

Cosmology, Evolution, and Christian Faith

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Abstract

To what extent can what we know from science about the evolution of life in the universe influence our religious attitudes? And, on the other hand, to what extent can religious thought make a contribution to our scientific understanding of the origins and evolution of life in the universe? This twofold question poses the serious risk of transgressing upon the epistemological independence of the various disciplines: theology, philosophy, astrophysics, biology and cosmology, and creating, thereby, more confusion than understanding. It is, therefore, necessary to maintain a consistent posture of preserving the integrity of each of the disciplines, especially that between the natural sciences and theology.

Key words: Cosmology; Evolution; Faith; Religion; Bible

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INTRODUCTION

It is clear, for instance, that in the Age of the Enlightenment in the 16th and 17th centuries natural theology was a truly remarkable movement. It represents one of the last major interactions between science and theology. The climax of this movement came with Isaac

Newton. For Newton, for instance, there was no known reason for the fact that, with few exceptions, all of the planets and their moons orbit the sun in almost the same plane and in the same direction and that the each rotate on their axis in that same direction. Since many comets in the solar system move in orbits that are strongly inclined to this plane, Newton concluded these systematic motions could not be due to any necessity in nature itself. The lack of scientific reasons for such striking structure and his refusal to regard them as mere coincidences made Newton conclude that “the motions which the planets now have could not spring from any natural cause alone but were impressed by an intelligent Agent.”¹ He then expresses admiration for this agent by noting that: “to adjust all these things together in so great a variety of bodies argues that cause to be not blind and fortuitous, but very well skilled in Mechanics and Geometry.”² And so was born the great “God of the Gaps,” the God who explains what science cannot explain.

Newton, however, was but one voice in an almost unanimous chorus of scientists who sang the praises of nature as hailing from the finger of God and, therefore, replete with evidences of his wisdom and power. Astronomers, physicists and naturalists here joined ranks with Job and the Psalmist in recognizing God as the ultimate ground of everything in heaven and upon earth. For this was perhaps the most notable mark of natural theology. It did not originate in theology, but in science. It was not started by theologians trying from above to impress a religious perspective on science. It began as a movement among believing scientists who were convinced both that God’s existence could be proved and some of His attributes described from below, that is, on

¹Newton, I., *Four Letters from Sir Isaac Newton to Doctor Bentley containing some Arguments in Proof of a Deity*, London, 1756. The most recent edition is in *The Correspondence of Isaac Newton*, ed. H. W. Turnbull, Cambridge, 1961, III, 233-256.
² *Ibid.*, 235.

the basis of the expanding world of scientific knowledge. This also convinced them that they had nothing to fear from the indubitable progress of science; for beyond the receding frontier between the known and the unknown there was no dark and dangerous abyss in which the religious mind might get lost, but just another territory to be surveyed in the search for new evidence of the Creator.

The end result is that in that Age of Enlightenment with the surge of scientific reasoning, most scientists, who were religious believers, were unreasonable in their approach to religious belief, since they sought to found their religious belief on purely rational grounds. This created at that time among some people, and continuing today among many, an unnecessary rift between science and religious belief. While philosophical and theological reasoning may serve as a prolegomena to religious faith and while faith does not of itself contradict any rational discourse, true religious faith is, for use of a better word, transcendent. It goes beyond the rational.

As an aside, atheism is an exercise in faith. There is no rational proof that God does not exist. While it may defy logic to require a proof that something or someone does not exist, the long and profound history of religions throughout humanity's time on this earth should be approached more reasonably than happens among most modern atheists.

