(Address given by the Reverend Theodore M. Hesburgh, C.S.C., President of the University of Notre Dame, at the banquet of the American Physical Society, Friday evening, June 21, at Notre Dame, Indiana)

For a man who has to talk frequently on a wide variety of subjects, I have approached my task this evening with an unusual degree of trepidation. It is not so much that I cannot say something of reasonable appropriateness, but rather that I would like to say some very appropriate things - and I have some legitimate doubts about my ability to approach a very appropriate yet very difficult subject - science and theology. In this matter, not even a ghost writer could help - because, first, I don't have one, and secondly, I wouldn't know where to look for an adequate one on this subject.

I should be assumed to be fairly competent in theology after six years of special study in this field - but that was some years ago, and university presidents tend to become more and more illiterate, even in their academic specialty, as the years go by, and we get further away from the bench, as you gentlemen would say. My rustiness in theology is compounded in science, although, through force of circumstances, I have spent much more time with scientists, and particularly physicists, the past several years than I have with theologians.

This association has generated an ever-growing curiosity on my part regarding the relationship of science and theology in our day. My experience represents a strange reversal of the historical situation that saw a complete rupture of relationships between the scientists and theologians. In the Middle Ages, the theologians held the field, and the first real scientists received short shrift (in the colloquial, the bums rush) when in the classical case of Galileo, his new scientific theory was looked upon as a threat to theological truth. The rift that began then grew wider and wider until it became a chasm measurable in a figure to about the tenth power or more.

I was, of course, acquainted with this age-long conflict between theology and science when, as a new theological Galileo, I walked into a group of reigning scientists. Perhaps because I was trying to help in their field of work, on the National Science Board, the MURA Board, and at the Atoms for Peace Conference at United Nations, I wasn't given a one-way trip to the exit as the original Galileo was when the situation was reversed. As a matter of fact, I became immensely interested in the exciting dimensions of the physicists' work, was greatly impressed by their intelligence, their friendliness, and, particularly as a priest, by the good sense of values that is generally reflected

in their personal lives. We went through some scientific battles together as comrades in arms, and are still bleeding together in some good scientific causes. But with all this cordiality and teamwork, I am afraid that my respect for their devotion to science is not quite matched by their understanding of my devotion to theology. I submit that this is quite normal, given the historical precedents of scientific-theological conflict. Cleavages that occur over centuries are not bridged in days or weeks. If I were a first-rate scientist and a first-rate theologian, I suspect that the materials would be at hand to begin building the bridge. But the first-rate theologians and scientists haven't been on speaking terms for centuries. They don't even speak the same language any more. Yet almost unconsciously, there have been some tentative attempts at bridge building from both sides of the divide.

Maybe the physicists have begun to sense a broader responsibility for the world of nuclear fission and fusion that they have introduced to the brink of great good or great evil. As Oppenheimer said after Hiroshima and Nagasaki - the scientist has known sin - a theological reality. Possibly there is an impression among scientists that science indeed has occasioned problems that science alone cannot answer.

Whatever the catylist, I am heartily in favor of building the bridge, for anyone today with a sense of our times cannot miss the advances and the challenges of modern science, and anyone with a sense of the history of Western man cannot ignore the riches of inspiration, moral enlightenment, human dignity and destiny that have been derived primarily from theology. Here are two strengths that can obviously be more meaningful to America, and to man generally, if they are working together, each in its own way, for the good of mankind, and not at cross purposes. Whatever man has wrought in his understanding and control of nature, this great power of science will be most meaningful if it is directed towards man's ultimate perfection and destiny. If there is a God, and if He has spoken, man will indeed be poorer for living as though he himself is the ultimate focus of all of his powers.

But, I am getting ahead of myself. I do not mean to preach here, since we are not in church; I mean only to speculate. I suspect that the bridge between science and theology might be built much easier if we could go back and take an honest look at the parting of the ways - Galileo again. The fundamental error here was that the proper theological questions were not asked. The real theological question involved was how could this heliocentric doctrine of

Copernicus and Galileo be squared with the fundamental Christian doctrine regarding the nature and destiny of man. Actually, there was and is no theological problem involved in the new theory. Instead of asking the proper theological questions, however, the heliocentric system was viewed as opposed to a literal interpretation of the early chapters of Genesis, an interpretation which no self-respecting theologian would espouse today. (now would at have been accepted by many earlier theologians such as St. Augustine) Galileo's theory might indeed have been questioned on scientific grounds, but on these grounds alone, since he was teaching science, derived by scientific methods. Unfortunately, he was opposed by bad theology, using a valid method badly, and in the wrong field.

