherto accepted scale of the universe had to be multiplied by a factor of two or even more.

To the same astronomer we owe the first mention of the central theme of your present discussions, the existence of two types of stellar

populations. Baade's paper, published in 1944, starts with the statement that recent photographs on red-sensitive plates, taken with the 100-inch telescope at Mount Wilson, for the first time resolved into stars the two companions of the Andromeda nebula and the central region of the Andromeda nebula itself. This was no chance discovery, it was the fruit of long and painstaking research. With giant modern telescopes it was possible to resolve the outer parts of the nebula and to photograph individual stars, but the central nucleus remained completely amorphous, even photographed with the most powerful instruments. Finally, skill and patience overcame the difficulty. On various grounds it seemed reasonable to suppose that the nucleus really contained individual stars, but that these stars were too faint to appear as such on the plates. It also seemed likely that the brightest stars in the nucleus would be red giant stars. Baade thought that it should be possible, by using red sensitive plates, to pick up at least these red giants. By taking every precaution and using very long exposures (of up to nine hours) Baade reached the very limit of what was possible with the means then available and succeeded in photographing great numbers of stars in the nucleus of the Andromeda nebula and in its two companions.

Baade then showed that these newly discovered stars are cooler and less luminous than the blue giants in the spiral arms of the nebula and came to the conclusion that the stellar populations of the galaxies can be divided into two groups, one represented by the blue giants and the stars in galactic clusters (Type I), the other by the stars in the nucleus, those in globular clusters and short period Cepheid variables (Type II). The two types of stars differ not only in brightness and colour, but in age, location, chemical composition, and in the mode and rate of energy production.

In the same paper Baade points out that, as early as 1926, Oort had distinguished in our Galaxy two groups of stars, a group of stars moving with high velocity relative to the Sun, as contrasted with the stars moving more slowly. These two classes, which differ also in frequency of their spectral types and in galactic concentration, correspond to Baade's type II and type I respectively. Thus these discoveries of Baade and Oort supplement each other. They opened the way to a flood of theories and researches, with which you will deal in this conference.

A glance at the programme that you have prepared shows, even to one who is not a specialist in these matters, the complexity of the topics that bear on your problem and the many different lines of approach that are needed for a thorough examination of the subject. You commence with a study of external galaxies and proceed later to a detailed discussion of our

own Milky Way system. This is indeed the logical approach to a study of the question of stellar populations, and the line which advance in knowledge has in fact taken, for it has been extremely difficult to chart the details of our own Galaxy, owing to the fact that our own solar system is embedded in it. The first indications of your problem were found in external galaxies, although in the meantime a great deal has been learnt about our own Galaxy. The Dutch astronomers, for instance, have succeeded in tracing the spiral arms of the Galaxy by means of their observations of radio waves emitted by the hydrogen in the arms. Since the stars of our system are much less distant than those in external galaxies, the astronomer can learn a great deal more about them, by studying their brightness, their spectra, their motions and distribution in space.

Much of this knowledge could be acquired only with the aid of the most powerful means available. Thus the study of globular clusters, which has proved so fruitful in providing information about stars of population II, has been carried out with the 200-inch telescope at Mount Palomar. Nevertheless much excellent work can be done with more modest instruments, notably in the study of variable stars, to which, we are happy to note, the Vatican Observatory is bringing a useful contribution. For the Cepheid variables, which constitute a precious source of information for the problem of stellar populations, one needs a more precise estimate of their distribution in the Galaxy, as well as more information about their spectra and their motions and about the mechanism which is responsible for their variability. As for the flare stars, those remarkable objects that flare up suddenly, remaining bright for a short time and then fading more slowly to their original brightness, no doubt new ones will be discovered and more will be learned about their behaviour and their distribution.

You will give much attention to problems connected with the evolution of the stars, the production of energy in their interior, the formation of atoms and the transmutations which they undergo. Here you need the aid of nuclear physicists and of experts in statistics, in order learn more about the nuclear changes in the intensely hot interior of a star, the different cycles that may succeed one another in the development of an individual star and the differences in this respect between the various types of stars. You will try to determine how the chemical composition affects the development of the different types and what changes it then undergoes, as well as what effects the interstellar medium, dust or gas, has on the stars which pass through it, what exchange of matter there is between medium and star, and what effect these processes have on both.

Of very great interest is the enormous difference in the ages that you now assign to various types of stars. Whereas you believe that stars of population II are about 5,000 million years old, about as old as the universe itself, the age of population I stars seems to be at most some tens of millions of years. It is understandable that the blue supergiants, which emit continuously such a vast quantity of energy in the form of heat and light, are so spendthrift of their store that they must burn themselves out comparatively quickly, whereas such ancient stars as our Sun husband their resources better, though even the Sun pours out what seems to us enormous quantities of energy. You may succeed in discovering stars more youthful still, or even perhaps in observing the very birth of a star.

The formation and evolution of the older stars of population II will also demand much of your attention, in spite of the interest naturally evoked by the spectacular transformations of their younger companions. Our Sun in particular cannot be neglected, for, apart from the direct influence it has on the earth and its inhabitants, it is so much nearer to us than any other star that we can learn far more about its secrets, and its study must ever remain an essential department of astronomy.

No one would think, on that account, of neglecting the external galaxies, the importance of which for astronomical research We have already emphasized. The Magellanic Clouds in particular have the advantage of being the two stellar systems nearest of all to our Galaxy, and information can be obtained from them that cannot be obtained from more distant systems. You have therefore invited to your conference the representative of a great observatory in the Southern hemisphere, who has devoted much of his labours to these systems.

The elliptical galaxies, which contain mainly stars of population II, bear some resemblance to globular clusters, but differ from them certainly in size and origin. The globular clusters themselves, when subjected to precise examination, show certain differences from one to another. Thus the Hertzsprung-Russell diagram in one cluster does not correspond precisely to that in another. It is even possible that the types of stellar population are not limited to two. It is now your task to debate among yourselves and to communicate on this point, as on the other topics which We have mentioned, the facts that you have gathered and the conclusions to which you have been led.

The tireless search for precise facts, the development of theories to explain the facts, the verification of theory by new observations, the modification of a theory when necessary, its replacement by another more perfect theory which fits better the data acquired, such is the incessant

labour of the astronomer, a labour which appears titanic even to the uninitiated. Whatever stage the astronomer has reached by his researches, he cannot dispense with a general picture of that universe, whose minutest details he is scrutinising. Even if awkward gaps in his knowledge cause some of his constructions to break down, he cannot lose the exciting conviction that by thought he is greater than the cosmos, and will sooner or later tear from it new secrets.

But even when he holds in his hands the keys which will open to him doors as yet closed, his task will still be far from finished; not only because the evolution of stellar worlds constantly renews the object of his interest, but also because the truth which will satisfy his urge is in reality on a higher plane than that of scientific research. The knowledge of the physical universe, from the infinitely small to the infinitely great, intoxicates the mind of man, by its tantalizing, but alluring riddles; yet it does not free him from his unease. Like all other scientists, like the engineer at grips with modern applications of electronics or of nuclear energy, but also like the humblest of intellectual or manual workers, the astronomer seeks a truth which far surpasses that of mathematics, or of general laws of physics, or of material objects which he can measure, move, or control. What would the immensity of the cosmos, its splendour, its organization be, without the intelligence which discovers itself in contemplating the cosmos and which sees in it as it were its own image? Is not what man reads in the stars a symbol of his own greatness, a symbol which invites him to mount higher, to seek elsewhere the meaning of his existence? Contemporary scientific thought is accustomed not to retreat before any problem, and that is legitimate so long as it remains within its own domain. But, since the moral universe transcends the physical world, every gain made by science is on a lower plane than that of man's personal destiny—the ultimate aim and purpose of his existence—and of the relations which unite him to God. Scientific truth becomes a decoy from the moment when it is considered adequate to explain everything, without being linked up with other truths and above all with subsistent truth, which is a living and freely creative Being. The labour of the scientist, however disinterested and courageous, loses its ultimate motive if he refuses to see, beyond purely intellectual ends, those proposed to him by conscience, the decisive choice between good and evil, the profound orientation of his life towards the acquisition of spiritual values, of justice and of charity; above all of that charity which is not merely philanthropy or a feeling of human solidarity, but which proceeds from a divine source, from the revelation of Jesus Christ.

Happy is he who can read in the stars the message which they contain, a message worthy of its author, and capable of rewarding the seeker for his tenacity and his ability, but inviting him also to recognize Him who gives truth and life and who establishes His dwelling in the heart of those who adore and love Him. While expressing the sincere wish that your discussions will come up to your expectations and will bring you the lively satisfaction of having accomplished a most fruitful task, We beg the Author of all good to grant you His aid and protection, in pledge of which We give you with all Our heart Our Apostolic Benediction.

DISCOURSES
OF
HIS HOLINESS POPE JOHN XXIII



Discourse of His Holiness Pope John XXIII given on October 30th 1961 at the Solemn Audience granted to the Plenary Session of the Academy and to the Study Week on the theme "Macromolecules of Biological Interest with Special Reference to Nuclear Proteins".

TO THE PONTIFICAL ACADEMY OF SCIENCES

Gentlemen: We are happy to receive today for the first time the new President and members of your illustrious and learned assembly. This day, which is the anniversary of Our election, happens also to be that of the episcopal consecration of Pius XI, the wise founder, or, to be more exact, the restorer of the academy which bears the title of Pontifical Academy. Our pleasure is all the greater as your ranks have recently been increased by other outstanding persons from many countries, who are recommended by their lofty merit and by the breadth of their scientific learning.

In response to Our cordial invitation, you have been meeting for several days to hold a plenary session as well as a new study week on the structure of macromolecules, which are of biological interest.

Let Us thank you sincerely for the eagerness with which, despite your manifold occupations, you answered this invitation, and express to you the pride felt by the Church in seeing such a select group of scientists meeting in the Vatican City to exchange information.

By the diversity of your origins and by the variety of your specialities, gentlemen, you really constitute a reflection of the present-day world of learning and bear witness to the complete agreement which has always existed between the Church and true science.

As you know, it is not because of a desire to remain true to the humanistic traditions inherited from the Renaissance that the Church welcomes you. It is because of a consciousness that in receiving you she is fulfilling part of her constant mission as mother and educator. Wherever she has established herself, she has always created a noteworthy enthusiasm for the development of intellectual culture.

Such was, indeed, the noble purpose pursued by Our predecessor, Pius XI when he founded, precisely a quarter of a century ago, the Pontifical Academy of Sciences. This purpose led him to include in the *motu proprio* of establishment the shining statement from the First Vatican council on the relationships between faith and reason, which it pleases Us to recall here:

“Not only can faith and reason never be in opposition to each other, but they render to each other reciprocal assistance”. And the same Pope concluded from that: “It is Our ardent and firm hope that by this institution which is both Ours and theirs, the Pontifical Academicians may always contribute to the better progress of science. We are not asking anything else of them, for the service in favour of truth which We look for from them consists in this generous purpose and noble work” (*Motu proprio In Multis Solaciis*, Oct. 28, 1936; AAS 28, p. 421).

This expectation is also Ours, you may be sure. You all know the importance which We attach personally to intellectual work and scientific investigation. It has always been close to Our heart to use the leisure left to Us by Our diverse functions in pastoral and historical research. It was therefore with joy that We greeted at the time of its creation this Academy of yours.

In this perspective, We want to mention today the memory of its first president, Agostino Gemelli, who showed himself to be faithful to the admirable program laid out by your founder. His life brought honour to the Church and to science. It is also pleasant for Us to appreciate for its just value the happy choice made by your illustrious society in conferring the gold medal of Pius XI on Professor Robert Burns Woodward of Harvard University, whose scientific activity in the chemical field is full of success and of promise.

In fact, far from fearing the most daring discoveries of mankind, the Church believes, on the contrary, that any progress in the possession of truth brings forth a broadening of the human person and constitutes and advance toward the primary Truth as well as a glorification of the creative work of God.

Holy Scripture often reiterates these important thoughts, and without doubt, it often happens to you, gentlemen, that, in the enthusiasm of research and discovery, you allow the magnificent song recorded in the book of Daniel to sing within you: *Benedicite omnia opera Domini Domino* [All you works of the Lord, bless the Lord] (*Dan 3:57*). Following

the three children of Israel, filled with admiration before the miracles of nature, how can we fail to call upon the angels, the stars and the elements, animals, plants, minerals, the most saintly men and those most heard by God, to interpret our feelings of praise to the Creator?

With the assurance that you are working with all your energy in this undertaking of knowledge and praise, We are glad to invoke upon your work and yourselves, as a token of Our paternal good will, an unstinted effusion of divine blessings.

Discourse of His Holiness Pope John XXIII given on 5th October 1962 at the Solemn Audience granted to the Plenary Session of the Academy and to the Study Week on the theme "The Problem of Cosmic Radiation in Interplanetary Space".

Gentlemen,

It is Our pleasant task to-day to receive the President and Members of the Pontifical Academy of Sciences, together with the scientists who have come from all over the world to take part in the Study week on "The Problem of Cosmic Radiation in Interplanetary Space".

Last year, We conveyed to the Pontifical Academy Our good wishes on the occasion of the twenty-fifth anniversary of its foundation by Our predecessor, the great and learned Pius XI. This year, We have the joy of personally and gladly bidding you welcome to Our house.

For in your persons, Gentlemen, permit me to say, it is science itself which the Church welcomes, that science which the scholars of the whole world, united in peaceful research, strive to advance by pooling the results of their labours.

On that account We are happy to be able to present to professor BENG T ER I K A N D E R S S O N, the young and distinguished physiologist of the Royal Institute of Veterinary Medicine at Stockholm, the gold medal bearing the revered name of the founder of Our Pontifical Academy.

The Church gladly encourages the researches which are being carried on the world over, and which lead to more complete knowledge of man and the universe, according to the command given by God to Adam in the first pages of Genesis (cf. *Gn* 9:7). Thus We congratulate with all Our heart this young scientist, who is an authority on the nervous mechanisms of hunger, thirst and body temperature, and We express Our best wishes for the fruitfulness of his scientific career, in the service of humanity.

We must also point out, Gentlemen, with particular satisfaction, the timeliness of the theme chosen for your Study week "The Problem of Cosmic Radiation in Interplanetary Space". While it would be superfluous to emphasise its appropriateness, permit Us at least to mention the close interest that the Church takes in those problems which are rightly engaging the attention of the men of our time, and which are

the object of scientific investigation by leading specialists. You know how much We share the delight and satisfaction deriving from the brilliant results obtained by the scientists and technicians of our day, who have succeeded in taming nature in a way which, but lately, would have seemed impossible to the most fertile imagination.

We said recently "Oh! How we wish that these undertakings would signify a homage rendered to God, Creator and supreme Legislator. May these historic events, which will have their place in the annals of the scientific knowledge of the cosmos, likewise become the expression of a true and peaceful progress, contributing their share to the solid foundation of the brotherhood of man" (*L'Osservatore Romano*, 24 August 1962).

We have entered, thank God, upon an epoch when, let us hope, questions about opposition between the conquests of the human mind and the demands of faith will become less frequent. The First Vatican Council, in 1869-1870, stated clearly the relations between reason and faith. The exciting discoveries and achievements of the twentieth century, far from casting doubt on these solidly based truths, helps the mind to a deeper appreciation of their value. The progress of science, while permitting us to understand better the extraordinary richness of creation, enriches the praise which the creature renders in thanksgiving to his Creator, who is the Redeemer of our souls. The heart of man, as also his intelligence, remains ever eager to reach the absolute and to surrender himself to it.

On the eve of the opening, now close at hand, of the Ecumenical Council, We cannot but call to your mind, Gentlemen, this great Assembly and the promises that it holds out, supported by the prayers of Catholics and by the expectation of the whole world. It presents to us the vision of a gathering, at once fraternal, pacific and spiritual, which should be devoted entirely to the praise of God and to the service of man, in his noblest aspirations to know the truth, to seek to attain it and to embrace it lovingly.

Such are the thoughts, Gentlemen, suggested to Us by the presence of your illustrious and learned assembly. We are happy to have been able to meet you and to let you know the great interest that We take in your labours. With all Our heart We invoke the abundance of divine graces on your Study Week, on yourselves and on your families, in token of which We impart to you a special Apostolic Benediction.

DISCOURSES
OF
HIS HOLINESS POPE PAUL VI



Discourse of His Holiness Pope Paul VI given on 13th October 1963 at the Solemn Audience granted to the Plenary Session of the Academy and to participants in the Study Week on the theme "The Econometric Approach to Development Planning".

Gentlemen,

We do not propose to deliver a discourse. Not that we should not have plenty to say to you; this meeting with the Pontifical Academy of Sciences in fact calls to mind many topics, questions, feelings which it would be worthwhile to express, but this is not the time. In these days, absorbed as they are by the Council and the problems to which it gives rise, We have no time to spare. This will be merely a brief greeting that We address to you, a greeting full of cordiality for the persons that We have the great honour of meeting, full of respect for this institution that We are happy to see here once again.

As you have just said, Mr. President, an esteem of long standing and a sincere friendship binds Us to your Academy. We are glad to be able to-day to renew acquaintance with it and to greet you first of all, Mr. President, the worthy successor of the late lamented and unforgettable Padre Gemelli.

It is for Us a joy to find the Academy, and all its members, dedicated to the faithful carrying out of its traditional activities. We take this opportunity to express to the veteran Academicians our devoted esteem and to bid a happy welcome to those whom We have not previously had the pleasure of greeting as members of this illustrious society.

We wish also to express Our gratitude to those scientists who have accepted the invitation of Our Academy and who have come to take part in this study week, bringing to it the valuable contribution of their learned research and honouring it with their presence.

To those who belong to the Pontifical Academy of Sciences, and to those who participate in its work or honour it with their friendly interest, we wish to reaffirm our high esteem for this institution, and the resolution we have taken to grant it the support and honour which will ensure its stability and favour its development.

We have inherited a solemn responsibility from the Pope who founded your Academy, for whose members and promoters We cherish a profound

esteem; We have a keen appreciation of the importance and the needs of modern science and a lively sense of the duty, the interest, and in a way the necessity, for the Catholic Church to maintain the most sincere relations with the contemporary scientific world. Finally We may say that We feel ourselves stimulated by the certainty that our religion not only does not pose any real objection to the study of natural truths, but that, without crossing the bounds of its proper sphere, or transgressing those of the domain of science properly so-called, it can promote scientific research, honour its results and help them to be better used for the good of humanity.

The religion which we have the happiness to profess is, in fact, the supreme science of life. It is thus the highest and most beneficent mentor in all those domains where life is manifested. It might seem to be absent when it not merely permits, but directs, the scientist to obey only the laws of truth. But looking more closely, it will be seen to be still beside him, to encourage him in his difficult task of exploration, assuring him that truth exists, that it is intelligible, splendid, divine; and also to remind him at every step that thought is an instrument for the conquest of truth and that it should be used with such respect for its own laws that one feels continually the transcendent responsibility that it imposes.

This will show you, Gentlemen, how seriously and with what favour We regard this institution, which We like to consider as representative of the scientific world, to which We send through you, its authoritative interpreters, Our respectful greetings and encouragement.

A symbol of this greeting is the Pius XI Gold Medal which We have the pleasure of presenting to Professor Aage Bohr, son of Denmark, a nation whose signal merits are appreciated by Us, a scientist celebrated for his studies of nuclear structure and for the theoretical analysis of the motions of atomic nuclei. May the granting of this award be a token of respect and encouragement, both for the worthy person of this young professor as well as for the noble company, nowadays a whole army, of scientists devoted to the exploration of the marvels of the physical microcosm.

Coming from Our priestly hands may this award constitute a warm invitation, an evangelical appeal, to all those in authority, that they may never abuse science, or rather its multiple practical applications—in particular those of nuclear science and its terrible possibilities—that they may never make it a peril, a nightmare, an instrument of destruction for human life. Another of Our wise predecessors, Pius XII, already in 1943 and again in 1948, addressing this same Academy, warned against

the terrible and menacing possibility that atomic energy might become fatal for humanity. And, still more recently, Pope John XXIII, of happy memory, in his now famous Encyclical "Pacem in Terris", expressed the wish that atomic weapons be banned.

We wish to make Our own their fatherly appeal and to hope, with all good and wise men everywhere in the world, that this threat to the safety and peace of humanity may be averted.