1. THE NATURE OF RELIGIOUS FAITH

Too often discussions of the relationship between science and religion are carried out in very general terms. Such discourse can be quite unfruitful for two reasons. First, as compared to the natural sciences religion contains a larger measure of the subjective, of human experiences not totally verifiable by objective reasons. Such subjective experiences are not, of course, limited to religion. They are present in many areas of our lives. Nor need these experiences, religious or otherwise, necessarily conflict with reason. They simply are not limited to rational explanation. They go beyond what can be rationally justified. Secondly, while for the natural sciences we have a rather acceptable idea of what we mean by science, the very notion of religion is ill-defined. Does it mean worship? Does it mean being a "good person"? Does it mean accepting certain moral dictates that go beyond what is commonly accepted as good and bad? Does it mean accepting those dictates out of personal conviction or out of loyalty to a certain tradition? Does it mean believing in certain doctrines? Does it mean accepting a certain authoritative and hierarchical structure, i.e. being affiliated with a certain Church? To most of us religion would imply more of an affirmative than a negative answer to all of the above. And yet the situation is further complicated by the multiplicity of religions which differ among themselves, have even warred among themselves, over the responses given to such questions as the above. Even

today, if we look at some of the main religious traditions: Islam, Judaism, Christianity, Buddhism, etc., we see not only vast differences among them, but enormous divisions within any one of the traditions.

The only way, therefore, that dialogue as a rational experience can take place is that, on the part of religion, the dialogue be limited to the rational foundations for religious belief. Even then, the only way that any such dialogue could have universal significance is that we could assume that there existed common rational foundations across all religious traditions and that is simply not the case. It seems, therefore, that any fruitful dialogue requires that the rational basis for certain specific religious beliefs in certain specific religious traditions be confronted with what is known from the natural sciences. The natural sciences, in particular, have made great advances by adhering rigidly to canons of what is scientifically true. In fact, in recent years the norms for judging the scientific truth of a given theory of life's origins and evolution have been extended, as will soon be discussed, in the direction of inviting dialogue with philosophy and theology, and specifically within Christianity.

2. BIBLICAL FAITH AND CHRISTIANITY

The Bible is a collection of writings by various authors at various epochs using various literary genres. And so it best serves reason if one speaks of a specific book rather than of the Bible in general. It is clear, for instance, that the overall intention of the authors of Genesis is to evoke religious faith, an adherence to the God of Abraham, Isaac and Jacob, and not to teach science. There is simply no scientific teaching in Genesis. In the Judaea-Christian tradition the roots of religious belief reach to the earliest prophets about 2,000 years before Christ. But modern science cannot be dated before the 16th or 17th century, from the time of Galileo and then through many others to Newton, with the discovery of the universal law of gravity, the differential calculus, etc. We may even wish to go back to the beginnings of the experimental method with Roger Bacon and others in the 13th century. But, at any rate, the modern science that speaks to religion today is born much later than the religion to which it speaks. It has to be recognized that the religious tradition is historically much longer and to a certain extent has that richness of the past that modern science does not.

From ancient mythological views of the relationship of the gods to nature through the Golden Age of Greece, especially Plato, Aristotle and Archimedes, there was a development of conflicting views on the proper discourse on nature and the true relations between God and human beings (Pedersen, 2007). Soon Christianity, with its inherited Biblical faith, emerged from its obscure origin in Palestine. From its very birth it appears that Christianity was singularly uninterested in the scientific achievements of the Greeks. There is no treatise on cosmology in the

New Testament and extremely few references to particular elements of the Greek account of the universe. All efforts are spent on the proclamation of the belief that the birth, life, death and resurrection of Jesus had radically changed the way in which the relations between God and the world should be envisaged.

From the religion of Israel Christianity also inherited the belief that the one Lord of the world is also its Creator (Clifford, 1995, pp.151-166). Time and again the Old Testament underlines the fact that the world is created. It has come into being independently of man and without human assistance. "Where were you when I laid the foundations of the earth?" (Book of Job, 38: 4) was God's question to Job. However, the Biblical doctrine of creation seems to be marked by a paradox. On the one hand there is an existential chasm between God and His creatures. Nothing in nature is divine. On the other hand, the created world is said to testify to the divinity of its creator. The beginning of the Gospel of St. John indicates a solution of this dilemma. "In the beginning was the *logos*, and the *logos* was with God, and the *logos* was God. He was in the beginning with God. All things came into being through him, and without him not one thing came into being" (Gospel of John, I: 1). By introducing "*logos*" was Christianity embracing a fundamental notion in Greek philosophy? At a minimum it can be said that by using the word "*logos*" early Christianity was taking an important step towards assimilating the conception of the world as a rational structure according to the basic tenet of Greek philosophy.