Much of the same problem occurred in the last century regarding the evolution of man's body. Once more, it had to be reiterated by the best theologians that the Bible is a source of divine revelations for religious truths. It is not a book of science. Moreover, theology is concerned with ultimate truths, not the proximate truths that science properly seeks. If one says that God created all that is - this is an ultimate religious truth. And the method of demonstrating it from revelation is theological, not empirical. If one says that this creation took place ten billion years ago and that, in

the case of man, his body evolved over long ages, this is a scientific truth and it is as good as the scientific arguments that support it. While we can do little about the conflicts of the past, we can certainly build a more peaceful and constructive future, if we only remember the lesson of past misunderstandings. I would summarily reduce this lesson to one simple principle which itself may sound unclear because the language of science and theology are now different. Anyway, here is how a theologian or philosopher would put it:

Theology has its proper method to deal with its proper field, which is primarily - ultimate religious truths regarding man and his relationships to God, other men, and nature.

Science has its proper method to deal with its proper field - proximate scientific truths regarding all nature and man. Science, as science, cannot demonstrate that there is or isn't a God, as Richard Feynman stated in a recent article.

There are, of course, other ways of knowing too, philosophical and artistic intuition for example, which use neither the scientific nor the theological method. There is no reason to limit man's ways of knowing. If a scientist says there is no such thing as theology, he is out of his field, voicing an ultimate truth that is beyond science.

There seems to be another current misunderstanding that should be easily disposed of, since underlying it is a situation well enough known to all good scientists. There may well be areas of knowledge where the proximate truth stated by the scientist seems to conflict with the ultimate truth voiced by the theologian - although I suspect that most of these worrisome areas involve what is now outmoded - nineteenth century science. Science, as you well know, has recently abandoned scientific views three hundred years old regarding the nature of matter, space, and time. The latest theories are much more congenial to the corpus of Christian theological doctrine. But let us suppose that present scientific theories may change in a way that may seem to challenge theological truth. Should this possibility worry us? I think not, and I have no fears from science. Truth is our knowledge of what is, and given a fundamental unity of all that is, and different, valid ways of knowing it, the seeming conflicts of today can merge into understanding tomorrow. I have said that there has been bad theology and bad science at times in the past. While the fundamental revealed doctrines of the Church have never changed, theological understanding of them has progressed. The same may be said of scientific understanding which has often seen conflicts between different branches of science.

Take the famous nineteenth century argument about the age of the earth as a solid body. The biologists and geologists, on their evidence, wanted a time scale of thousands of millions of years. The physicists, under the leadership of Lord Kelvin, said an age of more than a hundred million years was impossible, and I will spare you the three good reasons he gave for this postulate. The spontaneous disintegration of radioactive atoms observed in 1896 allowed the earth to be older, than the physicists had supposed, and recent discoveries of nuclear fission and fusion vastly increased the possible age of the sun, too.

Another classic example of apparent contradiction within science itself is the centuries-long discussion on the nature of light as trains of waves or streams of particles, undulatory or corpuscular theory. The ultimate reconciliation through later developments of the quantum theory make the well-known paradoxes of relativity theory seem conventional by comparison.

If then, scientists have had to live with apparent contradictions, until science could ultimately find a reconciliation, I am sure we might expect similar difficulties between science and theology which use altogether different methods in their approach to knowledge. Rather than attempt to scuttle one another, they should learn to live together. The difficulty may some time be purely semantic, sometimes deeper, but patience and the refinement of both

science and theology is the byword.

I trust you will permit me to cite a short paragraph from Pope Pius XII, a great friend of science, from one of his addresses to students of the Sorbonne in 1953:

> "In your studies and scientific research rest assured that no contradiction is possible between the certain truths of faith and established scientific facts. Nature, no less than revelation, proceeds from God, and God cannot contradict Himself. Do not be dismayed even if you hear the contrary affirmed insistently, even though research may have to wait for centuries to find the solution of the apparent opposition between science and faith."

You will note here, in two precise phrases, the past cause of most theological-scientific conflicts. "The certain truths of faith" and "established scientific facts." Too often, as I have already admitted, theologians were all too little precise on what constituted "certain truths of faith." I say theologians, not the Church, which has been consistent in its precise statement of doctrine. And scientists, especially in the last century, were over-confident, to put it mildly, about "established scientific facts." You know of the materialistic

Victorian physicists who naively assumed the virtual finality, immutability, and even literal truth of their description of the true nature of the world, the billiard ball models, Newton's laws of motion and gravitation, Hooke's law of elastic strain and all the rest.