In your peaceful assembly you are, thank God, far removed from these sombre prospects. You will be speaking of "The Econometric Approach to Development Planning". This is the theme of your study week, a theme which seeks to gather together the latest results of a new branch of science, econometry, and to present them to political economists in order to aid them in formulating those plans for a more stable security and for greater development which can contribute so much to the well-being and peace of nations.

We do not intend to enter upon this theme or to comment on it, but We are happy that such eminent men have come to treat of it before this Academy, and We thank them for this important contribution which they are making to the advance of science and to the reputation of this Academy. We are happy to congratulate you on the choice, the method of treatment and the aim of a theme as fruitful for scientific research as it is rich in practical applications. We are sure also that these econometric studies, integrated with the rest of our knowledge of human phenomena, including those in the field of economics, will truly prove of great utility in the ordered progress of human civilisation.

We give you a fatherly greeting and beg the divine protection for you and for your labours, bestowing on you all Our Apostolic Blessing.

Discourse of His Holiness Pope Paul VI given on 3rd October 1964 at the Solemn Audience granted to the Plenary Session of the Academy and to participants in the Study Week on the theme "Brain and Conscious Experience".

Gentlemen,

Now that the study week organised by the Pontifical Academy of Sciences on the theme "Brain and Conscious Experience" is about to conclude, We have desired to bring you personally Our greetings and Our thanks and to express anew the interest with which We follow the development and the progress of your scientific activities.

1. First of all We greet with pleasure the President and the members of the Academy here present, and We also welcome most cordially the scientists of various nations who have accepted the invitation to attend this session. Their very presence in this place calls for lively gratitude on Our part, all the more when we consider the erudite communications which they have presented at this scientific meeting. Their many learned papers serve as an inspiration to the Pontifical Academy of Sciences, reflecting credit not only on the Holy See, but, We humbly dare to assert, for it is Our conviction, on the world of science itself.

We have had before Our eyes the series of researches already published in the official collection of the "Commentarii" of the Pontifical Academy of Sciences, as well as the three volumes of "Miscellanea Galileiana" which have been presented to Us in your name. These many signs of the vitality of your Academy are a source of deep joy to Us. The merit is yours, and with all Our heart we congratulate you and thank you.

2. Our intention, as you will surmise, is not to comment on the theme which you have been discussing during these days with such competence and scientific rigour. May We be permitted simply to underline in a word its importance, and to bring out its relationship—if one may use the term—with those domains in which the essential part of Our own activity is exercised: We refer to the moral and religious sciences.

"Brain and Conscious Experience": seeing these words associated, it suffices to make clear that there you touch on that which is most specifically human in man, on that which approaches most nearly the mechanisms

of his psychology, the problems of his soul. To be sure, when you speak of "consciousness", you do not refer to the moral conscience: the very rigour of your methods ensures that you do not leave that strictly scientific domain which belongs to you. What you have in mind exclusively is the faculty of perceiving and of reacting to perception, that is to say the psycho-physiological concept which constitutes one of the accepted meanings of the word conscience.

But who does not see the close connection between the cerebral mechanisms, as they appear from the results of experimentation, and the higher processes which concern the strictly spiritual activity of the soul?

3. Your labours are valued by Us, as you see, because of the domain in which they are pursued, because of their close affinities with that which is of supreme interest to a spiritual power such as Ours—the domain of the moral and religious activities of man.

But, widening Our field of view, We would like to profit by the occasion thus presented to Us to reaffirm before you the Church's attitude of esteem and confidence with regard to scientific thought in general.

The Church does not fear the progress of science. She undertakes willingly a dialogue with the created world and applauds the wonderful discoveries that scientists are making in that world. Every true scientist is for her a friend, and no branch of learning is shunned by her. The very variety of the subjects treated during the study weeks of the Pontifical Academy of Sciences is in itself a proof of this cultural "ecumenism" of the Church, of her readiness to welcome every true and real progress in the domain of the sciences, of every science.

The Church follows this progress with close attention, as she does also the spiritual expressions which accompany the scientific effort. These expressions have varied according to time and place, and their evolution is for the Church an object of great interest.

The scientific world, which adopted in the past a position of autonomy and of self-confidence, from which flowed an attitude of distrust, if not of contempt, for spiritual and religious values, is today, on the contrary, impressed by the complexity of the problems of the world and of mankind, and feels a sort of insecurity and fear when faced with the possible evolution of a science left, without any control, to follow its own driving force. Thus the fine self-confidence of early days has for many given place to a salutary unease, so that the soul of the scientist today is more easily open to religious values, and glimpses, beyond the prodigious achievements of science in the material domain, the mysteries of the spiritual world and the gleams of the divine transcendence.

How can the Church not rejoice at this happy evolution? She is beside you in your labours, Gentlemen, you may be sure, and always ready to offer you the help of the lights of which she is the trustee, whenever your learned researches bring you to the threshold of those grave questions which transcend the domain of science and which from all time have presented themselves to the consciences of men: questions of the origin and of the destiny of man and of the world.

Receive from Us, Gentlemen, these too brief thoughts, which are meant simply as a cordial affirmation of Our esteem for your persons and your work, and of the profound interest with which the Church follows the evolution of scientific progress in the modern world. We wish complete success for the present session, and we invoke for you, and for the happy continuation of your learned activities, the most abundant divine favours.

Discourse of His Holiness Pope Paul VI given on 23rd April 1966 at the Solemn Audience granted to the Plenary Session of the Academy and to participants in the Study Week on the "Molecular Forces".

Dear Gentlemen,

In welcoming you, Gentlemen, at the close of your study week on *Molecular Forces*, it is not Our intention—as you may imagine—to venture into the scientific field which is yours. We prefer to speak to you of the Church's esteem for you, of the interest with which she follows your activities, the desire which animates her to do all in her power to encourage the happy development and constant progress of your researches within the Pontifical Academy of Sciences.

The eminent founder of this Academy, the great Pope Pius XI, as you are aware, was deeply interested in this activity. So also were his two successors, and it is unnecessary to remind you here of the masterly addresses by which, in the course of his long and glorious pontificate, Our predecessor, Pius XII, desired to honour each of your sessions.

With the accession of Pope John XXIII, from whom We have inherited the heavy burden of office, it may be said that quite a new element entered into relations between ecclesiastical authority and the scientific world

It is no longer merely the visible head of the Church in isolated addresses, but the bishops of the whole world assembled in Council, who have been obliged to express their opinion as to the Church's attitude in the modern world, more particularly in view of modern cultural developments and in regard to the object of those labours to which your lives are so nobly devoted, namely, scientific research.

The results of this vast "examination of conscience" on the part of the Church in this field have been recorded in a document which, We believe, is worthy of your attention and with which many of you are no doubt already familiar, namely, the Pastoral Constitution on the Church in the Modern World.

Contemplating in its second section a certain number of real problems with which the Church is faced in our day, this important document deals with the domain of culture. It hails the progress of culture, in

the first place, and the advent of what may be called a "new humanism". But it points out immediately the complexity of the consequent problems, more particularly the one which seems to Us to be of special interest to you: "*As special branches of knowledge continue to shoot out so rapidly—it states—how can the necessary synthesis of them be worked out, and how can men preserve the ability to contemplate and to wonder from which wisdom comes?*" (No. 56, § 4).

It can be said that this brief paragraph places perfectly face to face the point of view of the specialized scientist—your own—and that of the Church. You are concerned—and this does you honour—before all else about the progress of human knowledge, to ensure fresh acquisitions continually in each of its branches. There follows, by force of circumstances, this continued "shooting out so rapidly" of which the conciliar document speaks. The Church herself is before all else solicitous for synthesis, for her mission is to safeguard the harmony and balance of the rational creature, to aid him to ascend to this higher "wisdom" stemming from the divine revelation of which she is the depository.

The Church is aware of the dangers involved in excessive specialization and of the obstacles which the latter can place in the way of the soul's impulse towards what is spiritual.

In man's own interests, the Church desires at all costs to save that "ability to contemplate and to wonder" to which a purely technical civilization would be in danger of attaching little value. Above all does she fear, like a mother solicitous for the true good of her children, "*that man, confiding too much in modern discoveries, may even think that he is sufficient unto himself and no longer seek any higher realities*" (*ibid.*, No. 57, § 5). These are again the very words of the Constitution on the Church in the Modern World and they introduce us into the heart of the debate between the Church and science. The Church asks: What exactly is the value of scientific research? Just how far does it go? Does it exhaust the whole of reality, or is it not rather a mere segment, the one pertaining to the truths that can be reached by scientific processes? And these truths themselves, so justifiably dear to the man of science, are they at least final, or are they not to be dethroned tomorrow by some new discovery. How many lessons do we receive on this point from the history of the sciences!

Besides, this study of the specialized researchers, however admirable and profound it may be, does it in the end supply the reason for the things it discovers? How many stars there are in the sky! Certainly, but how and why? How many marvels there are in the anatomy and physiology of the human body! Undoubtedly, but why does the human

body exist? Why does man exist? Science is mute at this stage, and must be so, under pain of departing from its own domain. It stops on the threshold of the decisive questions: who are we? whence have we come? where are we going?

Do not think, Gentlemen, that in bringing up these questions We have even the slightest intention of calling in question the value of the scientific method. More than anyone else the Church rejoices at every true acquisition of the human spirit, in any field whatsoever. She recognizes and keenly appreciates the importance of scientific discoveries. The effort of intelligence and organization necessary to reach new results in this domain is, as far as she is concerned, the object of encouragement and admiration. For she does not see here merely the magnificent use of the intellect. She discovers also the exercise of high moral values which confer on the scientist the aspect and the merit of an ascetic, at times of a hero, to whom mankind must pay an ample tribute of praise and gratitude

In her dialogue with the world of science, the Church does not limit herself to assigning to scientific research its exact place in the universe of knowledge, to stating precisely its limits and recognizing its results. She has a further word to say to the man of science concerning his mission in the universe created by God.

It is only too evident that science does not suffice in itself, is unable of itself to be its own end. Science does not exist except through and for man; it must leave the circle of research and pour itself out on man, and hence on society and history as a whole.

Science is a queen in her own domain. Who would dream of denying it? But it is a servant in relation to man, who is king of creation. If it were to refuse to serve, if it no longer aimed at the good and the progress of humanity, it would become sterile, useless and, let us say so, harmful.

The consequences of this mission of service are incalculable, and here we ought to face—but the too brief moments at our disposal do not allow of this—the immense problem of the morality of the applications of science. Whether it is a question of genetics, of biology, of the employment of atomic energy, of many other fields which affect what is essential in man, the upright scientist cannot but question himself as to the bearing of his discoveries on this psycho-physiological complex which is, in a word, a human person. Is everything permissible? Can applied science dispense with a norm of morality, can it proceed unchecked “beyond good and evil”? Who can fail to see the aberrations in which some could indulge in the name of science?

But the Church expects from science not merely that it may not injure morality or the profound welfare of the human being. She expects from it a positive service, what might be termed the "charity of knowledge". You, Gentlemen, are the ones who hold the keys of highest learning. We venture to assume towards you at this moment the office of advocate on behalf of the innumerable masses who receive only from a distance and rarely, a few drops, a few morsels of this vast human knowledge.

Allow Us to ask you on their behalf to cultivate research, but in order that it may be of use to others, that the light of discovered truth may be spread abroad, that the human race may be enlightened by it, improved and perfected; so that the political economy of the nations may draw from it directives which will lead more surely to the true welfare of mankind. This is the immense panorama which is unfolded before the scientist when, coming forth from his laboratory to look around him, he perceives something of man's expectation; an expectation which stirs men's hearts and opens them up to hope and joy, although leaving room at times it must indeed be said, for a feeling of uneasiness and anxiety.

This uneasiness and anxiety will be dissipated on the day on which men will become aware and will feel that the scientist is animated by a sincere spirit of service towards humanity, that he desires nothing so much as to enlighten men, to assist them, to ensure their progress and happiness.

You will no doubt recall, Gentlemen, that "message to men of thought and science" which was proclaimed on the closing day of the Council. Before dispersing, the imposing assembly turned to you to leave you with this urgent exhortation: "*Continue your search without tiring and without ever despairing of the truth ... Seek the light of tomorrow with the light of today until you reach the fullness of light!*" And the Council Fathers added: "*We are the friends of your vocation as searchers, companions in your fatigue, admirers of your successes, and, if necessary, consolers in your discouragement and your failures*".

This latter phrase may have astonished you. Does not scientific research bring its own reward? Is the scientist not repaid for his trouble by the deep intellectual satisfactions attached to his work?

The Church nevertheless brings a higher wisdom, the source of incomparably greater joys. It may be said that your life as scientists is spent in reading from the great book of nature. We have another book, one which communicates to us the thoughts of God concerning

the world, the inspired book, the holy book. This book gives us the decisive answers that science cannot give.

Allow Us, Gentlemen, in concluding, to open before you a page of this book, the page in which the inspired author describes the rapture of his soul when he is given access to this wisdom, higher than all human knowledge, which you have heard the Council evoke just now.

“I prayed and prudence was given me; to God I prayed and the spirit of wisdom came upon me. This I valued more than kingdom or throne; I thought nothing of my riches in comparison ... All my treasures of gold were a handful of dust beside it, my silver seemed but base clay in presence of it. I treasured wisdom more than health or beauty, preferred her to the light of day, for hers is a flame which never dies down. Together with her all blessings came to me ... The lessons she taught me are riches honestly won, shared without stint, openly proclaimed ... She is a treasure men will find incorruptible; those who acquire it win God’s friendship” (*Wisdom 7:7-14*).

May this wisdom be the faithful companion of your arduous labours, Gentlemen. This is Our wish and Our hope, as We invoke from God upon yourselves, your families and your activities, most abundant blessings.

Discourse of His Holiness Pope Paul VI given on 27th April 1968 at the Solemn Audience granted to the Plenary Session of the Academy and to participants in the Study Week on the theme "Organic Matter and Soil Fertility".

Dear Gentlemen,

In your persons, Gentlemen, We are happy to greet the organization of distinguished savants, both those present here today and those absent, constituting Our Pontifical Academy of Sciences, headed by its new and learned President, the Reverend Daniel O'Connell; and We are glad to have this opportunity of rendering public homage to your high standing in the scientific domain. The various contributions you render to the progress of science do you great honour, and that honour reflects upon the Holy See which assembled your organization in the first place. We begin, therefore, by greeting you and by thanking you.

Different circumstances, among them the sad death of your President, Monsignor Georges Lemaître, have prevented your Academy from abounding in external manifestations in recent times. Certainly, no one will be tempted to interpret this merely apparent and accidental decrease of activity as a sign of lessened vitality in an institution which has, by now, acquired throughout the world the fame and celebrity it merits. For Our part, We desire here and now to give solemn confirmation to the esteem and confidence We feel for you.

As you are aware, the idea which inspired the foundation of the Pontifical Academy of Sciences was that of giving, by means of the persons composing it and the activities it promotes, a proof of the love and respect which the Catholic Church nourishes for the contemporary scientific world. We wish now to renew Our assurance to you, that this initial purpose is more alive than ever in the conscience and plans of the Apostolic See. Its duty will be to preserve the full vigour of the Academy. Its intention is to give witness, in this way, to the veneration the Catholic Church professes for scientific research, the liberty She acknowledges in such research within its specific domain, the confidence with which She envisages its present and future achievements. In fact, if science, instead of being thought a sort of foreign body in the life of man, is properly inserted into his life, the Church believes that it can contribute to the progress,

not only speculative and technical, but moral and even, without here having recourse to artificial processes, to the religious and Christian progress of mankind.

This should suffice to show that respectful attention with which the Church considers the mission of the scientist. In her eyes, you are the seekers and explorers of the mysterious realities of creation; in other words, those who fulfil in the highest degree the task which God entrusted to man when He created him: that of conquering the earth, of uncovering the secrets of nature. For nature is full of secrets, and it cannot be doubted that those who strive to discover them—and you know better than We do, what patient and painstaking research this entails!—are responding to the Creator's original purpose and clear will.

When We fix Our attention upon your activity as scientists, it seems to Us to develop from a twofold premise, which constitutes as it were the pedestal of that superior degree of human excellence to which you are raised by the exercise of your vocations as researchers.

First of all, there is the systematic and perfected use of your intelligence. If you are, in a way, more fully men than other men, it is in the first place because you have developed to a high degree the potentialities of what is noblest and likeliest to God in man: that is, thought, the ability to become all things—the “*fieri omnia*” described by classical philosophy—that unique and incomparable privilege of the human intellect, the thinking being's power to conquer reality, assimilate it into himself, to turn it into a truth which becomes his own possession even though by its universality, it remains potentially the possession of all.

To this superior utilization of the highest faculty of the human being, there is added in the scientist—and this is the second premise—his entry into the scientific tradition. He collects, assimilates, deepens and perfects all that is of value in the vast heritage of the study and reflexion of those who preceded him; and he makes use of this patrimony of human knowledge amassed before him as a point of departure, to leap boldly forth towards new conquests, for the profit of his own generation and of those that follow.

Verily, then, men of science deserve honour and gratitude, and it is a heartfelt need, as well a duty, for Us to pay homage to your persons, Gentlemen, to such highly qualified representatives of modern culture and of its inspiring genius. We are well aware that, in doing so, We are faithfully interpreting the mind of the Church concerning you, a mind which She has often expressed in recent years, especially by the voice of Our Predecessor Pope Pius XII, a mind which She proclaimed again and proudly on the occasion of the recent Ecumenical Council. How could

We let pass an occasion like this, without recalling that the conciliar assembly willed to lend the full weight of its authority to the reaffirmation of the Church's positive attitude towards science?

Here is the aspect under which the Council envisages your calling as researchers: "Whoever labours to penetrate the secrets of reality with a humble and steady mind is, even unawares, being led by the hand of God, Who holds all things in existence, and gives them their identity". These words occur in the *Constitution on the Church in the Modern World*, which dedicates a whole chapter to the problem of culture. Analysing the development of culture, the Council document does not hesitate to note with satisfaction the positive acquisitions made by the present progress of science and of technology, and makes explicit mention of "scientific study and strict fidelity towards truth in scientific research, the necessity of working together with others in technical groups, a sense of international solidarity, an ever clearer awareness of the responsibility of experts to aid men and even to protect them, the desire to make the conditions of life more favourable for all, especially for those who are deprived of the opportunity to exercise responsibility or who are culturally poor" (Constitution *Gaudium et Spes*, Nos. 36 and 57). The conciliar document, of course, warns Christians against the perils of a purely earthly humanism; but at the same time shows them how the faith they profess "in no way decreases, but rather increases, the weight of their obligation to work with all men in constructing a more human world" (*ibid.*, No. 57).

As you see, Gentlemen, We are here far from the frequently petty and almost always sterile disputes which once gave pleasure to certain minds, inclined as they were to consider the Church, and the advance of human knowledge, as two openly struggling adversaries.

This does not mean that the ancient and ever reviving question of the relationship between science and faith has lost all meaning and interest. If the time at Our disposal were less limited, We should have liked to profit by an occasion like this to meditate the matter further with you. We should have liked to describe to you the new illumination which seems to shine on it today: that, namely, of a clearer distinction of the levels on which, separately, science and faith follow their proper methods, develop their knowledge; while the encompassing complexity of thought makes a happy synthesis of both orders of knowledge possible.

In that case, you would undoubtedly have demonstrated to Us, as having experienced it directly, how scientific research, by absorbing as it can all the knowing capacity of the seeker, can seem to provide sufficient satisfaction and repletion for the intellectual and spiritual activity of man; how it can succeed in annulling, not only the knowledge, but even the

desire of knowledge of God; to such a degree that finally atheism appears to some scientists to be a logical position, satisfying thought and justifying reality.

Then We, in turn, would be tempted to overthrow this fragile edifice of modern intellectual progress by affirming—and by calling again on your experience but on a deeper level—that science prepares for and presupposes an order of thought which transcends and justifies it, for science cannot explain everything; it can only explore what exists, what some Other, infinitely greater than science, has prodigally delivered over to the study of the sons of men. For if science is faithful in restricting research and certitudes within its proper sphere, that of the observable and measurable, so much the more will it progress in its investigations, and so much the more will it feel the need, as it were the intuition, of the immensity of that divine world which dominates it, and bestows upon it some reflection of itself.

We shall instead limit Ourselves to considering rather another aspect of the scientific world, to which your assembly so handsomely and laudably testifies, by asking: What use, what practical and useful employment should science, or rather men of science, and their brilliant pupils the technicians, make of the conquests of science? To this query only one reply is possible: Everything must tend towards the good of all mankind.