Despite its apparent lack of interest in matters scientific the New Testament presented Christianity in a way that contained a number of seminal ideas whereby the scientific discourse on the laws nature and the religious belief that these laws revealed a divine plan would develop. The belief in One God was a direct challenge to all previous polytheistic mythologies about the origins of nature. That nature was created meant that its inner connections were established independently of the human mind and that they were to be discovered by the workings of that same human mind. The *logos* Christology, furthermore, made the idea of an all-permeating rationality at home in a religion which hailed Christ as the Lord of the World.

3. THE NATURE OF THE NATURAL SCIENCES

Skeptics, dubious of ever being able to find a widely accepted definition of science, say that science is what scientists do. The element of truth in this statement is that science is not a univocal concept. It varies from one discipline to another, even, for instance, among the so-called hard sciences. But there is also sufficient commonality among them that the name "science" can be

legitimately given to each analogically. Let us do this with the study of biological evolution against the background of cosmological evolution. What are these disciplines? What do these scientists do? They begin with controlled data, that is, data which any other trained professional could independently verify. From the observed data use is made of biology, chemistry, physics, mathematics, etc. to develop a model which best explains the data. We will later on discuss what constitutes a "best explanation." There are many assumptions involved in this process of developing our knowledge of life's origins and history in the universe. One of the principal ones is to assume that it is valid to apply the scientific laws which are derived from our knowledge of what happens on the earth to the universe as a whole. At any rate the movement from observations to models is a continuously reciprocal process. The best model is used to determine what further observations must be made. The model is then revised with the new observations, etc. There is a constant going back and forth from observations to the model to the observations. It is important to note that in the very nature of this process of reciprocity there is an implicit acknowledgement that we do not possess the truth. The expectation is, however, is that we are continually approaching the truth. With this background let us approach the topic of evolution.

5. THE SCIENCE OF EVOLUTION

It is arguably difficult to find a more heated topic of discussion than that concerning the origins and evolution of the universe, especially of life and of intelligence in the universe, and whether such origins can be understood without evoking a Creator God. Responses range from the extremes of a Stephen Hawking or a Pope Pius XII to almost all conceivable intermediate positions. Hawking claims that, if his quantum cosmological theory of the origins of the universe without boundary conditions is correct, then we have no need of God (Hawking, 1989). Pius XII attempted to claim that with Big Bang cosmologies scientists were coming to discover what had already been known from the Book of Genesis, namely that the universe had a beginning in God's creative action, with the *fiat lux*. The Pope was referring specifically to the work of George Lemaître.³ In between we have such positions as evolutionary naturalism and episodic divine intervention. Evolutionary naturalists would claim that, although our scientific knowledge of evolution is limited, the best explanation of the universe and all that it contains is through increasing complexity in an expanding, evolving system in which both deterministic and chance

³ For an excellent discussion of the contrasts between Pius XII and Georges Lemaître see Josef Turek, "Georges Lemaître and the Pontifical Academy of Sciences", Vatican Observatory Publications, 2, 167; see especially pp. 170172.

processes play out their roles in a universe abundant with opportunities, 13.8 billion years old and containing 10^{22} (ten thousand billion billion) stars (Coyne, 2009, pp.9-26). Those who profess episodic divine intervention would claim that divine activity is required, at least in some phases of the evolutionary process and, in particular at the occurrence of human life and intelligence, because natural processes alone are not adequate to explain the end result. What is one who is both a religious believer and a scientist to make of all of this?

Let us first, however, review our scientific knowledge of life's origins. Within about 500 million years after the Big Bang the first stars were born. How is a star born? A cloud of gas and dust, containing about 100 to 1,000 times the mass of our sun begins to fragment and pieces of the cloud begin to collapse due to self gravity until the internal temperature reaches tens of millions of degrees and turns on a thermonuclear furnace. A star is born. In the thermonuclear furnace a star lives by converting hydrogen to helium, helium to carbon, and if it were massive enough, carbon to oxygen, to nitrogen, all the way up to iron. So, as a star lives it converts the lighter elements into the heavier elements. Stars also die. A star at the end of its life can no longer sustain a thermonuclear furnace and so it can no longer resist against gravity. It collapses for a final time, explodes, and expels its outer atmosphere to the universe. From this gas expelled from a first generation of stars another generation of stars will be born. Note that through this cycle of the birth and death of stars the universe is constantly being enriched with heavier elements. If this were not happening, we would not be here. In order to get the chemical elements to make life, we had to have three generations of stars. To get the chemistry for life we had to have the stars regurgitating material to the universe. Obviously this story of star birth and death is very important for us. Out of this whole process around the Sun, a third generation star, a group of planets came to be and among them the little grain of sand we call the Earth.