Well, those days are past, happily, I believe, for both the theologians and the scientists. I would ask your indulgence once more, to quote passages from Pope Pius XII's address to the Pontifical Academy of Sciences:

> "The scientist of today, directing his gaze more deeply into the heart of nature than his predecessor of a hundred years ago, knows well that inorganic matter is, so to speak, in its innermost being, countersigned with the stamp of mutability, and that consequently its existence and its sub-existence demand a reality entirely different, and one which is by its nature invariable.
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> "Just as in a picture done in chiaroscuro the figures stand out on a background of darkness, and only in this way achieve the full effect of form and life, so also the image of the Eternally Immutable Being emerges clear and resplendent

from the torrent which snatches up and carries off with itself all the material things of the macrocosm and the microcosm in an intrinsic mutability which knows no pause.....

"With the same clear and critical look with which it examines and passes judgment on facts (the scientific mind) perceives and recognizes the work of creative omnipotence, whose power, set in motion,by the mighty Fiat pronounced a thousand million years ago by the Creating Spirit, spread out over the universe, calling into existence with a gesture of generous love, matter bursting with energy. In fact, it would seem that present-day science, with one sweeping step back across millions of centuries, has succeeded in bearing witness to that primordial Fiat lux uttered at the moment when, along with matter, there burst forth from nothing a sea of light and radiation, while the particles of chemical elements split and formed into millions of galaxies .....

"What, then, is the importance of modern science for the argument for the existence of God based on the mutability of the cosmos? By means of exact and detailed research into the

macrocosm and the microcosm, it has considerably broadened and deepened the empirical foundation on which this argument rests, and from which it concludes to the existence of an Ens a se, immutable by his very nature. It has, besides, followed the course and the direction of cosmic developments, and, just as it was able to get a glimpse of the term towards which these developments were inexorably leading, so also has it pointed to their beginning in time some thousand million years ago. Thus, with that concreteness which is characteristic of physical proofs, it has confirmed the contingency of the universe and also the well-founded deduction as to the epoch when the cosmos came forth from the Hands of the Creator."

The Pope in the context of these passages clarifies the necessity of metaphysical reasoning to conclude from these physical facts. What is important at the moment, I believe, is that whereas so often in the past the theologians seemed to fear the advance of science, here is the Pope welcoming it in no uncertain terms, and finding in it a good base for further philosophical speculation about God and creation, a new and beautiful picture of the simple and unadorned words of revelation, "Let there be light ... and light was made."

At this point, and by way of both postscript and conclusion, I would like to append a few words that may tend to balance my earlier and rather critical remarks about Mediaeval theologians. As you know, we all have twenty-twenty hindsight, whatever our lack of wisdom today. Whatever the defects of Mediaeval theologians vis-a-vis science, they certainly had a comprehensive notion about God which even Whitehead admits "was the greatest contribution of Mediaevalism to the formation of the scientific movement." (Science and the Modern World, Chapter I)

The God of the Mediaeval theologian is not only a God of omnipotence and freedom, but also a God of rationality and order. While He was free to create or not create a cosmos, and in choosing to create, was free to create this cosmos or some other, when He did create it was a cosmos not a chaos that was created since it had to reflect His perfection and coherence.

Because God is rational, His work is orderly, and because He is free, there is no predicting absolutely just what that precise order will be. The world of Christian theism then is a world congenial to empirical science with its twin method of observation and experiment. Unless there were regularities in the world, there would be nothing for science to discover, and being

contingent regularities, they must be verified by experimentation.

We might also point to this peculiar combination of regularity and contingency in the physical world, the result of a rational and free Creator, as accounting for the peculiar interlocking of theory and experiment in physics. Dr. Max Born called attention to the phenomenon of alternating periods of experimental expansion and theoretical development in physics some years ago.

The two men who originally wrote on this concurrence between Christian theism and modern physics each stressed one of the points to account for the fact that empirical science did not arise in ancient Greece or India. Mr. Foster stresses the freedom of God and the consequent contingency of the world in Christian thought in contrast to the logicism and necessitarianism of the ancient Greeks. Dr. Whitehead emphasizes the rationality of God and the consequent regularity of the world in Christian thought in contrast to Asian views of God as impersonal or altogether arbitrary.

This gives rise to the further question: why was science so late in coming into this world of Christian theism that was congenial to it - but that would keep us here for the rest of the evening.

Thank you for being with us at Notre Dame this year. You are indeed welcome.