It is certainly not necessary to remind you, Gentlemen, that the spectre of most terrible calamities, capable of overwhelming and razing to nothing the whole inhabited earth, rises in fact from the most advanced laboratories of modern physical science? Can We remain silent about such prospects? No matter how great is the responsibility of politicians in this regard, yet the full responsibility of men of science also remains. For this reason, We shall never cease to pray and implore, as you now provide Us with a most propitious occasion to do. May necessary renunciations be made with courage! Let every measure be taken and every obligation assumed, in order to prevent and avert the manufacture and use of nuclear arms, of bacteriological warfare, of every other means of deriving from scientific progress the diabolic power of inflicting upon entire nations, even those uninvolved in possible conflicts, the scourge of horrible devastation! May mankind return to its senses! May men find in themselves, in their leaders, their teachers, the strength and the wisdom to forswear the evil use of destructive science! May they rather seek from science the secret of doing good to themselves!

This is what science is doing, indeed, to its own honour and for the advantage of all. You yourselves, Gentlemen, bear magnificent witness to this with the study week you are observing. Your theme,

which is "Organic Matter and the Fertility of Soil", is completely directed towards the good of men, nay rather, towards the integral and mutual development of mankind which We invoked, just a year ago, in Our Encyclical Letter "*Populorum progressio*". To make the earth fruitful, producing bread for all its dwellers, to struggle against the sterility of desert wastes, to multiply agricultural products, to derive from man's labour easier and more abundant results, to make possible a victory over hunger which today still affects entire nations, to give hope and the means of subsistence to the ever increasing generations of men—such is your conquest, such your art, your mission, your crown!

We are proud of you, Gentlemen, and glad of your studies and your contributions to mankind's well-being. With all Our heart do We express to you Our praise and Our good wishes. And, in the name of that God, so great and so mysterious, Whose works you explore; that God Who created the world and redeemed men; that God Whom in all humility but also in all truth We represent, We impart to you Our Apostolic Blessing.

Discourse of His Holiness Pope Paul VI given on 18th April 1970 at the Solemn Audience granted to the Plenary Session of the Academy and to participants in the Study Week on the theme "Nuclei of Galaxies".

Excellencies and dear Sirs,

We thank you heartily for the delicate sentiments just expressed to Us by Reverend Father O'Connell in the name of his illustrious colleagues. As you know, We are always happy to welcome the members of Our Pontifical Academy of Sciences, in the presence of the Diplomatic Corps and distinguished personalities. We also experience a certain emotion to see such qualified representatives of the entire world gathered together, a veritable Senate of scholars, at the head of scientific research and of reflection which it stimulates in the human mind. Is not the theme of your work, devoted to the "nuclei of galaxies", a striking sign of this?

1. Your Plenary Session marks an important moment in the life of the Academy, and We rejoice in this. For this Institute, remains highly significant: it can bring to our world appreciable help by the competency and universality of its testimony, and also provide a solid basis upon which believers can reflect for a fruitful dialogue with scientific thought. What roads have been travelled since the foundation of the Academy of "Lincei" in 1603, its revival by Pius IX, its enlargement under Leo XIII, and especially its reconstitution by the enlightened care of our great predecessor Pius XI, with the *Motu Proprio* of October 28, 1936, *In multis solaciis*, under the name of the Pontifical Academy of Sciences, comprised of seventy Pontifical Academicians "a Senate of learned men, as it were, or a scientific Senate to promote the progress of the sciences", under the presidency of Father Agostino Gemelli of happy memory (See *AAS*, 28, 1936, pp. 423-424).

Illustrious scholars have never ceased to honour the Academy by their presence and their work, and We Ourselves, yesterday, had the joy of adding to this select Cenacle twelve new members who provide a better representation of the ensemble of teachers who cultivate the

scientific disciplines with success throughout the world. Your studies of mathematical and experimental sciences, carried on with the liberty that is proper to culture, have certainly contributed to the progress of pure science, and prepared the progress of applied sciences. But should not such a development be extended to other domains today? While continuing your specialized researches whose importance does not cease to grow—experiences of the flights into space, the most recent of which We have followed these past days with anguish and, at the end, with thrilling joy and admiration—would it not be desirable and opportune to foster, in other Academies, other disciplines that are also essential to the human spirit, such as arts and letters, philosophy, law, history, economics, sociology, and the human sciences that characterize so profoundly the men of our times? This morning, We wish to entrust to you this thought upon which We have meditated for a long time and which, in Our mind, is more than a dream: a real desire which it would please Us to realize.

2. The very nature of your work prompts Us to underline two principles of which you are already convinced, and to which your own experience (We could say: your personality) bears witness every day. The fact that reason, however advanced it may be, is not and cannot be opposed to faith: “Science which is the true knowledge of things is never contradictory to the truths of Christian faith” (*Motu proprio, In multis solaciis, loc. cit., p. 421*).

Moreover, both faith and reason can be integrated in the unity of knowledge, while keeping their respective autonomy, as the first Vatican Council teaches: “Faith and reason ... are a mutual help to each other” (H. DENZINGER - A. SCHÖNMETZER, *Enchiridion symbolorum, definitionum et declarationum de rebus fidei et morum*; 34th ed. Freiburg im Breisgau, 1967, no. 3019, 1799).

Understand Us well. According to the pastoral Constitution *Gaudium et spes* which “recalls the teaching of the first Vatican Council”, the Church “affirms the legitimate autonomy of human culture and especially of the sciences”, with “their own principles and their proper method, each in its own domain” (*Gaudium et spes*, 59, par. 3). But these sciences which can so well “elevate the human family to a more sublime understanding of truth, goodness and beauty, and to the formation of judgments which embody universal values” (*ib.*, 57, par. 3), can also prepare man to discover and accept the whole truth, provided these sciences do not incorrectly consider “the methods of investigation which these sciences can use as the supreme rule for discovering the whole truth” (*ib.*, par. 5).

It is the same God who has created the world with its laws which you scrutinize—"all things in heaven and on earth, everything visible and everything invisible" (*Col* 1:16)—and who reveals Himself to men and brings them salvation in Jesus Christ. The same human spirit is capable of scrutinizing the secrets of creation and "of conquering the earth" (See *Gn* 1:28), and at the same time, of discovering and accepting "under the impulse of grace" the gift God makes of Himself to man, "The Word of God who, before He became flesh in order to save all things and to sum them up in Himself, 'He was in the world' already as the true light that enlightens every man" (*Jn* 1:9-10; see *Gaudium et spes*, 57, par. 4). How could the Church not encourage the investigation, the discovery, and the conquest of this universe which, with its marvellous and admirable riches, leads us, from the infinitely small to the infinitely great, towards the invisible which is the source of the visible? (See *Rom* 1:20).

3. But the theme you have just taken up, "the nuclei of galaxies", deserves special attention. Our imagination becomes baffled and leaves us filled with amazement, as though overwhelmed, almost crushed by the immensity of the perspective unfolded, "the silence of infinite spaces" so dear to Pascal. We follow with profound respect and great interest your patient work of observation, the coordination of experiments, and the formation of scientific hypotheses on the origin or evolution of astral worlds.

Does this mean that human thought exhausts all its possibilities at the level of these investigations?

In the background of these investigations, there is the problem of the very being of this cosmos, of this universe: the question of its existence. You remain, in fact, in scientific experimental observation, of a mathematical and cosmological order. But what prevents the mind, on philosophical grounds, from the possibility of ascending to the transcendent principle, to the Creator, "causa subsistendi et ratio intelligendi et ordo vivendi" (ST. AUGUSTINE, *De Civ. Dei*, I, VII, c. IV)? Too often today, we doubt this power. "The more science, while perfecting its methods, subjugates the world to man, the more being, which in reaction does not let itself be subjugated, evades him ... then comes the temptation to agnosticism" (H. DE LUBAC, *Sur les chemins de Dieu*, Paris, Aubier 1956, p. 84). But we cannot maintain such an attitude. "The intelligence absolutely cannot abdicate; it cannot renounce its formal law, which is to judge, that is, always affirm" (*ib.*). For the human mind, it is like "an irrepressible need to possess, at every moment of

its temporal experiment and in each state of its knowledge, an explanatory idea of the ensemble of things" (P. H. SIMON, *Questions aux savants*, Paris, Seuil 1969, p. 41).

We often speak of the "death of God". But should we not rather speak of the death of man and of his thinking in its superior form? Without this recourse to God, the source of Being, man's thinking seems to become engulfed in the darkness and incomprehensibility of things, in the ignorance of a unity which presides over them, and of the finality of a mysterious order which is inseparable from them, leading to an absurdity which exists only in its own making. Perhaps you are better spared than others from what must be called a true sickness of the mind, you who scrutinize objectively the sciences of nature, of astrophysics, of physics? (See C. TRESMONTANT, *Comment se pose aujourd'hui le problème de l'existence de Dieu*, Paris, Seuil 1966, p. 349). For the intelligence, by its very activity, (if it does not remain in the external appearance of reality), rises to the level of its transcendental cause, the real Absolute, Who gives consistency not only to all creation but especially to the human spirit, without ever becoming identical with them. As it has been happily said, the intelligence is "necessarily a power of assimilation as well as a power of ascent ... It understands in all realities that by which realities are, that is, realities open towards the illumination of the act. And thus, it can be rightly said that the intelligence is the sense of the divine, the avid and skilful faculty of recognizing the traces of God" (See Ch. DE MORÉ-PONTGIBAUD, *Du fini à l'infini*. Introduction à l'étude de la connaissance de Dieu, Paris, Aubier 1957, p. 65).

Here you have, it must be repeated, a natural development of thought, in its fundamental logic, and not an unjustified leap as claimed by an anti-metaphysical mentality improperly qualified as scientific. True science, far from arresting the thrust of thought, constitutes a springboard which enables it to rise, in this very thrust, towards the One who generously provides it with food. For, "the spirit itself is a road that travels ... We cannot get along without God" (H. DE LUBAC, *op. cit.*, p. 78).

We are amazed, as We said before, in the presence of your studies on the nuclei of galaxies. The solar system already appeared so vast and so mysterious to our predecessors! But for all that, we are not disconcerted, knowing that "God prefers rather to create beings in their seed in order to lead them subsequently to their blossoming" (Card. JOURNET, *L'Eglise du Verbe incarné*, t. 3, Essai de théologie de l'histoire du salut, Paris, Desclée de Brouwer, 1969, p. 114). Time and space, matter and form, can develop in a limitless way, indefinitely, as it were.

While listening to your teaching, We find assurance in our faith.

And to our mind, to us who are in the school of faith, come the words of Holy Scripture: "God created the heavens and the earth ... And God saw that it was good ... God saw all He had made, and indeed it was very good" (*Gn* 1:21-31). This joy God experienced in the presence of his creatures, why should we not have this same joy towards our Creator?

In our turn, we contemplate this mysterious beauty and goodness of creation. All these beings cry out to us, as they did to St. Augustine: we are not God, but it is God who made us. "Ecce caelum et terra clamant quod facta sint" (*Confessions*, I, XI, c. 4, no. 6; *PL* 32, 811 - Cf. *In Joannem tract.* 106, c. 17, no. 4; *PL* 35, 1910 - Cf. *Sagesse*, 13, 1 and 9). And Him we adore! The meeting with God is wrought before the quasi-limitless grandeur of his works (is it not a grace to be initiated in this grandeur?), in joy, in admiration, in prayer, in the adoration of the One who "in bestowing thousands of graces ... hurried through these forests, and while beholding them ... left them clothed with his beauty" (St. JOHN OF THE CROSS, *Spiritual Canticle*, verse 5).

At the conclusion of this contemplation of the supreme realities of the cosmos in their meeting with the supreme truths of the human mind, We cannot silence our emotions, our admiration, our satisfaction which are those of the entire world for the happy ending—yes, happy, very happy, even if the main aim of the adventurous flight of Apollo 13 was not achieved. All of you have certainly followed, with apprehension and then with joy, the unfolding of this extraordinary undertaking. And you will undoubtedly make it a point to congratulate warmly with Us the valiant astronauts who have escaped the dangers of this grandiose flight, and to render homage to all those who, by their studies, their activity and their authority, have once again brought before the eyes of the world the limitless power of sciences and modern technology. You will also raise with Us an ardent hymn of gratitude to God, Creator of the universe and Father of men, who, by these paths also, wishes to be sought after and found by man, adored and loved by Him.

Such are the thoughts, Excellencies and dear Sirs, suggested to Us by this very pleasant meeting. With all Our heart, We encourage you to pursue your scholarly work, to pool it in an unselfish manner, beyond frontiers, and to help all your brothers answer the question which science or rather its applications will never cease to ask. You can and should do this, in the light of the faith you bear within you. This is Our dearest wish. We accompany it for your intention with a generous Apostolic Blessing.

Discourse of His Holiness Pope Paul VI given on 15th April 1972 at the Solemn Audience granted to the Plenary Session of the Academy and to participants in the Study Week on the theme "The Use of Fertilizers and their Effect on the Increase of Crops, particularly with regard to Quality and Economy".

Mr. President. Members of the Academy, My Lords Cardinals, Messieurs Ambassadors, and all of you who have kindly honoured us with your presence.

The noble words we have just heard have given us a brief but striking picture of the phases of the fruitful work of the Pontifical Academy of Sciences in the last years, and they would suffice in themselves to show the vitality of this institution. The awarding of the Pius XI gold medal to Professor György Némethy is also a sign of this vitality. It has become, as you know, a tradition to recognize in this way the merits of a scholar of international repute, in his specific field. Professor Némethy, a son of the noble Hungarian nation, has at present a chair at the Rockefeller University. He is, you know better than We do, a specialist in the physical chemistry of liquids and solutions, and We are happy to confer on him this mark of esteem and encouragement in the presence of such a highly qualified audience as yours.

A tribute to science

Your presence here, Gentlemen, like Our own, is intended as a tribute to science; and the immensity of the horizons that this word itself conjures up before the mind's eye, gives rise to almost infinite reflections.

When in 1936 our great Predecessor Pius XI set up the Pontifical Academy of Sciences, he indicated the aim he proposed for it as follows: "Our wish and our hope is that, through this Institute, the "Pontifical Academicians" will contribute more and more and better and better to the progress of sciences. We do not task anything else of them: this noble intention, this brilliant labour, such is the service we expect from men enamoured of truth" (*Motu Proprio, In multis solaciis AAS 28 [1936], p. 424*).

The disinterested search for truth, the tireless pursuit of the secrets of the universe are, in fact, among the highest values, the most enthralling

ideals to which a man can devote his life, "Intellectum valde ama", St. Augustine said; and last century the geologist Pierre Termier (1859-1930) dedicated a book which perhaps you know, to "The joy of knowing". The scholar's joys are familiar to you, Gentlemen: suddenly to find the solution to problems after long study; after prolonged efforts, often painful, sometimes unavailing, to penetrate further into the secrets of nature; on the basis of ever more specialized researches, to construct suddenly a magnificent synthesis—sometimes seen in a flash—which gathers in a luminous theory a series of partial truths, apparently heterogeneous, and exclaim: "I have found it"; you have known these moments of exaltation.

Joy of the intelligence, rewarded for its works; aesthetic enjoyment, in the presence of a fine result; moral elevation, through the emphasis of effort: in all these ways the scholar rises above himself. And in this way, too, he serves mankind. As generation follows generation, new researches prolong previous discoveries; civilizations mature; progress expands. People have rightly spoken of the acceleration of history: True, it is due to the achievements of technique. But these achievements would not have been possible, or would have remained ambivalent, if the disinterested seeker had not first preceded, then accompanied the technician.

The real scholar goes even further. He knows that all civilization presupposes wisdom. "The future of the world stands in peril", Vatican II says, "unless wiser men are forthcoming". And it adds: "Many nations, poorer in economic goods, are quite rich in wisdom and can offer noteworthy advantages to others" (*Gaudium et Spes*, n. 15, 3).

This wisdom is not opposed to culture of the mind: they condition and complete each other. For science is not pride; it leads thereto only if deflected from its purpose. It is a lesson in humility: only by obeying nature is it possible to conquer it. Nature appears to us first of all as an obstacle to be overcome, darkness to be illuminated. It conflicts with our dreams and our fancies. But as we submit to its demands, we discover its laws. And we can gradually utilize them, discern means of putting them at the service of man. Thus the wise man accompanies the scholar; nature, at first hostile, but improved and transformed by work, becomes an ally and a friend.

The mystery of nature

This meeting of the scholar with nature sets him on a new path. One discovery leads to another, which in turn leads to yet another, but the spirit is never completely satisfied. Is it a case of indefinite progress towards an inaccessible goal? But this would be the abdication of intelli-

gence! Nature, gradually dominated, reveals a mystery greater than itself. And here the scholar is invited to become a philosopher. Either at the beginning or at the end of the enigmas he meets with on his way and which he works to solve, he is led to recognize, or at least to divine, the presence of a Wisdom of another order, unlimited, transcending space and time, which explains the presence of these laws, at first unyielding, but, then mastered and utilized.

The spark of light of human intelligence, unequally distributed but present in each of us, appears to the scholar as a participation in this absolute Light, where there is no darkness. Each step forward we take, each synthesis we make, reveals to us something of the plan that presides over the universal order of beings, over the forward effort of man and mankind. Here we are "in search of a new humanism which will enable modern man to find himself anew by embracing the higher values of love and friendship, of prayer and contemplation" (*Populorum Progressio*, n. 20).

So the task of the scholar is a hard one, if he claims to conquer nature by obeying it, to progress by dominating it. But that calls for other specific virtues, which are familiar to you: obdurate effort, in spite of apparent or temporary failure, patience in spite of the slowness of results, creative imagination in order to discover new ways, the passion for research with the determination to succeed. Then, as you have guessed, out of this alliance of deep reflection, of questioning about oneself, about mankind and the universe, which unites the scholar and the philosopher, there is born the wise man.

The study week of the Pontifical Academy of Sciences

At it advances, science has become more complex and specialized. Even a genius could not master it alone, not even in his own field. Any study whatsoever presupposes a series of problems, premises, a line of research and its own logic. All that may differ, not only according to previous individual discoveries or results, but depending on the angle of view chosen. Working on the same problem, isolated scholars may arrive at opposite conclusions. Collaboration, confrontation, call for personal and sufficiently prolonged contacts between them, if not with the hope of immediately solving the controversies, at least with the certainty of understanding divergences better and taking advantage of them. Thus the progress of science will become all the more rapid.

That is why you are here. Almost from its foundation, the Pontifical Academy of Sciences organized study weeks, the first in 1940. It invited

some eminent scholars, specialized in a clearly defined question, not too numerous in order that the dialogue would be really fruitful among them all, and that they could examine together all the facts relating to the problem. In spite of the circumstances—the world was then at war—the success measured up to the hopes. When peace was restored, the study weeks were multiplied, as we have just been reminded: yours is the twelfth.

“The use of the fertilizers and their effect on the increase of crops, particularly with regard to quality and economy”: this is your subject. It was with keen interest that we read the summaries sent by each of you for the preparation of the work. Their technical aspect is not within our competence and belongs to you alone. But the subject dealt with involves such human interests that the Church, concerned as she is with the development of the whole man and of all men, anguished by the drama of hunger in the world, anxious about the gap which, far from closing, seems to be widening between industrial countries and countries considered as being still in a rural economy, the Church, we say, expects a great deal from your researches, to contribute to the solution of these problems.

The drama of hunger in the world

To make food resources proportionate to the growing population of the globe, to overcome malnutrition, and finally to enable less industrialized countries, the producers of agricultural goods, to enter world commerce in conditions that are not too inferior: all these ambitions are human in the first place, and aim at meeting in a more satisfactory way the requirements of social justice, either between sectors of production in regions of advanced industrial civilization, or between the latter and populations that are mainly agrarian.

At least in the former unquestionable progress has been made, thanks to your work. The new rural generations are aware of the distance that still separates them from urban life, and the advantages that advanced technology offers the latter. If they do not benefit from them to the same extent, they receive the gleanings, and exploit them. Thanks to mechanization, they have been able to cultivate wider areas. By using fertilizers, they have increased and sometimes doubled their yields. They have learned to have their soil analysed in order to know what it is best suited for. They aim at specialization. Though their numbers are small, they are able to provide for the feeding of denser and more demanding populations.

Agriculture, once traditional and following a customary pattern, gradually becomes expert and technical. The peasant is replaced by the rural cultivator.