It is quite clear that we do not know everything about the process of biological evolution within the context of this brief description of cosmological evolution. But the best scientific explanation to date is that through neo-Darwinian evolution a process of building up ever more complex chemistry and, therefore, more complex organisms in an evolving universe resulted in the human brain. After the universe became rich in certain basic chemicals through three generations of stars, those chemicals combined in successive steps to make ever more complex molecules and organisms. Finally in some extraordinary chemical process the human brain came to be, the most complicated machine that we know.

Let us now address a question which is fundamental to Christian faith. Did we come about by chance or by necessity in the evolving universe? From the best of modern science we can describe the dance of the fertile

universe. For 13.8 billion years the universe has been dancing a fertile ballet. One of the ballerinas is chance. The other is chemistry in consort with physics, and eventually biology. When we speak about chance we mean that it is not certain that a given event would happen. The "uncertainty" can be calculated in mathematical terms. Such a calculation takes into account how big the universe is, how many stars there are, the distribution of stars by mass and temperature, how many stars would have developed planets, etc. In other words, it is not just guesswork. There is a foundation in scientific knowledge for making each successive calculation.

A good example of a chance event would be two very simple molecules wandering about in the universe. They happen to meet one another and, when they do, they are destined to make a more complex molecule because that is the nature of these molecules. But the temperature and pressure conditions are such that the chemical bonding to make a more complex molecule cannot happen. So they wander off, but they or identical molecules meet billions and billions of times, trillions if you wish, in this universe, and finally they meet when the temperature and pressure conditions are correct. This could happen more easily around certain types of stars than around others because of the characteristics of a wide variety of stars. Those characteristics are well known. From a strictly mathematical analysis of this variety of conditions, called the mathematics of nonlinear dynamics, one can say that as this process goes on and more complex molecules develop, there is more and more direction to the process. As the complexity increases, the future complexity becomes more and more determined due to the very nature of the universe.

All of this is happening in a universe that is so fertile that the eventual outcome has a quasi predetermined nature. The result is inevitable, to distinguish it from being necessary, because with a combination of chance and necessary processes in a very fertile universe with so many opportunities there is a narrowing down of the evolutionary process due to the nature of chemistry together with physics, biology and nonlinear dynamics. If we truly accept that there are chance processes involved, then the organism which results could be somewhat different. But since complexity proceeds towards an ever more determined direction the result could not be very different.

5. THE SEARCH FOR TRUTH

What degree of certainty can we place in our scientific knowledge of evolution in the universe? We certainly do not have the scientific knowledge to say how each living creature came to be in detail. We do not know precisely how each more complex chemical system came to contribute to the process of self organization which brought about the diversity of life forms as we know

them today. Most importantly, we do not know with scientific accuracy the sufficient elements in nature to have brought about the unbroken genealogical continuity in evolution that we propose actually happened. There are, in brief, epistemological gaps which prevent natural science from saying that a detailed scientific explanation of biotic evolution has been proven. What we have today is the most adequate account conceivable at this time considering the available empirical data. And that empirical data, with respect to biotic evolution, comes from various independent scientific enterprises, including genetics, molecular biology, paleontology and comparative anatomy.