This being so, a deeply human task awaits you. You are and will be to an increasing extent the educators of this rural cultivator; he expects a great deal from your teachings. You will teach him to seek quality more than quantity, for it is a question of the food of mankind; to make a well-balanced use of his fertilizers, in order not to exhaust his land by demanding from it more than it can give; not to contribute to the pollution of waters by an illegitimate use of uncontrolled pesticides. It is a highly moral problem. You will teach him that if the desire for a more just remuneration for his work and the aspiration for a more dignified human life, are legitimate, he has also the noble mission of bringing men wholesome foodstuffs, not contaminated by unhealthy articles, that serve only to hasten an abundant quantitative production.

But as you know, our concern goes first and foremost to the poorest, who, owing to their economic weakness, remain in a condition of inferiority in the field of international trade. That is why we rejoice to find in your programme identical concerns: the correct use of fertilizers in humid tropical and sub-tropical regions, the importance of soil fertility in tropical Latin America, the role of fertilizers in African agriculture. Here again you will be indispensable educators, the only ones perhaps, capable of awakening to new horizons a population too much attached to its routines.

The activity of F.A.O.

A great deal has already been undertaken. For over twenty years, F.A.O. has been studying these problems, not without difficulties, but not without results. Thanks to the use of more suitable fertilizers, to better seed selection, to less backward techniques, countries that seemed condemned to endemic famine have considerably improved the yield of their soil and increased their production. But there remains a great deal to be done. You will have to carry out, in the first place, a work of persuasion, by means of varied, but conclusive experimentation. For the peasant, even if uneducated, or even illiterate, believes in what he has seen. Your researches will teach him not to exhaust a soil that is already too poor, by exploiting it excessively or in too primitive a way, to balance the rotation of his crops in order to be less the victim of climatic uncertainties, to adapt the use of fertilizers to the conditions of the land and the climate. One thing is certain: too large a part of the earth is

not rationally exploited. The first act of the struggle against hunger consists in getting the soil to produce everything it can: this is part of your competence.

If you succeed in convincing not only the farmer stooped over his desolate land, but first of all those in charge of the national economy, a great step forward will have been taken. Having improved his conditions of material life, the Indian, African, South American peasant will at least be able to acquire more fully the goods of the spirit to which he aspires, a culture that is not copied from others but is specifically his, which will allow him, too, to rise above himself and become more of a man.

May your researches, sometimes obscure but efficient, lead to a common effort of all men of goodwill to use the immense resources of brain and brawn to fertilize the land (cf. Address on 16 November 1970 to F.A.O., in *AAS*, 1970, p. 873). Is not that, after all, the conclusion of one of you: "Technical means", Professor Baade writes: "better plant food, the use of commercial fertilizers, we have known all that for a hundred and fifty years. But the utilization of these technical means depends on progress in the field of human morality; and the real progress of peoples, which is determinant, consists in this" (Prof. Dr. F. Baade, Kiel, Germany: programme of the Study Week on the use of fertilizers: "A century of crop increase, thanks to the use of commercial fertilizers; looking back to the year 1900 and forward to the 2000", p. 135).

The interest of the Church in scientific research

So, as you see, Gentlemen, what started out as a talk of science ends up as a talk on man, on his spiritual and moral value, the condition of real progress for the person as well as for society: this is the entire justification of the deep interest the Church takes in scientific work.

There remains for us, at the end of this talk, only to express to you once more our congratulations and best wishes. We do so wholeheartedly, invoking the abundance of divine blessing on the activities of your Academy and the happy continuation of your work, on yourselves, your families and all those who have kindly wished to emphasize the solemnity of this audience with their presence.

Discourse of His Holiness Pope Paul VI given on 19th April 1975 at the Solemn Audience granted to the Plenary Session of the Academy and to participants in the Study Week on the theme "Biological and Artificial Membranes and Desalination of Water".

Your Eminences, Excellencies

At the end of your Study Week, We are happy to renew to you the expression of Our deep esteem and Our warm encouragement to bring to scientific progress the high quality contribution of which the Pontifical Academy of Sciences is capable.

If the Holy See rejoices at this contribution, and with you is proud of it, it is on account of the considerable service you can render mankind in a more thorough knowledge of nature and the improvement of living conditions. The Church is even more directly concerned when it is a question of fields in which science, ethics and faith are involved at one and the same time, sectors in which your testimony as believers together with your scientific competence is particularly appreciated.

During the year 1974, the activities of the Pontifical Academy of Sciences were continued, under the great drive of its President, to whom we wish to pay tribute. Work and meetings of experts, scientific publications, cultural events, speeches in connection with the Synod of Bishops manifested brilliantly the vitality of your institution, which will soon celebrate its fortieth anniversary. We remember particularly the Commemoration of Guglielmo Marconi, an initiative of yours.

At present you have just studied the highly specialized problem of the biological and artificial membranes capable of bringing about the desalination of water. As you can imagine, we will not go into the technical question, or into the possibilities of its application, which would probably still be premature. But we know that it is a question of a kind of important metabolism, which it is in the interest of mankind to discern since the shortage of reserves of fresh water threatens to hinder its development.

Let Us just emphasize, in the more general field of scientific research, two attitudes which, it seems to Us, should characterize the scientist, and especially the scientist who is a Christian. On the one hand, he must honestly consider the question of the earthly future of mankind

and, as a responsible person, contribute to prepare it, preserve it and eliminate risks; We think that this solidarity with future generations is a form of charity to which a great many men are sensitive today, in the framework of ecology. But at the same time, the scientist must be animated by the confidence that nature has in store secret possibilities which it is up to intelligence to discover and make use of, in order to reach the development which is in the Creator's plan. This hope in the Author of nature and of the human spirit, rightly understood, is capable of giving new and serene energy to the researcher who is a believer.

In this spirit, We encourage you to continue with your work and to carry out, according to the financial means, alas limited, of the Academy, the happy initiatives that do it credit.

We have the joy of presenting now the Pius XI Medal to Mr. Stephen William Hawking whose studies, among others, on "Black Holes" have rightly won him an international reputation. All Our congratulations, dear Professor, and Our best wishes for all of you, Gentlemen, for your activities and those of the Academy. We add our Apostolic Blessing, as a token of Our solicitude for your spiritual life.

Discourse of His Holiness Pope Paul VI given on 23rd October 1976 at the Solemn Audience granted to the Plenary Session of the Academy (which celebrated the fortieth Anniversary of its renewal by Pius XI) and to participants in the Study Week on the theme "Natural Products and Plant Protection".

Your Excellencies,

We are happy to receive you in special audience at the end of your Study Week, the central subject of which was of quite particular interest: "Natural substances and plant protection". We greet you all very cordially and are anxious to assure you that We sincerely appreciate the valuable work you are carrying out, with dedication and a spirit of sacrifice, for the benefit of scientific progress. Our esteem is all the deeper in that your fundamental concern, as We know, is to serve man, and that is also the final aim of your research. You feel deeply within you the solidarity that binds you to mankind today and in the future, and that is why you adopt an attitude which is that of the ever serious scientist, the attitude of one who—as we had the opportunity to stress during our meeting last year—"must honestly consider the question of the earthly future of mankind and, as a responsible person, contribute to prepare it, preserve it and eliminate risks" (AAS 67, 1975, p. 268).

The subject chosen for the present Week reflects this concern in an evident way. With regard to the harmful agents which threaten plants, the fruits of which constitute directly or indirectly the main source of subsistence for the human being, protection is carried out today thanks above all to synthetic chemical products. But the latter are causing more and more serious concern, owing to their possible long-term toxic effects on man, and owing, too, to the changes they bring to the natural environment, with the consequent disturbances of the ecological balance. This is what prompts the scientist to intervene to study the possibility of using, for this work of protection, natural substances, which are already found in the environment and should not therefore cause ecological damage. This is precisely the subject of your Week.

We hope that this possibility of comparing and discussing the results of your researches in this field, will have contributed effectively to furthering the progress of scientific knowledge of the means of defence

put at man's disposal. May it also encourage the use of forms of protection which are not harmful to health! To stimulate the progress of science for the service of man represents the institutional purpose of this Pontifical Academy of Sciences.

We are happy to recall it on this occasion since we are celebrating this year the fortieth anniversary of its foundation by our predecessor Pius XI. The *Motu Proprio* which institute this new organism defined its aims as follows: "Our wish and our desire is that the *Academici Pontifici*, thanks to their and our Institute, will promote the progress of science more and more and better and better, and we ask nothing else of them, since it is this noble aim and this high task which constitute the service we expect of these men attached to truth" (cf. *AAS* 28, 1936, p. 424).

These forty years of activity have not disappointed this expectation: through Study Weeks, working groups, scientific publications and the other initiatives of the past decades, the Pontifical Academy, we say so expressing your legitimate pride, has made a valuable contribution not only to the progress of scientific knowledge, but also to the cause of collaboration and understanding among men.

The very composition of the Academy, which gathers men of science regardless of nationality, religion or belief, effectively emphasizes this universality of science which is a primary element of meeting and understanding among peoples. Science tends by its very nature to go beyond the limits that men have given themselves by setting up frontiers between them. It seeks a truth which does not admit, as such, any political colouring. It engages in this research with rational methods which cannot but be the same for all scientists, whatever their origin may be. So it fosters a mentality which permits a trusting, sincere and respectful dialogue with all those involved in the common destiny of mankind. It can clearly be seen, then, what an instrument of mutual understanding and peace serious scientific research can represent, and what a contribution the Assembly which you constitute can make from this point of view to promote a more united and peaceful life among the nations.

The Church has always valued, and in a particularly forceful way at the conclusion of the Council, the seekers of truth that scientists are, whose paths are not alien to her own (cf. *Message to men of thought and science*). Not only does she recognize the legitimate methodological autonomy of modern science (cf. *Gaudium et Spes*, n. 36), but she appreciates, in the change that the latter brings into the way of thinking and living, positive values which are not unrelated to the work of

salvation with which she is charged. That is why the Church needs, you, your demanding sense of research and your love of truth.

We encourage you therefore to continue generously on your way as conscientious seekers, aiming at the conquest of new possibilities for human progress. Quoting once more some words of the great Pontiff Pius XI, We express the wish that "this Academy will become an increasingly rich source of that beneficial charity which Truth is" (cf. Address for the meeting on 27 December 1925 of the Pontifical Academy of Sciences, Nuovi Lincei). And We accompany this wish with Our prayer, asking Almighty God, the Source of life and of the human spirit, to assist you in your research in the service of mankind and to bless you personally, as well as all those who are dear to you.

Discourse of His Holiness Pope Paul VI given on 22nd October 1977 at the Solemn Audience granted to participants in the Study Week dedicated to the theme: "The Role of Non-Specific Immunity in the Prevention and Treatment of Cancer".

Mr. President,
Ladies and Gentlemen,

We are very happy to receive your visit. And the reason is a double one: the presence of the Council of the Pontifical Academy of Sciences and that of eminent cancerologists.

We are always ready, in fact, to encourage the activity of our Academy stimulated zealously by its President and its Council. The Holy See is anxious to honour in this way, in the persons of the members of this Pontifical Institution, and through them, all those who in a worthy way, shed lustre on science. For, by examining objectively the immense field of physical and biological realities, they contribute to ensuring the real progress of scientific knowledge, according to the Creator's invitation, and to preparing technical progress in harmony with man's vocation and complete good, and therefore under the responsibility of conscience.

But this morning, Our interest takes on a concrete form and grows since with the specialists that We are happy to greet, you have just dedicated a week of studies to what is, rightly, the object of deep concern on the part of our contemporaries: the prevention and treatment of cancer.

You have concentrated your attention on non-specific immunity in this field. We Ourselves attribute great importance to this work, for We share the anxiety of our brothers and Christ's ardent desire to see the sick relieved or cured of their infirmities. And it is a question of a terrible affliction, which strikes, still too often irremediably and in the midst of cruel sufferings, a large number of people, even at a comparatively young age, from every country. The disease is all the more powerful in that its mechanisms seem closely linked with the normal processes of cellular reproduction, in which they create grave anarchy.

In addition to surgical operations and radiological treatments which have already made great progress, at the risk, however, of acting on

normal cells as well as on cells of cancerous tumours, you have wished to study the exploration of a new way, by utilizing immunological and immunochemical means, to activate the defences of the organism or stop the proliferation of neoplastic cells. We thank you heartily for informing us of the results of your work. We hope that it will help to prepare the medical progress to which so many people aspire, physicians, patients and the relatives of patients. We congratulate you on this high service to humanity and We willingly implore on you and on the members of your families the blessings of God, the source of life and Saviour.

DISCOURSES
OF
HIS HOLINESS POPE JOHN PAUL II





*Discourse of His Holiness Pope John Paul II
given on 10th November 1979 at the Plenary
Academic Session to commemorate the centenary
of the birth of Albert Einstein.*

Venerable Brothers,
Your Excellencies,
Ladies and Gentlemen,

1. I thank you heartily, Mr. President, for the warm and fervent words you addressed to me at the beginning of your discourse. And I rejoice also with Your Excellency, as with Mr. Dirac and Mr. Weisskopf, both illustrious members of the Pontifical Academy of Sciences, in this solemn commemoration of the centenary of the birth of Albert Einstein.

The Apostolic See also wishes to pay to Albert Einstein the tribute due to him for the eminent contribution he made to the progress of science, that is, to knowledge of the truth present in the mystery of the universe.

I feel in full solidarity with my predecessor Pius XI and with those who succeeded him in Peter's See, in calling upon members of the Pontifical Academy of Sciences, and all scientists with them, to bring about "the progress of sciences more and more nobly and intensely without asking anything else of them; and that because the mission of serving truth, with which we charge them, consists in this excellent intention and in this noble labour ... (Motu proprio *In multis solaciis* of 28 October 1936, on the Pontifical Academy of Sciences: *AAS* 28, 1936, p. 424).

2. The search for truth is the task of basic science. The researcher who moves on this first aspect of sciences, feels all the fascination of St. Augustine's words: "Intellectum valde ama" (*Epist.* 120, 3, 13; PL 33, 459), "he loves intelligence" and the function that is characteristic of it, to know truth. Pure science is a good, which all people must be able to cultivate in full freedom from all form of international slavery or intellectual colonialism.

Basic research must be free with regard to political and economic

authorities, which must cooperate in its development, without hampering it in its creativity or harnessing it to serve their own purposes. Like any other truth, scientific truth is, in fact, answerable only to itself and to the supreme Truth, God, the creator of man and of all things.

3. In its other aspect, science turns to practical applications, which find their full development in the various technologies. In the phase of its concrete achievements, science is necessary to mankind to satisfy the rightful requirements of life, and to overcome the different ills that threaten it. There is no doubt that applied science has rendered and will continue to render immense services to man, provided it is inspired by love, regulated by wisdom, and accompanied by the courage that defends it against the undue interference of all tyrannical powers. Applied science must be united with conscience, so that, in the trinomial, science-technology-conscience, it is the cause of man's real good that is served.

4. Unfortunately, as I had occasion to say in my encyclical *Redemptor Hominis*, "The man of today seems ever to be under threat from what he produces ... This seems to make up the main chapter of the drama of present-day human existence" (n. 15). Man must emerge victorious from this drama which threatens to degenerate into a tragedy, and he must find again his true kingship over the world and his full dominion over the things he produces. At the present time, as I wrote in the same encyclical, "The essential meaning of this 'kingship' and 'dominion' of man over the visible world, which the Creator himself gave man for his task, consists in the priority of ethics over technology, in the primacy of the person over things, and the superiority of spirit over matter" (n. 16).

This threefold superiority is maintained to the extent to which the sense of the transcendence of man over the world and of God over man, is preserved. Exercising her mission of guardian and advocate of both transcendences, the Church considers she is helping science to keep its ideal purity in the aspect of basic research, and to carry out its service of man in the aspect of its practical applications.

5. The Church willingly recognizes, moreover, that she has benefited from science. What the Council said about certain aspects of modern culture must be attributed to it, among others: "As regards religion there is a completely new atmosphere that conditions its practice. People are taking a hard look at all magical world-views and prevailing superstitions and demanding a more personal and active commitment to faith, so that

not a few have achieved a lively sense of the divine" (*Gaudium et Spes*, n. 7).

The collaboration between religion and modern science is to the advantage of both, without violating their respective autonomy in any way. Just as religion demands religious freedom, so science rightly claims freedom of research. The Second Vatican Council, after reaffirming, with the First Vatican Council, the rightful freedom of the arts and of human disciplines in the field of their own principles and their own method, solemnly recognizes "the legitimate autonomy of culture and especially of the sciences" (*Gaudium et Spes*, n. 59). In the occasion of this solemn commemoration of Einstein, I would like to confirm again the declarations of the Council on the autonomy of science in its function of research on the truth inscribed in creation by the finger of God. The Church, filled with admiration for the genius of the great scientist in whom the imprint of the creative Spirit is revealed, without intervening in any way with a judgment which it does not fall upon her to pass on the doctrine concerning the great systems of the universe, proposes the latter, however, to the reflection of theologians to discover the harmony existing between scientific truth and revealed truth.

6. Mr. President! You said, very rightly, in your address that Galileo and Einstein characterized an era. The greatness of Galileo is known to everyone, like that of Einstein; but unlike the latter, whom we are honouring today before the College of Cardinals in the apostolic palace, the former had to suffer a great deal—we cannot conceal the fact—at the hands of men and organisms of the Church. The Vatican Council recognized and deplored certain unwarranted interventions: "We cannot but deplore"—it is written in number 36 of the conciliar constitution *Gaudium et Spes*—"certain attitudes (not unknown among Christians) deriving from a shortsighted view of the rightful autonomy of science: they have occasioned conflict and controversy and have misled many into thinking that faith and science are opposed". The reference to Galileo is clearly expressed in the note to this text, which cites the volume *Vita e opere di Galileo Galilei* by Mgr. Pio Paschini, published by the Pontifical Academy of Sciences.

To go beyond this stand taken by the Council, I hope that theologians, scholars and historians, animated by a spirit of sincere collaboration, will study the Galileo case more deeply and, in loyal recognition of wrongs from whatever side they come, will dispel the mistrust that still opposes, in many minds, a fruitful concord between science and faith, between the Church and the world. I give all my support to this task, which will be able to honour the truth of faith and of science and open the door to future collaboration.

7. Allow me, Gentlemen, to submit to your attention and your reflection some points that seem to me important to set again in its true light the Galileo affair. For in this affair the agreements between religion and science are more numerous and above all more important than the incomprehensions which led to the bitter and painful conflict that continued in the course of the following centuries.

He who is rightly called the founder of modern physics, declared explicitly that the two truths, of faith and of science, can never contradict each other, "Holy Scripture and nature proceeding equally from the divine Word, the former dictated, as it were, by the Holy Spirit, the latter as a very faithful executor of God's orders", as he wrote in his letter to Father Benedetto Castelli on 21 December 1613 (National Edition of the works of Galileo, vol. V, pp 282-285). The Second Vatican Council does not express itself otherwise: it even takes up again similar expressions when it teaches: "Methodical research in all branches of knowledge, provided it is carried out in a truly scientific manner and does not override moral laws, can never conflict with the faith, because the things of the world and the things of faith derive from the same God" (*Gaudium et Spes*, n. 36).

Galileo feels in his scientific research the presence of the Creator, who stimulates him, inspires and helps his intuitions, acting in the deepest recesses of his spirit. In connection with the invention of the telescope, he writes at the beginning of *Sidereus Nuncius*, recalling some of his astronomical discoveries: "Quae omnia ope Perspicilli a me excogitati divina prius illuminante gratia, paucis abhinc diebus reperta, atque observata fuerunt" (*Sidereus Nuncius*, Venetiis, apud Thomam Baglionum, MDCX, fol. 4). "All that has been discovered and observed in the last few days thanks to the 'telescope' that I have invented, after having been enlightened by divine grace".

Galileo's confession of divine illumination in the mind of the scientist, finds an echo in the text already quoted of the conciliar constitution on the Church in the modern world: "The humble and persevering investigator of the secrets of nature is being led, as it were, by the hand of God in spite of himself" (*loc. cit.*).

The humility which the conciliar text stresses is a virtue of the spirit necessary for scientific research as well as for adherence to faith. Humility creates a climate favourable to the dialogue between the believer and the scientist; it calls for the illumination of God, already known or still unknown but loved in both cases by him who humbly seeks the truth.

8. Galileo formulated important norms of an epistemological character, which are indispensable to reconcile Holy Scripture and science. In

his letter to the grand-duchess mother of Tuscany, Christine of Lorraine, he reaffirms the truth of the Scriptures: "Holy Scripture can never lie, provided, however, that its real meaning is understood. The latter—I do not think it can be denied—is often hidden and very different from what the mere sense of the words seems to indicate" (National Edition of the words of Galileo, vol. V, p. 315). Galileo introduces the principle of an interpretation of the sacred books which goes beyond the literal meaning but is in conformity with the intention and the type of exposition characteristic of them. It is necessary, as he affirms, that "the wise men who expound it should show its real meaning".

The ecclesiastical magisterium admits the plurality of the rules for the interpretation of Holy Scripture. It teaches expressly in fact, with Pius XII's encyclical *Divino afflante Spiritu*, the presence of different literary styles in the sacred books and therefore the necessity of interpretations in conformity with the character of each of them.

The various agreements that I have mentioned do not in themselves solve all the problems of the Galileo affair, but they contribute to creating a starting point favourable to their honourable solution, a state of mind propitious to the honest and loyal solution of old oppositions.

The existence of this Pontifical Academy of Sciences, with which Galileo was associated in a certain way through the old institution which preceded the present one, to which eminent scientists belong today, is a visible sign which manifests, without any form of racial or religious discrimination, the deep harmony that can exist between the truths of science and the truths of faith.

9. In addition to the foundation of your Pontifical Academy by Pius XI, my predecessor John XXIII wished the Church to continue to promote scientific progress and to reward it, by establishing the Pius XI Gold Medal. In conformity with the choice made by the Council of the Academy, I am happy to confer this high distinction on a young researcher, Dr. Antonio Paes de Carvalho, whose basic research works have made an important contribution to the progress of science and the good of mankind.

10. Mr. President and Members of the Academy, before the Lords Cardinals present here, the Diplomatic Corps accredited to the Holy See, the illustrious scientists and all the personalities attending this academic session, I would like to declare that the universal Church, the Church of Rome united with all those in the world, attaches great importance to the function of the Pontifical Academy of Sciences.

The title "Pontifical" attributed to this Academy signifies, as you know, the interest and support of the Church. These are manifested in

very different forms, of course, from those of ancient patronage, but they are no less deep and effective. As the distinguished President of your Academy, the late Mgr. Lemaître, wrote: "Does the Church need science? Certainly not, the cross and the gospel are sufficient for her. But nothing human is alien to the Christian. How could the Church have failed to take an interest in the most noble of the strictly human occupations: the search for truth?" (O. Godart - M. Heller, *Les relations entre la science et la foi chez Georges Lemaître*, Pontificia Academia Scientiarum, Commentarii, vol III, n. 21, p. 7).

In this Academy which is yours and mine, believing and non-believing scientists collaborate, concurring in the search for scientific truth and in respect for the beliefs of others. Allow me to quote here again an enlightening passage by Mgr. Lemaître: "Both of them, (the believing scientist and the non-believing scientist) endeavour to decipher the palimpsest of nature, in which the traces of the various stages of the long evolution of the world are overlaid on one another and confused. The believer has perhaps the advantage of knowing that the enigma has a solution, that the underlying writing is, when all is said and done, the work of an intelligent being, therefore that the problem raised by nature has been raised in order to be solved, and that its difficulty is doubtless proportionate to the present or future capacity of mankind. That will not give him, perhaps, new resources in his investigation, but it will contribute to maintaining in him a healthy optimism without which a sustained effort cannot be kept up for long" (*o.c.*, p. 11).

I wish you all this healthy optimism of which Mgr. Lemaître speaks, an optimism which draws its mysterious but real origin from God, in whom you have put your faith, or from the unknown God to whom the truth, which is the object of your enlightened researches, is directed.

May the science that you profess, Members of the Academy and scientists, in the field of pure research as in that of applied research, help mankind, with the support of religion and in agreement with it, to find again the way to hope and to reach the last aim of peace and faith!

*Discourse of His Holiness Pope John Paul II
given on 14th November 1980 at the Solemn
Audience granted to the participants in the Study
Week dedicated to "Energy and Humanity".*

Your Excellencies, Ladies and Gentlemen,

You know the value I attach to the research work of members of our Pontifical Academy of Sciences. This tells you how happy I am to meet you here, before the end of your work which honours the Holy See, to express to you myself my esteem and encouragement.

The Study Week which has brought you together deals with one of the most serious questions that humanity must cope with today. And precisely your analysis of the scientific data on energy is geared to concern with the fate of mankind: "Energy and Humanity". I congratulate you, I who, at the tribune of UNESCO, last June 2, stressed the necessity of preventing the progress of disinterested scientific knowledge from ignoring the responsibilities of consciences (nos. 20-22).

Allow me now to recall before you, in a very simple way, free of technicalities, these data which are, of course, very familiar to you; I do so only for the purpose of manifesting to you my interest in your discussions and of sharing some ethical concerns with you.

In the course of his history, man has developed the forms of energy that he needed, passing from the discovery of fire to ever richer forms of energy, and arriving finally at nuclear energy, which is staggering from so many points of view. At the same time, the progress of industrialization has given rise, especially in recent times, to ever increasing consumption, to such an extent that some natural resources are becoming exhausted. Our civilization—above all its scientists and technicians—must look for new methods in order to use the sources of energy that Divine Providence has put at the disposal of man. It is necessary, furthermore, that governments themselves should pursue a unified energy policy, so that the energy produced in one region can be used in other regions.

It certainly seems that the sun, the first source of energy and the richest one for our planet, should be studied more attentively by researchers; it must become one of their main concerns. While it is

true that direct use of solar energy is still far away, this prospect must not reduce the efforts of researchers or the support of governments. Moreover, results have already been achieved and are being used to advantage in different parts of the world. Furthermore, other forms of energy, such as wind, marine or geothermal energy, have already been used, even if to a limited extent as yet, and depending on geographical conditions.

I have learned that use of biomass has drawn your attention and that you have dwelt on the necessity of developing studies concerning photosynthesis.

Wood takes its place among the oldest sources of energy. In the developing countries, it will undoubtedly remain for a long time the main source of energy. But it is necessary that use of this traditional and important form of energy should not give rise to deforestation and destruction of forests, which creates serious ecological imbalances. It would be necessary, therefore, to plan active reforestation, to be carried out by botanists, ecologists and pedologists, and its implementation should be the object of attentive care on the part of planners and politicians.

As regards other forms of energy, such as waterfalls, coal, oil and nuclear energy, their choice is based, of course, on various factors depending on natural and human resources, population growth, ways of development, and the economy. I am sure that you will have considered in your discussions the rules that are necessary to eliminate the dangers that threaten, from far and near, those who are exposed to possible harm due to the use of certain sources of energy, and also always to promote ecological safeguards, the protection of fauna and flora, to avoid the destruction of natural beauty which fills the heart with admiration and poetry.

I myself have seen the harm done to the beauty of nature by industrial installations which could have been placed elsewhere or planned differently. Above all, I have had personal experience of the sufferings of coal miners, whose lungs are impregnated with the dust that poisons the mine tunnels. I hope and trust that, in the name of human rights and for the improvement of the quality of life, new and effective measures have already been adopted for the utilization of conventional sources of energy, and that in this way we will no longer have to see jeopardized not only the natural environment, but also workers and populations.

Finally it is opportune to reflect on the economic and moral dangers due to what is called the consumer civilization of today and its struc-

tures. As I wrote in my encyclical *Redemptor Hominis*: "Everyone is familiar with the picture of the consumer civilization, which consists in a certain surplus of goods necessary for man and for entire societies—and we are dealing precisely with the rich highly developed societies—while the remaining societies, at least broad sectors of them, are suffering from hunger, with many people dying each day of starvation and malnutrition ...

So widespread is the phenomenon that it brings into question the financial, monetary, production and commercial mechanisms that, resting on various political pressures, support the world economy. These are proving incapable either of remedying the unjust social situations inherited from the past, or of dealing with the urgent challenges and ethical demands of the present. By submitting man to tensions created by himself, squandering at an accelerated pace material and energy resources, and compromising the geophysical environment, these structures unceasingly make the areas of misery spread, accompanied by anguish, frustration and bitterness" (n. 16).

The frustrations to which man is subject today due to excessive consumption on the one hand and the energy crisis on the other, can be solved only if it is recognized that energy, whatever its form or origin, must contribute to the good of man. Energy and the problems that it raises must not serve the selfish interests of particular groups which are trying to increase their sphere of economic and political influence, far less must it divide peoples, make some nations dependent on others, and increase the risks of war or of a nuclear holocaust.

Energy is a universal good that Divine Providence has put in the service of man, of all men, to whatever part of the world they may belong, and we must think also of the men of the future, for the Creator entrusted the earth and the multiplication of its inhabitants to man's responsibility.

I think it can be considered a duty of justice and charity to make a resolute and persevering effort to husband energy resources and respect nature, so that not only humanity as a whole today may benefit, but also the generations to come. We are bound in solidarity to the generations to come. And I hope that Christians, moved particularly by gratitude to God, by the conviction that life and the world have a meaning, by unlimited hope and charity, will be the first to appreciate this duty and draw the necessary conclusions.

I thank you, Ladies and Gentlemen, for having responded in such large numbers to the appeal that the Pontifical Academy of Sciences had made to you in view of your high competence, and I express my

best wishes that your work may serve the good of the whole of humanity. I pray to God to assist you in this noble task, at the moment when I am setting out for Germany to commemorate St. Albert the Great, whose scientific work was considerable for his time, as well as his philosophical and theological reflection. I also pray to the Lord to bless you personally, and your families.

Discourse of His Holiness Pope John Paul II given on 3rd October 1981 at the Solemn Audience granted to the Plenary Session and participants in the Study Week dedicated to "Cosmology and Fundamental Physics" with members of two Work Groups who had discussed "Perspectives of Immunization against Parasitic Diseases" and "Effects Resulting from an Atomic Bombing".

Mr. President,
Members of the Academy,
Ladies and Gentlemen,

1. The programme of work which your President has presented, and with which I was already acquainted before this meeting, demonstrates the great vitality of your Academy, its interest in the most acute problems of modern science and its interest in the service of humanity. On the occasion of a previous solemn session I have already had the opportunity to tell you how highly the Church esteems pure science: it is "a good, worthy of being loved, for it is knowledge and therefore perfection of man in his intelligence ... It must be honoured for its own sake, as an integral part of culture" (Address to the Pontifical Academy of Sciences, 10 November 1979).

Before speaking of the questions which you have already discussed during these days and those which you now propose to study, permit me to express my warm thanks to your illustrious President, Professor Carlos Chagas, for the congratulations which he kindly expressed in the name of your whole Assembly for my having regained my physical strength, thanks to the merciful Providence of God and the skill of the doctors who have cared for me. And I am pleased to avail myself of the occasion to express my particular gratitude to the Members of the Academy who from all parts of the world have sent me their good wishes and assured me of their prayers.

2. During this Study Week, you are dealing with the subject of "Cosmology and Fundamental Physics", with the participation of scholars from the whole world, from as far away as North and South America and Europe and China. This subject is linked to themes already dealt with by the Pontifical Academy of Sciences in the course of its prestigious history. Here I wish to speak of the session on microseisms, stellar

clusters, cosmic radiation and galactic nuclei, sessions which have taken place under the presidency of Father Gemelli, Monsignor Lemaitre and also Father O'Connell, to whom I address my most fervent good wishes and whom I pray the Lord to assist in his infirmity.

Cosmogony and cosmology have always aroused great interest among peoples and religions. The Bible itself speaks to us of the origin of the universe and its make-up, not in order to provide us with a scientific treatise, but in order to state the correct relationships of man with God and with the universe. Sacred Scripture wishes simply to declare that the world was created by God, and in order to teach this truth it expresses itself in the terms of the cosmology in use at the time of the writer. The Sacred Book likewise wishes to tell men that the world was not created as the seat of the gods, as was taught by other cosmogonies and cosmologies, but was rather created for the service of man and the glory of God. Any other teaching about the origin and make-up of the universe is alien to the intentions of the Bible, which does not wish to teach how heaven was made but how one goes to heaven.

Any scientific hypothesis on the origin of the world, such as the hypothesis of a primitive atom from which derived the whole of the physical universe, leaves open the problem concerning the universe's beginning. Science cannot of itself solve this question: there is needed that human knowledge that rises above physics and astrophysics and which is called metaphysics; there is needed above all the knowledge that comes from God's revelation. Thirty years ago, on 22 November 1951, my predecessor Pope Pius XII, speaking about the problem of the origin of the universe at the Study Week on the subject of microseisms organized by the Pontifical Academy of Sciences, expressed himself as follows: "In vain would one expect a reply from the sciences of nature, which on the contrary frankly declare that they find themselves faced by an insoluble enigma. It is equally certain that the human mind versed in philosophical meditation penetrates the problem more deeply. One cannot deny that a mind which is enlightened and enriched by modern scientific knowledge and which calmly considers this problem is led to break the circle of matter which is totally independent and autonomous—as being either uncreated or having created itself—and to rise to a creating Mind. With the same clear and critical gaze with which it examines and judges the facts, it discerns and recognizes there the work of creative Omnipotence, whose strength raised up by the powerful *fiat* uttered billions of years ago by the creating Mind, has spread through the universe, calling into existence, in a gesture of generous love, matter teeming with energy".

3. Members of the Academy, I am very pleased with the theme that you have chosen for your Plenary Session beginning on this very day: "The Impact of Molecular Biology on Society". I realize the advantages that result—and can still result—from the study and applications of molecular biology, supplemented by other disciplines such as genetics and its technological application in agriculture and industry, and also, as is envisaged, for the treatment of various illnesses, some of a hereditary character.

I have firm confidence in the world scientific community, and in a very special way in the Pontifical Academy of Sciences, and I am certain that thanks to them biological progress and research, as also all other forms of scientific research and its technological application, will be carried out in full respect for the norms of morality, safeguarding human dignity, freedom and equality. It is necessary that science should always be accompanied and controlled by the wisdom that belongs to the permanent spiritual heritage of humanity and that takes its inspiration from the design of God implanted in creation before being subsequently proclaimed by his Word.

Reflection that is inspired by science and by the wisdom of the world scientific community must enlighten humanity regarding the consequences—good and bad—of scientific research, and especially of that research which concerns man, so that, on the one hand, there will be no fixation on anticultural positions that retard the progress of humanity, and that on the other hand there will be no attack on man's most precious possession: the dignity of his person, destined to true progress in the unity of his physical, intellectual and spiritual well-being.

4. There is another subject which, during these days, has occupied the thoughts of some of you, eminent scholars from different parts of the world who have been brought together by the Pontifical Academy of Sciences: the question of parasitic diseases, diseases which strike the poorest countries of the world and are a serious obstacle to the development of man in the harmonious framework of his physical, economic and spiritual well-being. The efforts to eliminate, as far as possible, the serious harm caused by parasitic diseases to a considerable part of humanity are inseparable from the efforts which should be made for the socioeconomic development of those same peoples. Human beings normally need a basic minimum of health and material goods in order to be able to live in a manner worthy of their human and divine vocation. It is for this reason that Jesus turned with infinite love to the sick and infirm, and that he miraculously cured some of the diseases about which you have been concerned in these past days. May the Lord inspire

and assist the work of the scientists and doctors who dedicate their research and profession to the study and treatment of human infirmities, especially those which are the most grave and humiliating

5. In addition to the question of parasitic diseases, the Academy has been studying the question of a scourge of catastrophic dimensions and gravity that could attack the health of humanity if a nuclear conflict were to break out. Over and above the death of a considerable part of the world's population, a nuclear conflict could have incalculable effects on the health of the present and future generations.

The multi-disciplinary study which you are preparing to undertake cannot fail to be for the Heads of State a reminder of their tremendous responsibilities, and arouse in all humanity an ever more intense desire which comes from the most profound depths of the human heart, and also from the message of Christ who came to bring peace to people of good will.

By virtue of my universal mission, I wish to make myself once more the spokesman of the human right to justice and peace, and of the will of God who wishes all people to be saved. And I renew the appeal that I made at Hiroshima on February 25 of this year: "Let us pledge ourselves to peace through justice; let us now take a solemn decision, that war will never be tolerated or sought as a means of resolving differences; let us promise our fellow human beings that we will work untiringly for disarmament and the banishing of all nuclear weapons; let us replace violence and hate with confidence and caring".

6. Among the efforts to be made in order to secure the peace of humanity, there is the effort to ensure for all peoples the energy needed for their peaceful development. The Academy concerned itself with this problem during its Study Week last year. I am happy to be able to award today the Pius XI Gold Medal to a scientist who has contributed in an outstanding way, by his research in the field of photo-chemistry, to the utilization of solar energy: Professor Jean-Marie Lehn of the Collège de France and the University of Strasbourg, and I express to him my most cordial congratulations.

To all of you, I offer my sincere compliments on the work which you are doing in scientific research. I pray that Almighty God will bless you, your families, your loved ones, your collaborators, and the whole of humanity, for whom in diverse yet converging ways you and I are carrying out the mission which has been entrusted to us by God.

*Discourse of His Holiness Pope John Paul II
given on 23rd October 1982 at the Solemn Audi-
ence granted to participants in the Study Week
dedicated to "Modern Biological Experimentation".*

Mr. President, Ladies and Gentlemen,

1. I desire to express to you my deep gratitude for your visit and to present my best wishes for your activities, of which Professor Chagas has spoken. Permit me, first of all, to offer my felicitations to the President of the Pontifical Academy of Sciences for the intense work performed in various areas of science and for the initiatives undertaken for the well-being of all humanity, such as the recent appeal against nuclear war, endorsed by approximately forty Presidents of Academies throughout the world and by other scientists who gathered on 23-24 September last in the Casina Pio IV, the headquarters of our own Academy.

2. The Work which you have accomplished during these days, besides having a *high scientific value*, is also of *great interest for religion*. My predecessor Paul VI, in his discourse to the United Nations Organization on 4 October 1965, spoke from the viewpoint of being an "expert in humanity". This expertise is indeed linked with the Church's own wisdom, but it likewise comes from culture, of which the natural sciences are an ever more important expression.

In my talk to UNESCO on 2 June 1980, I mentioned, and now I wish to repeat it to you scientists, that there exists "an organic and constitutive link between culture and religion". I must also confirm before this illustrious assembly what I said in my address of 3 October 1981 to the Pontifical Academy of Sciences, on the occasion of the annual Study Week: "I have firm confidence in the world scientific community, and in a very particular way in the Pontifical Academy of Sciences, being certain that, thanks to them, biological progress and research, as also all other scientific research and its technological application will be accomplished in full respect for the norms of morality, safeguarding the dignity of people and their freedom and equality". And I added: "It is necessary that science should always be accompanied and guided by the wisdom that belongs to the permanent spiritual heritage of humanity, and which is inspired by

the design of God inscribed in creation before being subsequently proclaimed by His Word”.

3. Science and wisdom, which in their truest and most varied expressions constitute a most precious heritage of humanity, are *at the service of man*. The Church is called, in her essential vocation, to foster the progress of man, since, as I wrote in my first Encyclical: “... man is the primary route that the Church must travel in fulfilling her mission: *he is the primary and fundamental way for the Church*, the way traced out by Christ Himself” (*Redemptor Hominis*, 14). Man is also for you the ultimate term of scientific research, the whole man, spirit and body, even if the immediate object of the sciences that you profess is the body with all its organs and tissues. The human body is not independent of the spirit, just as the spirit is not independent of the body, because of the deep unity and mutual connection that exist between one and the other.

The substantial unity between spirit and body, and indirectly with the cosmos, is so essential that every human activity, even the most spiritual one, is in some way permeated and coloured by the bodily condition; at the same time the body must in turn be directed and guided to its final end by the spirit. There is no doubt that the spiritual activities of the human person proceed from the personal centre of the individual, who is predisposed by the body to which the spirit is substantially united. Hence the great importance, for the life of the spirit, of the sciences that promote the knowledge of corporeal reality and activity.

4. Consequently, I have no reason to be apprehensive for those *experiments in biology* that are performed by scientists who, like you, have a profound respect for the human person, since I am sure that they will contribute to the *integral well-being of man*. On the other hand, I condemn, in the most explicit and formal way, experimental manipulations of the human embryo, since the human being, from conception to death, cannot be exploited for any purpose whatsoever. Indeed, as the Second Vatican Council teaches, man is “the only creature on earth God willed for itself” (*Gaudium et Spes*, 24). Worthy of esteem is the initiative of those scientists who have expressed their disapproval of experiments that violate human freedom, and I praise those who have endeavoured to establish, with full respect for man’s dignity and freedom, guidelines and limits for experiments concerning man.