How do we know we are on the path to the truth in the scenario of life's origins just described? In other words how do we judge what is the best way to explain life's origins. In the natural sciences there are a number of criteria whereby an explanation is judged to be best. A list of the principal criteria would include the following: (1) verifiability, i.e., there is, at least in principle, a way of judging whether the explanation fits the data; (2) predictability, i.e., from data on past or present events it is possible to predict future events and then observe to see that the future events actually occur; (3) simplicity or economy, i.e., the least assumptions are made to get the greatest explanatory power; (4) beauty, i.e., the explanation has an aesthetic quality about it; although, especially for the natural sciences, this may appear to be a very subjective criterion, almost all great scientific discoveries have benefited from its application; (5) unifying explanatory power; i.e. not only are the observations at hand explained but the attempt to understand is also in harmony with all else that we know, even with that which we know outside of the natural sciences.

This last criterion is significant, since it appears to extend the semantics of the natural sciences towards the realm of other disciplines, especially to theology and Christian faith. Put in very simple terms this criterion is nothing else than a call for the unification of our knowledge. One could hardly be opposed to that. The problem arises with the application of this criterion. When is the unification not truly unifying but rather an adulteration of knowledge obtained by one discipline with the presuppositions inherent in another discipline, as indicated in the Introduction. History is full of examples of such adulterations. It is for this reason that scientists have always hesitated to make use of this criterion. And yet, if applied cautiously, it could be a very creative one for the advancement of our knowledge and, therefore, of our faith.

The supposition is that there is a universal basis for our understanding and, since that basis cannot be self-contradictory, the understanding we have from one discipline should complement that which we have from all other disciplines. One is most faithful to one's own

discipline, be it the natural sciences, the social sciences, philosophy, literature, theology, etc., if one accepts this universal basis. This means in practice that, while remaining faithful to the strict truth criteria of one's own discipline, we are open to accept the truth value of the conclusions of other disciplines. And this acceptance must not only be passive, in the sense that we do not deny those conclusions, but also active, in the sense that we integrate those conclusions into the conclusions derived from one's own proper discipline. This, of course, does not mean that there will be no conflict, even contradictions, between conclusions reached by various disciplines. But if one truly accepts the universal basis I have spoken of above, then those conflicts and contradictions must be seen as temporary and apparent. They themselves can serve as a spur to further knowledge, since the attempt to resolve the differences will undoubtedly bring us to a richer unified understanding.

6. A MUTUAL INTERACTION: SCIENCE AND CHRISTIAN FAITH

The discussion above particularly applies when we are addressing fundamental and ultimate questions such as life's origins and their meaning for Christian faith. Does the existence of intelligent beings in the Universe have any significance for understanding the Universe as a whole? Does our knowledge of God depend on our understanding of the Universe? In fact, a very strong piece of evidence that there is a universal basis for understanding is the very clear drive of the human being for meaning. This is seen clearly from the very dawn of human history where, with even a very primitive collection of data, our ancestors sought for the meaning of life in the physical universe, as well as in the events of their personal lives and those of society in general. There are two topics which are of particular importance for the mutual interaction between science and Christian faith: (1) biological evolution and the nature of the human person; (2) scientific cosmology and the Christian faith in a Creator God. Let us discuss each in turn.

7. BIOLOGICAL EVOLUTION AND THE PERSON

For historical reasons, and not truly religious ones, biological evolution has been the enigma of religions. Fundamentalist religious thought denies it. Catholic thought, as it has matured, accepts it as scientifically acceptable, but hesitates in how to deal with it. Why the denial and the hesitancy? Is it because God must be omnipotent and have everything under his control? The dynamism intrinsic in the universe in evolution seems to escape this omnipotence.

Let us examine a recent example of ‘Catholic hesitancy’ in light of the positive turn that it has taken. A message of John Paul II on evolution was received by the members of the Pontifical Academy of Sciences on 22 October 1996 during the Plenary Session of the Academy being held at the seat of the Academy in the shadow of St. Peter’s Basilica and was subsequently made public (John Paul II, 1996). It stirred a vast interest among both scientists and the public. While the encyclical of Pope Pius XII in 1950, *Humani Generis*, considered the doctrine of evolution to be a serious hypothesis, worthy of investigation and in-depth study equal to that of the opposing hypothesis, John Paul II states in his message:

Today almost half a century after the publication of the encyclical [*Humani Generis*], new knowledge has led to the recognition that the theory of evolution is no longer a mere hypothesis.