The experimentation that you have been discussing is directed to a greater knowledge of the most intimate mechanism of life, by means of artificial models, such as the cultivation of tissues, and experimentation

on some species of animals genetically selected. Moreover, you have indicated some experiments to be accomplished on animal embryos, which will permit you to know better how cellular differences are determined.

It must be emphasized that new techniques, such as the cultivation of cells and tissues, have had a notable development which permits very important progress in biological sciences, and they are also complementary to experimentation done on animals. It is certain that animals are at the service of man and can hence be the object of experimentation. Nevertheless, they must be treated as creatures of God which are destined to serve man's good, but not to be abused by him. Hence the diminution of experimentation on animals, which has progressively been made ever less necessary, corresponds to the plan and well-being of all creation.

5. I have learned with satisfaction that among the themes discussed during your Study Week you have focused attention on *in vitro* experiments which have yielded *results for the cure of diseases related to chromosome defects*.

It is also to be hoped, with reference to your activities, that the new technique of modification of the genetic code, in particular cases of genetic or chromosomic diseases, will be a motive of hope for the great number of people affected by those maladies.

It can also be thought that, through the transfer of genes, certain specific diseases can be cured, such as sickle-cell anaemia, which in many countries affects individuals of the same ethnic origin. It should likewise be recalled that some hereditary diseases can be avoided through progress in biological experimentation.

The research of modern biology gives hope that the transfer and mutations of genes can ameliorate the condition of those who are affected by chromosomic diseases; in this way the smallest and weakest of human beings can be cured during their intrauterine life or in the period immediately after birth.

6. Finally, I wish to recall, along with the few cases which I have cited that benefit from biological experimentation, the important advantages that come from *the increase of food products* and from the formation of new edible plant species for the benefit of all, especially people most in need.

In terminating these reflections of mine, which show how much I approve and support your worthy researches, I reaffirm that they must all be subject to moral principles and values, which respect and realize in its fulness the dignity of man. I express the hope that the scientists of those countries which have developed the most advanced modern

techniques will take into sufficient account the problems of developing nations and that, beyond every economic or political opportunism which reproduces the schemes of an old colonialism in a new scientific and technical edition, there can be had a fruitful and disinterested exchange. This exchange must be that of culture in general and of science in particular, among scientists of nations of different degrees of development, and may there thus be formed, in every country, a nucleus of scholars of high scientific value.

I ask God, who is the merciful Father of all, but especially of the most abandoned and of those have neither the means nor the power to defend themselves, to direct the application of scientific research to the production of new food supplies, since one of the greatest challenges that humanity must face, together with the danger of a nuclear holocaust, is the hunger of the poor of this world.

For this intention and for the overall genuine progress of man, created in the image and likeness of God, I invoke on you and on your scientific activities abundant divine blessings.

Discourse of His Holiness Pope John Paul II given on 12 November 1983 at the Solemn Audience given to the inaugural sitting of the Plenary Session dedicated to the theme "Science in the Service of Peace", to scientists participating in the Study Week on "Chemical Events in the Atmosphere and their Impact on the Environment" and to scientists in a Working Group discussing "Specificity in Biological Interactions".

1. In this prestigious Assembly of Scientists, honoured by our presence, Cardinals and brother Bishops, and by the Diplomatic Corps accredited to the Holy See, as well as numerous representatives and leaders of the world of culture, I wish to extend heartfelt greetings and an expression of my highest consideration to the distinguished members of the Pontifical Academy of Sciences as they prepare to address in their Plenary Session the theme: "Science at the Service of Peace".

With the same cordial sentiments I greet the distinguished scientists who have come from every part of the world for a week of study on the theme: "Chemical Events and their Impact on Environment", and, in a working session, another equally important theme: "Specificity in Biological Interactions".

In a few day's time another working-group will meet to deal with "Modern Biology applied to Agriculture".

I congratulate you, Mr. President, Professor Carlos Chagas, for the wisdom and dedication with which you have contributed new and important developments to the life of the Academy. I congratulate you for the planning and promotion of this present series of meetings of personages who devote their energies to the search for truth at the service of humanity.

2. All knowledge takes its nobility and dignity from the truth that it expresses. Only in the unbiased pursuit of truth do culture and especially science preserve their freedom and are able to defend it from any attempt at manipulation by ideologies or powers.

"The truth will set you free": these words from the Gospel enjoy perennial validity and illumine with divine light the endeavours of the scientist who refuses to subordinate his commitment and his research to anything but the truth.

Truth is the goal of the whole universe: *finis totius Universi est veritas*, as one of the greatest thinkers of all time, Thomas Aquinas,

wrote¹. The truth of all beings, their forms and their laws are hidden in the bosom of the Universe, which yearns for its truth to be discovered by the human intellect. You, Men of Science, who welcome the world into your minds, work upon it in your laboratories, and investigate its most secret byways in your dedicated efforts, what are you seeking if not the truth?

Have courage and the boldness of reason that untiringly seeks the truth and you will find in the Church and in this Apostolic See your most convinced allies. Of course, the conquests of science are at times provisional, subject to review and rethinking, and they will never succeed in expressing the whole truth hidden in the Universe. The sense of mystery is part of your intellectual heritage and reminds you that what you do not know is much vaster than what you do know. In the search for truth, the boldness of reasons is linked with the humility of its own limits, the joy of knowing goes hand-in-hand with wonder at the unknown.

Furthermore the sense of mystery also envelops those truths which science cannot discover, but which question the mind of the scientist in the innermost part of his being, where he experiences an irresistible longing and yearning for the divine. The goal of the Universe is not only to reveal the truths it holds within itself, but to manifest the First Truth which gave the worlds its origin and form.

3. Whatever the paths of your scientific research, may you always be assisted by the sense of the divine. How can one fail to mention here Isaac Newton? He in no way thought, as Auguste Comte was to claim later, that science must rise on the ruins of religion and metaphysics; but he saw in the Universe the presence of God, a presence not immanent but transcending nature.

In the *Scholium Generale* added to the second edition of his *Philosophiae Naturalis Principia Mathematica*, Newton wrote: "This most elegant order of the sun, planets and comets could not have been born without the design and power of an intelligent and powerful being. He rules all things, not as the soul of the world, but as Lord of the Universe ... From blind metaphysical necessity that is absolutely identical always and everywhere, no variety in things can be born. The whole truth of things, including places and times, could only have arisen from the ideas and the will of a necessarily existing being".²

¹ *Contra Gentiles*, 1-1-c.1.

² Cf. L. GEYMONAT, *Storia del pensiero filosofico e scientifico*, Milan, Garzanti 1970, vol. II, p. 646.

The message addressed by the Second Vatican Council to the “men and women of thought and science” agrees with Newton in his conviction that scientific thought and religious thought are inseparable: “Never perhaps, thank God, has there been so clear a possibility as today of a deep understanding between real science and real faith, both in the service of the one truth. Do not lose the occasion of this important encounter: have confidence in faith, this great friend of intelligence”.

Gentlemen, the scientific truth which ennobles your intellect and lifts your research to the level of contemplation of the world and of its Creator, must be transmitted to the whole of humanity for the integral development of each human being and of all nations, for the service of peace, which is the object of your reflections and projects.

4. There are different ways for men and women of culture to live the precious value of knowledge. Bernard of Clairvaux, one of the strongest personalities in history, who came down from the loftiest peaks of mysticism to share divine and human truth with the ecclesial and civil society of his time, as a true master of love and knowledge, described the different types of men and women of culture always found in history. According to Saint Bernard there are five motives that lead human beings to study: “There are people who only wish to know for the sake of knowing: this is base curiosity. Others wish to know in order that they themselves may be known: this is shameful vanity, and such people cannot escape the mockery of the satirical poet who said about their likes: ‘For you, knowing is nothing unless someone else knows that you know’. Then there are those who acquire knowledge in order to re-sell it, and for example to make money or gain honours from it: their motive is distasteful. But some wish to know in order to edify: this is charity. Others in order to be edified: this is wisdom. Only those who belong to these last two categories do not misuse knowledge, since they only seek to understand in order to do good”.³

The words of Saint Bernard the mystic indicate a profound grasp of what motivates those who engage in culture, and they are more than ever relevant in order to remind both the teachers of thought as well as their disciples of the true purpose of knowledge. In my address of 15 November 1980 in Cologne to the scholars and students of the German Universities I pointed out that “all areas of our culture are impregnated by a science that proceeds in a mostly functional way”. And I warned that “a purely functional science, deprived of values and alienated from truth, can be completely enslaved by one or other ideology”.

³ S. BERNARDUS, *Sermo XXXVI in Cantica*, PL, CLXXXIII, 968.

I gladly recall here what an illustrious and now deceased member of the Pontifical Academy of Sciences had to say some forty years ago in a conference to young university students at Lausanne: "One has come to replace the search for truth by the search for what is useful. The young people who previously turned to the masters of thought in order to enlighten their minds, began to ask them for the secrets of nature from which would spring material goods in such abundance. Of the various fields of knowledge, one little by little came to value not those that seek the highest reaches of thought but those that seem more fertile in practical applications".⁴

Saint Bernard of Clairvaux raised knowledge to the level of love, to the level of charity and understanding: "*Sunt qui scire volunt ut aedificent et charitas est*".

5. Members of the Academy, Men of Science, at this very grave moment of history, I ask from you the love of knowledge that builds peace.

Peace is a gift of God offered to people of good will. I speak now to all men and women of good will, whatever faith they belong to, and especially to you who are listening to me now.

The science which brings together those engaged in research, technicians and workers, which mobilizes political and economic powers, which transforms society at all levels and in all its institutions, has a task today which is proving more urgent and indispensable than ever, namely the task of cooperating in preserving and building up peace.

From the depths of centuries past there rises the voice of an unarmed prophet, Isaiah: "They shall beat their swords into ploughshares and their spears into pruning hooks" (*Is* 2:4).

In recent times, at a moment when war was imminent, there rose with biblical force the prophetic voice of an unarmed Pope, Pius XI, who quoted the Psalm: "*Dissipa gentes quae bella volunt*" (*Ps* 67:31).

Unarmed prophets have been the object of derision in every age, especially on the part of shrewd politicians, the supporters of power. But today must not our civilization recognize that humanity has need of them? Should not they alone be heard by the whole of the world's scientific community, so that the laboratories and factories of death may give place to laboratories of life? The scientist can exercise his freedom to choose the field of his own research. When, in a particular historical

⁴ G. COLONNETTI, *Pensieri e fatti dall'esilio. Conferenza del 12 giugno 1944*, Accademia Nazionale dei Lincei, Roma 1973, p. 31.

situation, it is all but inevitable that a certain form of scientific research will be used for purposes of aggression, he must make a choice that will enable him to work for the good of people, for the building up of peace. By refusing certain fields of research, inevitably destined, in the concrete historical circumstances, for deadly purposes, the scientists of the whole world ought to be united in a common readiness to disarm science and to form a providential force for peace.

Faced with this great patient in danger of death which is humanity as a whole, scientists, in collaboration with all the other members of the world of culture and with the social institutions, must carry out a work of salvation analogous to that of the doctor who has sworn to use all his powers to heal the sick.

6. Peace is born not only from the elimination of theatres of war. Even if all these latter were eliminated others would inevitably appear, if injustice and oppression continue to govern the world. Peace is born of justice: *Opus iustitiae pax* (Is 32:7). Now science, which seeks the truth and is free from all ideologies, can and must promote justice in the world; while not remaining a slave of the economically privileged peoples, it can and must spread everywhere, in order to ensure, through appropriate technical means, that all peoples and all individuals are given their due. The modern world awaits the liberation of science that is a result of the liberation of the mind. Gentlemen, be united in the defence of your liberties in order to build up peace in justice throughout the world.

This is a relentless work that will never cease, for because of sin, both individual and social, sources of injustice continually arise in the world. With an acute sense of history, the Second Vatican Council warned us of this: "The common good of people is in its basic sense determined by the eternal law. Still the concrete demands of this common good are constantly changing as time goes on. Hence peace is never attained once and for all, but must be built up ceaselessly" (*Gaudium et Spes*, 78).

Pax perpetuo aedificanda: peace has to be ceaselessly built up. Peace is a continuous effort which, in so far as it is up to you, is entrusted to your research, to the technical applications that you must direct, through your authority, to the promotion of justice, with that freedom, that freedom of thought which enables you to make other choices when efforts are made to do you violence, in order to exploit your research and discoveries against justice and peace.

7. More than any other, the scientific community is a community of peace, for your rigorous search for the truth in the field of nature is

independent of ideologies and therefore of the conflicts that result from them. Your activity demands sincere collaboration, and the frank communication of the results of your research.

The scientific community, a community of peace, must be extended to all nations, through the foundation everywhere of institutes for research and sound technological application. It is not enough that political colonialism has ceased; every form of scientific and technological colonialism must cease as well. I cannot fail to note with satisfaction that the Pontifical Academy of Sciences includes an ever greater number of scientists from all the nations of the world, with no racial or religious discrimination. This is a form of cultural ecumenism which the Church, as the promoter of true religious ecumenism, cannot but regard with a sense of lively satisfaction.

8. From the scientific community, especially when it extends to all the regions of the world, there have come discoveries which have helped the development of humanity in every field: diseases and epidemics have been conquered, new food resources have been found, communications between people have been intensified, the peoples of all the continents have come closer together, natural disasters have been foreseen and overcome. Who can list the benefits brought by science? And cannot one say that these benefits would have been much more important if the techniques resulting from science had not been manipulated by evil powers? Who can deny that science and its applications can be placed at the service of man and of a greater justice?

It is an irreplaceable task of the scientific community to ensure, as is your intention, Mr. President of the Pontifical Academy of Sciences, that the discoveries of science are not placed at the service of war, tyranny and terror.

The intention to direct science to the promotion of justice and peace demands a great love for humanity. Every human virtue is a form of love. This is the case, in particular, of justice, which is love of neighbour, of individuals, and of peoples. Only the person who loves wants justice for the other person. The person who does not love seeks only to obtain justice for himself.

9. Truth, freedom, justice and love: such, Gentlemen, must be the cornerstones of the generous choice of a science that builds up peace. These four values, the cornerstones of science and of the life of civilized society, must be at the basis of that universal call of scientists, of the world of culture, of the citizens of the world, which the Pontifical Academy of Sciences, with my full and convinced approval, desires to address to the world for the reconciliation of peoples, for the success

of the only war that must be fought: the war against hunger, disease and the death of millions of human beings whose quality and dignity of life could be helped and promoted with seven per cent of the amount spent each year for the incessant and threatening rearmament of the richest nations.

Permit me at this point to recall with you, in the name of science and in the name of your personal moral authority, the need for a universal conversion to the true goods of man. Peace cannot be invoked, as it is too often, in order to guarantee ethical permissiveness and consumerism. The universal call for peace must be marked by profound reflection on the destiny of man, on the meaning and quality of life. When conversion to truth, freedom, justice and love does not become a necessity widely recognized and put into practice everywhere, social peace is unstable, because it lacks its deepest root, which is found in the heart of man.

10. It is from God that peace comes for those who are in communion with Him and also for those who, even though they have not found Him, are seeking Him with a sincere heart, in a spirit which, far from stifling the sense of the divine, seeks to liberate it within itself. Mr. President, Members of the Academy, and distinguished scientists, I renew the expression of my confidence in you, and as I bring this speech to a close I would like to make my own the words which my predecessor Paul VI addressed in 1966 to the Pontifical Academy of Sciences: "More than anyone else the Church rejoices in every true conquest of the human spirit in whatever field it may be. She recognizes and values highly the importance of scientific discoveries ... she sees in them not only a magnificent use of the intelligence, but she discovers in them also the exercise of high moral virtues, which confer on the scientist the character and the merit of an ascetic, sometimes of a hero, to whom humanity must repay a generous tribute of praise and gratitude".⁵

Gentlemen, as men of thought and science, as pilgrims of the truth, as explorers in the different branches of science and knowledge, about man and the universe, who submit yourselves to the labour of observing, thinking, searching, so that man may be ever more man and may find in nature the proper environment for his development: I ask you to work for justice, love and peace, and to believe that today more than ever the Catholic Church is your ally, this Church which loves true science and right thinking, this Church which prays for you and which in my person, respecting your beliefs, invokes upon each one of you the blessing of God.

⁵ Speech of 23-4-1966; Pontificiae Academiae Scientiarum: *Scripta Varia* n. 31, p. XLV.

Discourse of His Holiness Pope John Paul II given on 1st June 1984 at a Solemn Audience granted to the Working Group studying "Immunology, Epidemiology and Social Aspects of Leprosy".

Mr. President, Ladies and Gentlemen,

1. Today's meeting is a source of deep interest for me, as the theme which you are studying during these days recalls to my heart, no less than to yours, the terrible sufferings of a large number of our brothers and sisters, those who are afflicted by the dreaded disease of leprosy, and especially those in whom it has caused irreversible loss of limbs. *My interest* is matched by my *sincere admiration* for the careful and untiring researches which you conduct for the purpose of fighting this illness and saving many human lives.

At this moment my thoughts go to the various meetings which Jesus had with lepers. I wish to quote from just one, as told by Saint Mark in the first chapter of his Gospel. The sacred text reads: "And a leper came to Him beseeching Him, and kneeling said to Him: "If you will, you can make me clean". At this request Jesus "stretched out his hand and touched him, and said to him: 'I will; be clean'. And immediately the leprosy left him, and he was made clean" (*Mk* 1:40-42).

By touching the leper's sores with His hand, *Jesus knocked down the barrier* separating the untouchables from the human community, and by this miraculous cure He opened a path of hope that religion and science have to follow. Neither for the one nor for the other can any person henceforth be called unclean, but every individual will have to be respected and helped to regain the good health worthy of the human person.

2. The sense of universal brotherhood proclaimed by the Gospel evoked from followers of every faith a *generous eagerness to assist sufferers from leprosy*, and leper colonies and hospitals were set up in every part of the world. In every place there was a widespread movement to provide voluntary aid, an "unexpected gift of private mercy" on the part of those who, "strong in courage ... moved by pity, took upon themselves and virtuously maintained the care to which they were not called by their duties", as happened during the plague in Milan described by Alessandro Manzoni in his famous novel *I Promessi Sposi* (Chapter 32).

Among the apostles of the lepers who appeared among the Christian missionaries, both Catholic and Protestant, I cannot fail to mention *Father Damien De Veuster* of the Picpus Fathers, who has been honoured throughout the world as the most generous example of Christian charity towards lepers. Together with him I wish also to mention among the lay apostles Marcello Candia, who made a total gift of himself and his resources to the sufferers from this disease.

However, the care given by generous volunteers, and the institutions subsequently set up by governments, could not have been effective on the health-care level had not science offered and provided means and methods of diagnosis and therapy.

3. As in every other field, so in the sphere of the treatment of the widely differing forms of disease, feelings of brotherhood and *scientific research* link hand in order to rescue humanity from its needs and afflictions. The help of charitable volunteers and the scientist's work both call for powerful spiritual energies. Scientific research is not only a magnificent use of the mind; in the words of my predecessor Paul VI, in a speech to the Pontifical Academy of Sciences, it also demands "the exercise of lofty moral virtues, which confer upon the scientist the aspect and merit of an ascetic, sometimes of a hero, to whom humanity must pay a great tribute of praise and gratitude" (Discourse of 23 April 1966).

Eminent moral virtues and *the assistance of the Spirit* are needed by the scientist who not only devotes himself to research but who also wishes to exercise the charity of knowledge. When reason, tired and perhaps disillusioned in the efforts of study, seems to give in to the temptation of abandoning its undertaking, the Spirit comes to the aid of those who wish heroically to persist in the efforts they are making for love of neighbour, and at the highest point of the mind He lights a spark that brings a sudden intuition of the truth, whence research resumes its path and reaches the longed-for discovery.