In order to set the stage for dialogue the message distinguishes in traditional terms the various ways of knowing. The correct interpretation of observed, empirical, scientific data accumulated to date leads to a theory of evolution which is no longer a mere hypothesis among other hypotheses. It is an established scientific explanation. But since philosophy and theology, in addition to the scientific analysis of the empirical facts, enter into the formulation of a theory, we do better to speak of *several* theories. And some of those theories are incompatible with revealed, religious truth. It is obvious that some theories are to be rejected outright: materialism, reductionism, spiritualism. But at this point the message embraces a true spirit of dialogue when it struggles with the opposing theories of evolutionism and creationism as to the origins of the human person. And this is obviously the crux of the message.

The dialogue progresses in the following way: The Church holds certain revealed truths concerning the human person. Science has discovered certain facts about the origins of the human person. Any theory based upon those facts which contradicts revealed truths cannot be correct. Note the antecedent and primary role given to revealed truths in this dialogue; and yet note the struggle to remain open to a correct theory based upon the scientific facts. The dialogue proceeds, in tension as it were, between these two poles. In the traditional manner of Papal statements the main content of the teaching of previous Popes on the matter at hand is reevaluated. And so the teaching of Pius XII in *Humani Generis* that, if the human body takes its origins from pre-existent living matter, the spiritual soul is immediately created by God. And so, is the dialogue resolved by embracing evolutionism as to the body and creationism as to the soul? Note that the word “soul” does not reappear in the remainder of the dialogue. Rather the message moves to speak of “spirit” and “the spiritual”.

If we consider the revealed, religious truth about the human being, then we have an “ontological leap”, an “ontological discontinuity” in the evolutionary chain at the

emergence of the human being. Is this not irreconcilable, wonders the Pope, with the continuity in the evolutionary chain seen by science? An attempt to resolve this critical issue is given by stating that:

The moment of transition to the spiritual cannot be the object of this kind of [scientific] observation, which nevertheless can discover at the experimental level a series of very valuable signs indicating what is specific to the human being.

The suggestion is being made, it appears, that the “ontological discontinuity” may be explained by an epistemological discontinuity. Is this adequate or must the dialogue continue? Is a creationist theory required to explain the origins of the spiritual dimension of the human being? Are we forced by revealed, religious truth to accept a dualistic view of the origins of the human person, evolutionist with respect to the material dimension, creationist with respect to the spiritual dimension? The message, it appears, when it speaks in the last paragraphs about the God of life, gives strong indications that the dialogue is still open with respect to these questions.

The inspiration of those closing paragraphs suggests that reflections upon God’s continuous creation may help to advance the dialogue with respect to the dualistic dilemma mentioned above. It may be that God creates through the process of evolution and that creation is, therefore, continuous. Since there can ultimately be no contradiction between true science and revealed, religious truths, this continuous creation is best understood in terms of the best scientific understanding of the emergence of the human being, which I think is given in the following summary statement by the eminent evolutionary chemist, Christian de Duve, in his paper at the very Plenary Session of the Pontifical Academy of Sciences to which the Papal message on evolution was directed:

... evolution, though dependent on chance events, proceeds under a number of inner and outer constraints that compel it to move in the direction of greater complexity if circumstances permit. Had these circumstances been different, evolution might have followed a different course in time. It might have produced organisms different from those we know, perhaps even thinking beings different than humans (De Duve, 1997, pp.311-331).

Does such contingency in the emergence of the human being contradict religious truth? Might this not be an invitation to theologians to develop a more profound understanding of God’s continuous creation? God in his infinite freedom continuously creates a world which reflects that freedom at all levels of the evolutionary process to greater and greater complexity. God lets the world be what it will be in its continuous evolution. He does not intervene, but rather allows, participates, loves. Is such thinking adequate to preserve the special character attributed by religious thought to the emergence of spirit, while avoiding a crude creationism? Only a protracted dialogue will tell. The spirit of the closing paragraphs of the message of John Paul II on evolution is, it appears, an invitation to just such dialogue.