4. Ladies and Gentlemen, you are following the path traced out by Gerhard Hansen, who through the perseverance of reason and the spark of the Spirit discovered the cause of leprosy: *Mycobacterium leprae*. Through your enlightened scientific work, in harmonious collaboration with wise doctors and generous volunteers, and through the farsightedness of governmental and private institutions, leprosy has diminished in many parts of the world. But there are still *millions of our brothers and sisters* who suffer its terrible consequences. For the sake of these people efforts must be everywhere increased to ensure that those who are still condemned to a sort of social death *can rediscover life*, improve its quality, and find

in society a place corresponding to their human dignity, for like all other people they are made in the image and likeness of God. There is no reason at all why those who have been cured should not be fully reintegrated into society.

Mr. President, in your address you have rightly stated that science when directed towards peaceful purposes can lessen the world's ills, improve the human condition, and help to raise the quality of life, especially of those who are the humblest and the most neglected among human beings.

5. I therefore call upon governments, international institutions and philanthropical associations to make increasing contributions to the work being done by research scientists, doctors and volunteers in order to free leprosy patients from their sickness and from their humiliating and tragic rejection by society.

Mr President, you mentioned my apostolic pilgrimage to Brazil and in particular my visit, accompanied by yourself, to the leprosarium at Marituba. There and also, more recently, in Korea I have had the opportunity to express my solidarity personally with those who suffer and to assure them of the *love and concern of the universal Church*.

Ladies and Gentlemen, continue your research and your therapy, and be assured that the Church fully supports your works, for like you she has received Christ's command, written in the Gospel, to "heal the lepers", and she knows that lepers who have been cured are a sign of the Kingdom of God (cf. *Mt* 10:8; 11:5). Help to build up the Kingdom of God, which is also the kingdom of humanity. Be dispensers of justice and love to all those who, in the most desolate corners of the world, are waiting to receive *a message of hope* from today's society.

May God bless you and your dear ones in the service of His people.

*Discourse of His Holiness Pope John Paul II
2nd October 1984 at a Solemn Audience granted
to participants in the Study Week dedicated to
the subject of "The Impact of Space Exploration
on Mankind".*

Dear Friends,

1. I am very grateful to the Pontifical Academy of Sciences and to its President, Professor Carlos Chagas, for having arranged this interesting Study Week on the subject of "The Impact of Space Exploration on Mankind" being held in the Casina of Pius IV.

For me it is a source of great satisfaction to meet you, the members of the Pontifical Academy and scientists from all over the world. The present assembly gives me an opportunity to express my admiration at the exceptional developments which have taken place in space technology. At the same time it enables me to expound the guidelines of a moral, social and spiritual order which belong to the mission entrusted to the Successor of Peter by Christ.

2. Centuries have passed since Galileo's telescope penetrated the heavens and gave mankind a new vision of the universe. In his brief but fundamental work entitled *Sidereus Nuncius*, published in Venice in 1610, he spoke of the discoveries made by means of his telescope, but he added, being both a scientist and a believer, that he had made them *divina prius illuminante gratia*, preceded by the enlightenment of divine grace.

Other great scientists such as Kepler and Newton likewise searched the heavens with the spirit of believers. Poets and philosophers such as Pascal contemplated with awe the mysterious silence of outer space.

3. Today, your gaze is directed at the heavens not only in order to study and contemplate the stars created by God, as was done by the great figures I have just mentioned, but in order to speak of the space probes, space stations and satellites made by man. I am with you in your work, for I regard the presence in space of man and of his machines with the same admiration as that of Paul VI at the time of the Apollo 13 understaking when he invited those taking part in the Study Week on "The Nuclei of the Galaxies" to "pay homage to

those who, by their study, action and authority have once more shown the world the unlimited powers of the sciences and of modern technology. With us also you will raise an ardent hymn of gratitude to God, the Creator of the universe and Father of humanity, who in these ways also wishes to be sought and found by man, adored and loved by him”.

4. Today, years after those first events, we can see the immense path covered by man's intelligence in knowing the universe, and we rejoice in this by reason of our very faith, for the perfection of man is the glory of God. The researches of sciences on the nature of our universe have progressed and will progress still more, with the use of highly sophisticated systems such as those perfected by the late member of the Pontifical Academy, Professor Giuseppe Colombo. Instruments are capable of going into space and avoiding the disturbances connected with the earth's surface and the lower layers of the atmosphere. Space probes, a new challenge by man to the distances of space and a symbol of his ever restless desire for knowledge, are coming ever closer to the heavenly bodies, in order to reveal their inmost secrets. Permanent space stations will in their turn be centres of observation making possible experiments never before attempted and the study of new techniques. All these new space instruments have been achieved thanks to the great progress of fundamental scientific research in mathematics, physics and chemistry, and through the development of the telecommunications techniques discovered by a great member of the Academy, Guglielmo Marconi.

5. These various modes of man's presence in space lead us to ask a question: to whom does space belong? While space was something merely observed and studied by the human eye, though with the aid of powerful astronomical instruments, this question was not yet asked. But now that space is visited by man and his machines, the question is unavoidable: to whom does space belong? I do not hesitate to answer that space belongs to the whole of humanity, that it is something for the benefit of all. Just as the earth is for the benefit of all, and private property must be distributed in such a way that every human being is given a proper share in the goods of the earth, in the same way the occupation of space by satellites and other instruments must be regulated by just agreements and international pacts that will enable the whole human family to enjoy and use it. Just as earthly goods are not merely for private use but must also be employed for the good of neighbour, so space must never be for the exclusive benefit of one

nation or social group. The questions of the proper use of space must be studied by jurists and given a correct solution by governments.

The presence of man in space with his satellites and other instruments also involves other matters of a cultural, moral and political nature which I would bring to your attention.

6. One of the biggest tasks that can be carried out by the use of satellites is the elimination of illiteracy. About one billion people are still illiterate. Again, satellites can be used for a wider spreading of culture in all the countries of the world, not only in those where illiteracy has already been eliminated but also in those where many can still not yet read or write, for culture can be spread with the use of pictures alone. I hope that the scientific and technological progress which you are now discussing will cooperate in the spreading of a culture that will truly promote the all-round development of man.

But the transmission of culture must not be identified with the imposition of the cultures of the technologically advanced countries on those still developing. Peoples with ancient cultures, though sometimes still partly illiterate but endowed with an oral and symbolic tradition capable of passing on and preserving their own cultures, must not fall victim to a cultural or ideological colonialism that will destroy those traditions. The rich countries must not attempt, through the use of the instruments at their disposal and in particular modern space technology, to impose their own culture on poorer nations.

7. Satellites will carry out a beneficial task when instead of imposing the culture of the rich countries they favour a dialogue between cultures, which means a dialogue between the nations, essential for the peace of the world. Nations have cultural frontiers that are more deeply rooted than geographical and political ones: it must be possible to cross these latter, for every human being is a citizen of the world, a member of the human family. These barriers must not however be altered in a violent way. Similarly, cultural frontiers must not impede a fruitful dialogue between cultures, nor must they be violated by forms of cultural or ideological dictatorship. Modern space technology must not be used by any form of cultural imperialism, to the detriment of the authentic culture of human beings in the legitimate differences that have developed in the history of the individual peoples.

8. Modern space technology properly understood also provides observations useful for the cultivation of the earth, far beyond anything that can be done by any system working on the earth's surface. Through the use of satellites it is possible to obtain exact data regarding the

condition of tracts of land, the flow of water and weather conditions. These data can be used for the purpose of improving agriculture, checking the state of woodlands and forests, evaluating the condition of individual zones or of the whole earth, thus making it possible to draw up particular or global programmes in order to meet concrete situations.

This so-called "remote sensing" is of fundamental importance in the fight against hunger, provided that the economic and political powers that possess these special means of observing the world situation help the poorer countries to draw up programmes of economic development and help them in a practical way to carry out these programmes.

9. With your knowledge and practice of modern space technology, you are well aware of how it would be possible to work out adequate programmes for helping the world to overcome the imbalance of agricultural practices, the advance of deserts, ecological disasters caused by human rapacity against the earth, in the waters and in the atmosphere, with the ever more alarming destruction of animal and plant life, and with grave and mortal illnesses affecting human life itself.

Order and justice must be re-established, harmony between man and nature must be restored. We must strive for a technology that will free the poor peoples and relieve oppressed nature, that will promote projects and agreements. Space technology can make a highly effective contribution to this cause.

10. Ladies and Gentlemen, true peace is born from the heart of those who are open to the gift of God, that God who at the coming of Christ promised peace to people of good will. In your scientific researches and technological inventions I invite you to seek the God of peace, the Invisible One who is the source of everything that is visible. I exhort you to seek Him by listening to the silence of space. Heaven and earth proclaim that they are only creatures, and they urge you to rise into the supreme heaven of transcendence, in order to open your minds and hearts to the love that moves the sun and the other stars. Thus you will be the creators not only of ever more perfect instruments but also of that civilization which is the only one desired by God and by men and women of good will: the civilization of truth and love, so necessary to guarantee peace between the nations of the world.

Discourse of His Holiness Pope John Paul II given on 21st October 1985 at a Solemn Audience granted to participants in two Working Groups studying the themes: "The Artificial Prolongation of Life and the Determination of the Exact Moment of Death", and "The Interaction of Parasitic Diseases and Nutrition"

Ladies and Gentlemen,

1. I extend a most cordial welcome to all of you. And I rejoice with the Pontifical Academy of Sciences and its illustrious President, Professor Carlos Chagas, for having succeeded in bringing together two groups of such distinguished scientists to reflect on the themes: "The Artificial Prolongation of Life and the Determination of the Exact Moment of Death", and "The Interaction of Parasitic Diseases and Nutrition".

In the specialized areas encompassed by these themes, the men and women of science and medicine give yet another proof of their desire to work for the good of humanity. The Church is joined with you in this task, for she too seeks to be *the servant of humanity*. As I said in my first Encyclical, *Redemptor Hominis*: "The Church cannot abandon man, for his 'destiny', that is to say, his election, calling, birth and death, salvation or perdition, is so closely and unbreakably linked with Christ" (No. 14).

2. Your presence reminds me of the Gospel parable of the Good Samaritan, the one who cared for an unnamed person who had been stripped of everything by robbers and left wounded at the side of the road. *The figure of that Good Samaritan I see reflected in each one of you*, who by means of science and medicine offer your care to nameless sufferers, both among peoples in full development and among the hosts of those individuals afflicted by diseases caused by malnutrition.

For the Christian, life and death, health and sickness, are given fresh meaning by the words of Saint Paul: "None of us lives for himself, and none of us dies for himself. If we live, we live for the Lord, and if we die, we die for the Lord; so then, whether we live or whether we die, we are the Lord's" (*Rom 14:7-8*).

These words offer great meaning and hope to us who believe in Christ; non-Christians, too, whom the Church esteems and with whom

she wishes to collaborate, understand that within the mystery of life and death there are values which transcend all earthly treasures.

3. When we approach the theme which you have dealt with in your first Group, "The Artificial Prolongation of Life and the Determination of the Exact Moment of Death", we do so with two fundamental convictions, namely: Life is a treasure; Death is a natural event.

Since *life is indeed a treasure*, it is appropriate that scientists promote research which can enhance and prolong human life and that physicians be well informed of the most advanced scientific means available to them in the field of medicine.

Scientists and physicians are called to place their skill and energy at the service of life. They can never, for any reason or in any case, suppress it. For all who have a keen sense of the supreme value of the human person, believers and non-believers alike, euthanasia is a crime in which one must in no way cooperate or even consent to. *Scientists and physicians must not regard themselves at the lords of life, but as its skilled and generous servants.* Only God who created the human person with an immortal soul and saved the human body with the gift of the Resurrection is the Lord of life.

4. It is the task of doctors and medical workers to give the sick the treatment which will help to cure them and which will aid them to bear their sufferings with dignity. Even when the sick are incurable they are never untreatable: whatever their condition, appropriate care should be provided for them.

Among the useful and licit forms of treatment is *the use of pain-killers*. Although some people may be able to accept suffering without alleviation, for the majority pain diminishes their moral strength. Nevertheless, when considering the use of these, it is necessary to observe the teaching contained in the Declaration issued on 4 June 1980 by the Congregation for the Doctrine of the Faith: "Painkillers that cause unconsciousness need special consideration. For a person not only has to be able to satisfy his or her moral duties and family obligations; he or she also has to prepare himself or herself with full consciousness for meeting Christ".

5. The physician is not the lord of life, but neither is he the conqueror of death. *Death is an inevitable fact of human life, and the use of means for avoiding it must take into account the human condition.* With regard to the use of ordinary and extraordinary means the Church expressed herself in the following terms in the Declaration which I have just mentioned: "If there are no other sufficient remedies, it is permitted,

with the patient's consent, to have recourse to the means provided by the most advanced medical techniques, even if these means are still at the experimental stage and are not without a certain risk ... It is also permitted, with the patient's consent, to interrupt these means, where the results fall short of expectations. But for such a decision to be made, account will have to be taken of the reasonable wishes of the patient and the patient's family, as also of the advice of the doctors who are specially competent in the matter ... It is also permissible to make do with the normal means that medicine can offer. Therefore one cannot impose on anyone the obligation to have recourse to a technique which is already in use but which carries a risk or is burdensome ... When inevitable death is imminent in spite of the means used, it is permitted in conscience to take the decision to refuse forms of treatment that would only secure a precarious and burdensome prolongation of life, so long as the normal care due to the sick person in similar cases is not interrupted".

6. We are grateful to you, Ladies and Gentlemen, for having studied in detail the *scientific problems connected with attempting to define the moment of death*. A knowledge of these problems is essential for deciding with a sincere moral conscience the choice of ordinary or extraordinary forms of treatment, and for dealing with the important moral and legal aspects of transplants. It also helps us in the further consideration of whether the home or the hospital is the more suitable place for treatment of the sick and especially of the incurable.

The right to receive good treatment and the right to be able to die with dignity demand human and material resources, at home and in hospital, which ensure the comfort and dignity of the sick. Those who are sick and above all the dying must not lack the affection of their families, the care of doctors and nurses and the support of their friends.

Over and above all human comforts, no one can fail to see the enormous help given to the dying and their families by *faith in God and by hope in eternal life*. I would therefore ask hospitals, doctors and above all relatives, especially in the present climate of secularization, to make it easy for the sick to come to God, since in their illness they experience new questions and anxieties which only in God can find an answer.

7. In many areas of the world the matter which you have begun to study in your second Working Group has immense importance, namely *the question of malnutrition*. Here the problem is not merely that of a scarcity of food but also the quality of food, whether it is suitable

or not for the healthy development of the whole person. Malnutrition gives rise to diseases which hinder the development of the body and likewise impede the growth and maturity of intellect and will.

The research which has been completed so far and which you are now examining in greater detail in this colloquium aims at identifying and treating the diseases associated with malnutrition. At the same time, it points to the need of adapting and improving methods of cultivation, methods which are capable of producing food with all the elements that can ensure proper human subsistence and the full physical and mental development of the person.

It is my fervent hope and prayer that your deliberations will encourage the governments and peoples of the economically more advanced countries to help the populations more severely affected by malnutrition.

8. Ladies and Gentlemen, the Catholic Church, which in the coming world Synod of Bishops will celebrate the twentieth anniversary of the Second Vatican Council, reconfirms the words which the Council Fathers addressed to the men and women of thought and science: "Our paths could not fail to cross. Your road is ours. Your paths are never foreign to ours. We are the friends of your vocation as searchers, companions in your labours, admirers of your successes, and, if necessary, consolers in your discouragement and your failures".

It is with these sentiments that I invoke the blessings of God, the Lord of life, upon the Pontifical Academy of Sciences, upon all the members of the two present Working Groups and upon your families.

*Discourse of His Holiness Pope John Paul II
given on 20th June 1986 at the Solemn Audience
granted to the participants in the Study Week de-
dicated to "Remote Sensing and Its Impact on
Developing Countries".*

Mr President,
Ladies and Gentlemen,

It is a pleasure to receive today those taking part in the *Study Week organized by the Pontifical Academy of Sciences, on the subject of "Remote Sensing and Its Impact on Developing Countries"*.

An ever deeper knowledge of the earth, and in particular of its poorest zones, is the purpose for which the Pontifical Academy and its distinguished President have brought you together in order to study this theme.

1. The new technique of remote sensing makes it possible to survey anything from a few square metres to huge expanses of the earth's surface. Certain areas, the home of hundreds of thousands of people, are being affected by the *terrible phenomenon of desertification*, with consequent famine and disease. The causes of this phenomenon vary from unsuitable methods of farming to climatic factors such as cyclones and other atmospheric disturbances.

Surveys carried out *with the aid of satellites* linked with a network of ground tracking stations can provide a detailed and exact picture of crops, including their increase or deterioration, and can offer the chance of using *technical means of combating the encroaching desert*, which imperils the livelihood of a high percentage of the world's population.

With the help of remote sensing, it is possible to give useful advice for many schemes. These latter include the improvement of soil condition, forecasting and increasing the development of crop harvesting both in quantity and quality, the introduction of new crops, the prevention of the destruction of forested areas needed for ecological balance, and the taking of measures to meet possible atmospheric conditions, both harmful and beneficial.

By means of remote sensing it is likewise possible to detect the presence of concealed sources of energy, both renewable and non-renewable,

as also the presence of food resources on the seabed and in rivers and lakes, together with the mineral wealth lying in the subsoil.

2. Your meeting has highlighted the possibility of aiding all peoples, with the help of advanced technological methods, to attain a *more just form of worldwide coexistence, so that the earth's resources, which are the patrimony of all, may be fairly distributed and shared*. This is in accordance with the will of the Creator who made man and woman in His own likeness and said to them, "... have dominion over the fish of the sea and over the birds of the air and over every living thing that moves upon the earth... I have given you every plant yielding seed which is upon the face of all the earth, and every tree with seed in its fruit; you shall have them for food" (*Gen 1:28-29*).

The resources of science make it possible to feed the whole human family, with the remedying of past and present mistakes and shortcomings. Nevertheless, one cannot help noting that there is still a lack of firm determination in political circles to make proper use of the technological means which you have been examining during these days of study and of service to human welfare. We know that *progress must not be the exclusive privilege of the favoured few*. We should not forget the words of Pope Paul VI who said that development is the new name of peace.

3. It is a source of satisfaction that the conclusions of your previous Study Week, held in October of the year before last, on the subject of "The Impact of Space Exploration on Mankind", have been adopted by the United Nations Organization and sent to all member States. This is indeed a sign of profound respect for the relevance and importance of the work being done by the Pontifical Academy.

It is my hope that by means of joint agreements and commitments all Governments will promote the *peaceful uses of space resources for the sake of the unification of the human family in justice and peace*. I take this occasion to express once more my conviction that national and international economic powers should serve all peoples and every individual, but with special preference for those whose lives are particularly threatened and who need assistance for securing their very survival and the means of living in a manner consonant with human dignity.

May the Lord of heaven and earth look kindly upon you and grant to you and your families the abundance of His blessings.





*Discourse of His Holiness Pope John Paul II
given on 26th September 1986 at the Solemn
Audience granted to participants in the Study
Week dedicated to "Persistent Meteo-Oceanographic
Anomalies and Teleconnections".*

Mr. President,
Ladies and Gentlemen,

1. The present *Study Week on Persistent Meteo-Oceanographic Anomalies and Teleconnections* offers a fresh proof of the intention of the *Pontifical Academy of Sciences* to be of service to humanity, especially by its interest in the main scientific problems of the day. The theme of your Symposium is in fact one of the most urgent at the present time.

I extend a most cordial greeting to the eminent specialists in the fundamental oceanographic and atmospheric problems that you are dealing with. I am pleased to see that you come from many different parts of the world: from North and South America, Europe and Asia. This is yet another demonstration of the harmonious collaboration that exists between scientists and that is of such benefit to world peace.

2. Science does not merely have to study natural phenomena in themselves. It also has to *make a decisive intellectual and ethical effort to foresee the development and consequences of those phenomena*, in order to safeguard and enhance the welfare of humanity. This is the aim that you have set yourselves. You have been studying phenomena such as El Niño, the monsoons and their worldwide effects, the causes of the climatic disturbances in the eastern zones of the Pacific Ocean, as well as the prolonged drought in the Sahel.

The studies which you have carried out in the Institutes which you represent individually and which you have been dealing with in the tranquil surroundings of the Casina of Pius IV, the seat of the Pontifical Academy of Sciences, will enable you to provide those who are threatened by these and other negative phenomena with timely weather forecasts, thus making it possible to take the necessary steps for avoiding the most serious effects of approaching natural disasters. In various parts of the world it is now possible, as a result of dedicated efforts, to set up systems

for recording climatic phenomena and to gather facts on a worldwide scale which affect the entire globe.