On several occasions Pope Benedict (now emeritus) gave some indications of his views on evolution. At his general audience on 9 November 2005 he continued the series of talks in his catechesis of the prayer of the Church as derived from the Psalms (Benedict XVI, 2005, Nov. 6). On this occasion he addressed the so-called “Pascal Hymn” of God’s ancient chosen people (Psalm 135) which expresses the glory of God revealed in his creation as it celebrates God’s love and fidelity to his alliance with his chosen people. The Pope used the opportunity to speak indirectly of evolution.

“The first manifestation of this love and fidelity,” says the Pope, “is to be found in God’s creation: the heavens, the earth, the waters, the sun, the moon and the stars.” “Consequently, there exists,” he affirms, “a divine message, inscribed secretly in creation as a sign of God’s love and fidelity . . .” The discourse then moves on to more modern concerns with allusions to evolution as the Pope, recalling the thoughts of St. Basil the Great, states: “There are some who, tricked by their deeply imbedded atheistic stance, imagine a universe with no guidance or order, as if floating along by sheer chance.” The Pope, at that point departing from his written text, wonders about how many of those “some” among scientists today, drawn by atheism, see only chance in the world’s unfolding, when we know from God’s love and fidelity that he created the world out of love according to an intelligent design.

The Pope is speaking, of course, from a purely theological point of view in expressing God’s love in creating a world which, to respect his fidelity, is orderly and does not evolve by sheer chance. It is well to recall at this point that neo-Darwinian evolution does not claim that the world evolves by sheer chance. The Pope says nothing about whether the natural sciences, respecting their own methodology, are capable of discovering God’s intelligent design - and this is the critical issue. The Pope’s position is that God’s love and fidelity are at the source of his creation of the universe. If we use our best scientific knowledge of the “fertile” expanding and evolving universe to reflect upon the nature of God the Creator we will find, as the Pope suggests, that God is not primarily a “designer”, an attribute which diminishes her/his magnificence. She/he is primarily a lover who in creating shares her/his love.

In his homily at the Easter Vigil liturgy of 2006 Benedict again alludes to evolution when he suggests that the greatest “mutation” in the history of mankind is found in the Lord’s Resurrection (Benedict XVI, 2006, Apr. 17). Through God’s special intervention the human and the divine have been definitively united. These are, of course, religious and theological reflections but it is interesting that Benedict clearly adopts the language of evolution in expressing them.

8. SCIENTIFIC COSMOLOGY AND CHRISTIAN FAITH

Let us now examine the interaction between scientific cosmology and Christian faith. Cosmologists propose, for instance, that there is a fine tuning of the universe, the so-called anthropic principle (Wilson, 1993). This may be an invitation to return to an examination of the religious concept of the creation of the universe by God against the background of modern cosmologies. The inability to provide thus far a strictly scientific explanation to what is a strictly scientific problem, the fine tuning, may be an invitation to think that the explanation lies in a teleological consideration. It is important here to emphasize the word “invitation”, so as to preserve the epistemological independence of the various disciplines. One is perfectly free to accept the invitation or not. One can stay firmly put within one’s own discipline and continue to seek the answer there, uncontaminated by possible solutions arising elsewhere. But the invitation may be justly considered to be a very real one and well-founded; it, therefore, would require serious reasons to reject it. Those serious reasons must confront the long history of religious thought that there is a person at the source of the existence of the universe and that said person had a purpose or a design in “creating” the universe, a design which included, perhaps even centered upon, our existence.

One of the most productive areas of research in modern cosmology is the application of quantum mechanics to an analysis of the origins and very earliest stages of the universe. It is important to note that our observational knowledge of these early stages of the universe is very limited. But we can argue back quite rigorously to the physical conditions which characterized those stages by applying physics and mathematics to what we observe in the universe today. Amidst the myriads of such observational data there are three principal observations which emerge and which allow us to reconstruct the early universe: (1) from the measurements of distant galaxies and clusters of galaxies we know that the universe is expanding with very precise conditions; (2) from the measurement of the abundances of helium, lithium, deuterium and other light elements, we know that much of that material had to be created under extremely high temperature and density conditions in the early universe; (3) from a measurement of the current temperature of the universe, of the so-called cosmic background radiation, we can establish the temperature conditions of the early universe. When we combine all of this and other observations we can determine the age of the universe, its approximate mass and its mean density (Coyne, 2004).