3. Through your work you are carrying out the Biblical command to subdue the earth, to control the catastrophes that harm the human family, and to make the earth obedient to our service. Science encourages legitimate human curiosity to know the universe and to admire and contemplate its beauty and goodness. In this way we enter into communion with God Himself, who looked upon what He had created and saw that it was very good (cf. *Gen 1:31*). But *we are also called by God to control the movements of violence and death that occur in nature*, subject as it is to inevitable adjustments of its balance. We are called to discover new sources of energy, to replace those that are non-renewable or that prove to be insufficient. Unfortunately it sometimes happens that, in order to satisfy his unlimited craving for material well-being, man corrupts and squanders the world's resources, with effects that are especially harmful to those least able to defend themselves, who possess the fewest technical skills, and who inhabit the least hospitable territories.

You, on the other hand, are engaged in the genuine task of the scientist: you are studying in order to contemplate and understand, to control and make fruitful. In the course of your studies, you cannot fail to *admire the powerful forces of nature*. But at the same time you see that these forces can pose dangers and threats to humanity, and *you teach how to dominate them, so that they may be placed at the service of all*.

4. Ladies and Gentlemen, I am particularly grateful to the Pontifical Academy of Sciences and to its President for bringing you together. I invoke upon you the blessings of God, the Provident Creator, for the studies that you are engaged in for securing a harmonious environmental balance, which will favour human security and dignity, and which will especially benefit those who are unprepared and defenceless in the face of natural catastrophes.

*Discourse of His Holiness Pope John Paul II
given on 23rd October 1986 at the Solemn Audi-
ence granted to participants in the Working Group
dedicated to "Molecular Mechanisms of Carcino-
genic and Anti-tumor Activity".*

Mr. President,
Ladies and Gentlemen,

For the third time in its history, the Pontifical Academy of Sciences directs its attention towards cancer, an illness that destroys the organism of a great number of human beings and is terrifying in the diversity of its forms.

In 1948 a study week was devoted to "The Biological Problems of Cancer". In 1977 another study week researched "The Role of Non-specific Immunity in the Prevention and Treatment of Cancer". At the present meeting you have chosen the theme "Molecular Mechanisms of Carcinogenic Anti-tumor Activity".

The working group gathered this week in the Pontifical Academy of Sciences is composed of renowned scientists from around the world, who have devoted their activity to investigate, at the most fundamental level, the origins of cancer, the means to cure it and, if possible, the ways to prevent it.

You are coming from the most developed countries, which have the material means of conducting research at such a fundamental level and on such a large scale. The benefits of your work are, however, destined to all the world.

The particular feature of this working group is to combine, in the same exploration and discussion, the mechanism of action of carcinogenic and anti-tumor agents, those which cause the terrible disease and those which help to cure it. The discussions thus bear on the suffering of man, but also on his efforts to find a remedy for it.

Another striking feature of this working group is that it tries to go into the very fundamentals of the problem by investigating the molecular mechanisms of the events which are responsible for the action of the carcinogenic and anti-tumor agents.

I wish to express my gratitude to the Pontifical Academy for having

chosen such an important and urgent theme. I also thank the eminent scientists who have vigorously worked during these days. May your research achieve the results necessary to defeat this terrible scourge which is cancer.

God bless you and your families.

*Discourse of His Holiness Pope John Paul II
given on 28th October 1986 at the Solemn Audi-
ence granted in occasion of the fiftieth Anniver-
sary of the Pontifical Academy of Sciences.*

Your Eminences,
Mr. Director-General of UNESCO,
Mr. Minister of Scientific Research in Italy,
Your Excellencies,
Ladies and Gentlemen,

It is with great joy that I celebrate with you the fiftieth anniversary of the act by which Pope Pius XI renewed the Pontifical Academy of the "new Lincei" and made it the *Pontifical Academy of Sciences* with the *Motu proprio In multis solaciis* of 28 October 1936.

1. The word "Linceo" belongs to your history and to your very being, dear Academicians, because you draw your origin and your fundamental inspiration from the group of young scientists who were gathered by Prince Federico Cesi and gave birth in the year 1603 to the Academy of the "Lincei"; Galileo Galilei became a member in the year 1611 and thereafter signed all his works with the title "Linceo".

The bonds between the Church and the Academy became particularly intense under Pius IX, who entrusted to it tasks of scientific research in the service of the Papal States, and the relationship became even deeper under his successors, especially under Pius XI, who conferred on it the title and the function of *scientific Senate* of the Church, made up of seventy members whom the Sovereign Pontiff asked to "promote ever more and ever better the progresses of the sciences", adding: "We do not ask anything more of them, for this noble goal and this sublime task constitute the service that we expect from men closely bound to the truth".

My venerated predecessors Pius XII, John XXIII and Paul VI encouraged the Pontifical Academy, fully convinced of the indispensable role of science in the service of created truth, and ultimately in the service of the First Truth, who is God, following the path from the finite to the infinite—a path that is printed on the human spirit.

The Sovereign Pontiffs were actively supported in this by the succession of Presidents, from Father Agostino Gemelli, Monsignor Georges Lemaitre, and Father Daniel O'Connell to Professor Carlos Chagas, whom I thank warmly for the important work which he has carried out. Thanks to these Presidents, thanks also to the collaboration of all the members of the Chancellery, this Academy has acquired a celebrated prestige and a scientific role on a very high level, awakening elsewhere participation in important work of many representatives of the world scientific community.

2. In the course of the fifty years of your history, Ladies and Gentlemen, you have very properly given primacy to *pure* science, claiming for it its legitimate autonomy. When I addressed you in my first discourse in this very place, on 10 November 1979, I proclaimed the dignity and the high value of science, with regard to its theoretical side: "Fundamental research must be free in its relationship to political and economic power, which must cooperate in its development, without placing obstacles in its path ... Like every other truth, scientific truth is obliged to give account of itself only to itself and to the supreme truth that is God, the creator of man and of everything".

In addition to pure science, you have dedicated yourselves to the study of its consequences for *applied sciences*, which—as I said in that same discourse—"has rendered and will render immense services to man, provided that it is inspired by love, guided by wisdom, and accompanied by the courage that defends it against the undue interference of all tyrannic powers". Your Academy has been actively involved in the applied sciences as these relate to the needs of humanity as a whole, always in awareness of the requirements of the moral law.

3. The existence and the activity of this Academy, which was founded by the Holy See and is in constant liaison with it, illustrate above all the fact that there is *no contradiction between science and religion*. The Church esteems science, and even recognises a certain connaturality with those who dedicate their endeavours to science, as with all who seek to open up the human family to the noblest values of the true, the good and the beautiful, to the understanding of the things that have universal value (cf. *Gaudium et Spes*, 57, par. 3). The Pontifical Academy, for its part, shows clearly that *science* likewise needs to be in harmony with wisdom and with ethics, in order to satisfy the deepest requirements of man's spirit and heart, so that his dignity may be safeguarded.

A new type of dialogue has now begun between the Church and the world of science. In my discourse to men of science and students at

Cologne, on 15 November 1980, I went so far as to say: "The Church takes up the defense of reason and of science, recognising that science has the capacity to attain to the truth ..., defending the freedom of science which gives it its dignity as a human and personal good ...". If divergences can appear between the Church and science, "the reason for this must be sought in the finitude of our reason, which is limited in its extent and thus exposed to error".

4. We have the good fortune to experience today the close of a history in which the harmony between scientific culture and Christianity was not always easy (cf. *Gaudium et Spes*, 62). At the beginning of this discourse, I recalled the institution which prefigured the Academy around the year 1600. But one must consider above all the manner in which the question of the relationship between theology and the natural sciences was posed on the threshold of the modern period.

Isaac Newton synthesised and brought to completion the discoveries of Kepler, Copernicus, Galileo and Descartes; he was the witness and the decisive agent of *the scientific revolution* of the seventeenth century. It was then that modern science broke through the traditional boundaries which had been determined hitherto by a geocentric view of the universe and by a conception of the elements of nature that was more qualitative than quantitative. These great *scholars* who were experts in an experimental study of the universe, with ever increasing precision and specialisation, did not the less remain in an attitude that sought the global meaning of nature; their speculation as *thinkers* about the cosmos bears witness to this. Their bold researches helped to define better *the boundaries between the different orders of knowledge*. They were not always accepted on this point, and the Church herself took a long time to become reconciled to their points of view.

The experience of *Galileo* is a typical illustration of this. Although it was a painful experience indeed, it rendered an invaluable service to the world of science and to the Church, leading us to understand better the relationship between the revealed Truth and the truths that are discovered empirically. Galileo himself did not accept a genuine contradiction between science and faith: both come from the same Source and are to be brought into relationship with the first Truth.

Christians have been led to read the Bible afresh, without seeking in it a scientific cosmological system. And scientists themselves have been invited to remain open to the absoluteness of God and to an awareness of creation. In itself, no field is barred to scientific investigation, provided that this respects the human being; it is, rather, the

methodologies employed that bring the scientists to make certain abstractions and delimitations.

5. One could mention other very vivid tensions that belong—let us hope—to a vanished past. *In the last century*, in the name of the new sciences and the new philosophies, positivism blamed the traditional positions of the Church, accusing her of being opposed to science and to research. Leo XIII took up the challenge and showed that the Church joyfully welcomes whatever permits man to explore nature better and to improve the human condition. At the same time, he gave a vigorous impulse to the renewal of the ecclesiastical sciences.

In our days, *the distinction* and the complementarity of the orders of knowledge—the order of faith and the order of reason—were expressed with decisive clarity in the teaching of the *Second Vatican Council*: “The Church affirms the legitimate autonomy of culture, and particularly that of the sciences” (*Gaudium et Spes*, 59, par. 3). “It is by virtue of creation itself that all things are established in accordance with their own substance, truth and excellence, with their ordering and their specific laws” (*ibid.*, 36, par. 2). One must recognise the particular methods of each of the sciences. “This is why methodical research, in all the fields of knowledge, will never be truly opposed to faith, if it is carried out in a truly scientific manner and follows the norms of morality: worldly realities and the realities of faith find their origin in the same God” (*ibid.*). But it would be false to understand this autonomy of earthly realities to mean that they did not depend on God, and that man could dispose of them without reference to the Creator.

The principles are clear, and ought from now onwards to remove every attitude of fear or of defiance, but this does not mean that every difficulty is resolved: new researches and discoveries of the sciences pose *new questions* which will all be new demands for theologians in the way that they present the truths of the faith while always safeguarding the sense and the meaning of these truths (cf. *ibid.*, 62, par. 2). But the scientists themselves for their part go on to make a criticism of their methods and objectives.

Today, far from shutting herself up in an apologetic or defensive perspective, the Church rather makes herself the advocate of science, of reason, and of the freedom of research, to legitimize authentic science. Your Academy can bear witness to this. And I speak here, beyond your own persons, to the scientific community of the whole world.

6. It is indeed important to situate scientific endeavour *within the general context of culture*. Man can never neglect to ask himself the

question of the profound meaning of culture and of science for the human person (cf. *ibid.*, 61, par. 4).

Man lives a truly human life thanks to culture, that is, by cultivating the goods and the values of nature, affirming and developing the manifold capacities of his spirit and his body. A principal aspect of culture is the submission of the universe by means of knowledge (cf. *ibid.*, 53). The widening and deepening of scientific knowledge constitute therefore an undeniable progress for man, because this brings him closer to a precise knowledge of the truth.

This free search for truth for its own sake is one of the noblest prerogatives of man. Science goes astray if it ceases to pursue its ultimate end, which is the service of culture and hence of man; it experiences crisis when it is reduced to a purely utilitarian model; it is corrupted when it becomes a technical instrument of domination or manipulation for economic or political goals. There is then what one can call a crisis of the legitimation of science, and it is therefore urgent to defend authentic science that is open to the question of the meaning of man and to the search for the whole truth, *a free science that is dependent only on the truth*. From the point of view of the Church, it would be impossible to separate science and culture.

In the same way, the Church considers man to be not only the object of culture, but its subject, and she encourages the work of science: she appreciates not only the scientists' use of intelligence, but their professional and moral merit, their intellectual honesty, their objectivity, their search for what is true, their self-discipline, their cooperation in teams, their commitment to serve man, their respect in the presence of the mysteries of the universe. These are human values that display the spiritual vocation of man.

7. Besides this, the man of science is called in a new way to *openness*. With all respect for the methodological requirements of abstraction and specialised analysis, one may never neglect the unified orientation of knowledge. Modern conditions have brought to light *a risk of fragmentation* and the risk of limiting oneself to the immediate object of the research. Science cannot neglect the fundamental questions concerning its role and its goal; it cannot close itself to *the universal*, nor to the knowledge of things as a whole, nor to *the Absolute*, even if it is unable by itself to answer the question of meaning.

It seems to me today that the scientific community, after a necessary period of extreme specialisation on the level of experimentation, is in the process of recovering interest in things as a whole, *the question of the meaning of the universe*, the marvellous mystery of nature and of the

human being. Many scientists venture into this field; they may perhaps do so timidly, because of a certain agnosticism or through fear of going beyond what their own research permits them to say. But the fact that a certain number are more sensitive to the values of the spirit and of morality brings a new dimension to their disciplines. Does not the scientist remain a man, open to all human questions, to everything that is to serve man, to the search for the Truth in all its depth?

It may perhaps be difficult to ask all the specialists today to become philosophers, but the needs of contemporary culture spur you on strongly to contribute your indispensable participation in the *interdisciplinary researches in which scientists, thinkers and theologians must collaborate*. Philosophical and theological studies of man and nature need your contribution, so that our common knowledge of the inanimate world, of the living universe, and of the human being may advance.

8. If we go on from the progress of pure knowledge to consider the manifold technological applications of the researches and discoveries of science, we may say that the world scientific community has considerable moral responsibilities, of which it is more vividly aware.

When I spoke to this Academy in 1983, I emphasised how the collaboration of the scientists of the entire world had permitted discoveries that were greatly beneficial to the progress of all humanity. This is obvious.

But how could one fail to speak clearly about the dangers too, which humanity incurs if it uses thoughtlessly the power that comes to it from science? And although this goes beyond the competence of the researcher, he cannot remain indifferent: more and more, people turn to the community of scientists for an answer to the questions of collective ethics. As I said on 3 November 1982 to the University teachers at Madrid: "Men and women of science and culture, your *moral power* is considerable. Together, and thanks to your prestige, you can see to it that the scientific sector serves first of all man's culture, and is never employed for his destruction".

One thinks spontaneously of the dangers of *nuclear energy*. When atomic power was unleashed, the researchers who did so had their own share in the origin of a moral crisis that is without parallel in history, as I emphasised at Hiroshima. At Unesco, I insisted on the fact that the future of man and of the world would remain radically threatened, despite the intentions of men of science, if one were to use their discoveries for destructive purposes. I appealed also in a solemn manner from that distinguished seat of culture to the scientists, to help humanity by uniting conscience and science, by making the primacy of ethics

respected, and by being vigilant so that science should serve life and man (cf. *Discourse to Unesco*, 2 June 1980, 20-22).

The maintenance of *peace* among the peoples is absolutely fundamental, and we hope that the witness of many religious leaders, praying yesterday at Assisi for peace, will contribute in its own way to establish this peace, which is also a gift of God.

The harmonious relationship between man and nature is a fundamental element of civilisation, and it is easy to grasp all the contribution that science can bring in this field of *ecology*, in the form of defence against violent alterations of the environment and of growth in the quality of life through the humanisation of nature.

But how could one fail to think above all of the field of *genetics*, which is so immense nowadays? The temptation to manipulate man radically here, determining the conditions of his procreation, with the risk of damaging human life even in the state of the embryo or the foetus, and of damaging the integrity and equilibrium of the human being, poses such grave questions that some scientists themselves are asking themselves whether they should continue their experiments.

To sum up: scientists are asked to remain conscious of all the demands of ethics, which ensure the transcendent dignity of the human being. The decisive question is how can science *serve man*? How can it respect and ensure the objective fundamental rights of the person?

9. *The specific contribution of the Pontifical Academy of Sciences* is the objectivity of the data that are gathered scientifically by scientists who are outstanding, in the highly specialised fields that are theirs, for the rigour of their analysis of the facts, for the depth of their scientific intuitions, for their disinterested service of the truth, and for the importance which they give to moral values also. Politicians will be able to profit from these objective analyses and syntheses—for example, to measure the risks of using certain sources of energy or certain weapons, or the ecological consequences of certain undertakings. Sociologists and economists can likewise profit here; as can practitioners of medicine and surgery, in order to evaluate the meaning and the effects of their experimentations and operations; moralists, who need to know the laws of nature with precision; philosophers, who research into the meaning of existence and transcendent truth; theologians, who are especially interested in the relationship between faith and science. Your scientific contribution is therefore of first importance for all these fields, even if it is directly neither political nor theological; it constitutes an indispensable basis for the work of those who bear responsibility, and for the specialists whom I have just mentioned. For its part, the Holy See has received

the much appreciated service of the scientific competence of this Academy on various occasions, for questions that touched directly natural and evangelical morality, and it continues to count on you.

As a Body established at the Holy See, the Pontifical Academy of Sciences bears witness to the harmony between the Church and men of science, to their reciprocal support; and it is an appeal to the values of the conscience in the world of science.

10. One must *wish* that your work should be better known in the Church and in the world. It seems opportune that your intellectual research, your studies and your publications should continue to give even greater help to *the work of the Holy See* and of the Church *in Universities and in the field of culture*, for example in liaison with the Congregation for Catholic Education, the Pontifical Council for Culture, the International Theological Commission, with the other Academies and with the Universities. Is there not a need to explore some common projects, in which the link between science and culture would be manifested? The Academy, which unites various disciplines, has also an *interdisciplinary vocation* to realise this "cultural ecumenism" of which I have already spoken.

At the beginning of my pontificate, I had thought of an Academy of human sciences and culture. After consultations, I opted for a Pontifical Council for Culture. This indicates to you my concern to promote and defend man's culture, which is the basis of his dignity. I am convinced that the Pontifical Academy of Sciences shares efficaciously in this objective, and I encourage you warmly to emphasise more and more the cultural aspect of your labours; the intrinsic value of these is by itself a precious contribution to the progress of knowledge.

11. Your Eminences, Your Excellencies, Ladies and Gentlemen: in this half-century, the Pontifical Academy of Sciences has carried out a task of historic importance, for it has situated the objective fruits of scientific research in the perspective of truth, of freedom, of morality, of the service of humanity and of peace, of the ascent to the first Truth, which alone can answer the fundamental questions about the reason for existence and about the meaning of human life and of the world. I thank the President and each one of its members who have given their collaboration with great competence and with a meritorious dedication.

For my part, I have invariably had a great interest in the continuation and development of this Academy, in the line of the remarkable intuition of my venerated predecessor Pius XI who founded it, but with an increased insistence on looking at the human, moral and spiritual

problems of our time. In this jubilee year, I express my heartfelt wishes for its future: for the value of its work; for the enrichment which its members, so diverse in their origin and in their personal convictions, can bring to each other, and can bring together to humanity; for the unequalled service which the Academy can render to those who bear a heavy responsibility in the world community or in the Church, and especially at the Holy See, offering valuable data for their reflections and decisions and shedding light on the object of their moral responsibility. And above all, may this senate of scientists—who have been called to membership in the Pontifical Academy and who have loyally accepted this honour and this responsibility—bring more and more to the world the testimony to the esteem in which the Church holds the science that is worthy of the name, and to the trust which she has in those who dedicate themselves competently and honestly to science, and to the invitation which she offers them of dialogue and of cooperation that goes across all boundaries, and to the responsibility which she recognises they have for the good of humanity!

I am touched to see that many Academies of Sciences in the whole world have accepted the invitation addressed to them to come and associate themselves with this jubilee celebration. I greet their delegations and thank them warmly. I express my best wishes to these Academies also, that they may encourage their members to promote the progress of scientific knowledge in all liberty, in openness to the fundamental truth about man and about the cosmos, in order that their mutual relationships may be fruitful and that together they may, as it were, form a significant body within the world community, which uses the prestige of its moral authority to see that science always remains, in all its applications, at the service of man, at the service of his life, of his culture, and of his moral and spiritual elevation.

I am very happy to be able to pay homage to all the men of science present here, before the Cardinals and the Diplomatic Corps, and I invoke on you, as also on your families and those who collaborate with you, the Blessings of the Lord “in whom we live and move and have our being” (*Acts* 17:28).