This summary of the results of modern cosmology represents an amazing feat in the combination of our knowledge of elementary particle physics and observational astrophysics. But the nagging questions remain. How did it all begin? When it began were there

not certain initial conditions which determined how it would evolve? Did the universe really come to be in all its specificity from quantum fluctuations at its origin? Such considerations also suffer from problems of verifiability. The question also arises as to whether they really provide ultimate explanations.

It is precisely here, I believe, that the semantics of science and of Christian faith might fruitfully interact. Many of the concepts which are essential ingredients in the cosmological models have important implications in religious thought and those implications must also enrich cosmological thinking, so that the latter may have the greatest unifying explanatory power, a criterion for its veracity. In exploring these implications, however, it is essential that the fundamental significance of the concepts in the various disciplines not be confused. On the other hand the precise thrust of interdisciplinary dialogue is that a wider perspective will be gained on the fundamental reality by inter-relating the concepts arising from the diverse disciplines.

In most Hot Big Bang cosmological models the universe had a beginning. That beginning at time equals zero is a mathematical singularity. It cannot be addressed by classical mathematics or physics. To avoid that singularity it is claimed that quantum gravity must be applied at the extreme conditions of the universe's beginning. During this quantum gravity regime, however, the concept of time is inapplicable in any simple way. Most approaches require an origin of our specific universe from quantum fluctuations of a previous state, then an inflationary period where the universe expanded at many times the velocity of light, a period of nucleo-synthesis followed by recombination of fundamental particles and the so-called transparency of the universe, and then the beginning of structure in the universe with galaxies and stars. This sequence of stages in the development of the universe always leaves us wondering about the origins of the previous state upon which the subsequent state developed until we reach back to the quantum fluctuations. Does this sequence of cosmological events originating in quantum gravity considerations speak at all to the theological considerations of the creation of the universe from nothing (*creatio ex nihilo*)?

Religious perceptions of beginnings speak of creating out of nothing (*creatio ex nihilo*). There is a persistent confusion between cosmology and theology when it comes to consider the concept of "nothing." Quantum cosmological views of the beginning of the universe speak of "vacuum fluctuations" or a "quantum nothing." This is not the "nothing" of the theologians. The "vacuum" of quantum mechanics is something, if only a mathematical concept. To speak of "creation out of nothing" in philosophy or theology means that one is denying that any matter at all is changed or transformed into something else. The expression "out of nothing" or "from nothing" is, at its root, a denial of any material cause whatsoever in

the act of creation. The "from nothing" of the theologian asserts the total and exclusive dependence of the universe upon one God the Creator. There were no rival gods preexisting before the universe began, as all previous cosmogonies asserted. Furthermore, from its beginning and in its continuing existence the universe depends on God. The scientific study of origins neither denies nor affirms the theological assertion of creation. It would be equally confusing to deny the existence of God by stating that, since no boundary conditions were required for the quantum cosmological origin of the universe, God is not required. The God of the religious person is not a boundary condition for the universe. She/he is the creator, whatever content that notion of creator might have beyond asserting the dependence upon God for its existence.

The key to understanding the difference between creation and origins is the notion of change (Carroll, 2003).⁴ Changes in nature are what the natural sciences study. The exchanges between energy and matter, the fusion of hydrogen to helium, the birth of stars from interstellar gas, the unraveling of the double spiral in DNA are all proper to exploration by the natural sciences. There is an immense difference between seeking the nature of specific beings in nature through the changes that brought them to exist as such specific beings and the quest to understand their very existence. To understand the very existence of whatever exists is proper to the notion of creation, a metaphysical quest of the theologian. To seek to understand the chain of events which bring about a specific kind of being is proper to science. Creation speaks to the source of being of whatever exists. It does not address the evolution of one kind of being from another. To create, therefore, is not to work on or with some already existing material. Creation is not, therefore, a cause such as those we experience in everyday day life and which the scientist explores. On the other hand, one might consider creation as the *complete* cause of all things. To create is to give existence to whatever exists in a specific way. It does not mean to change "nothing" into "something", in the sense of changing it from not being to being. To exist means to depend upon a source of existence. Creation, therefore, is not some distant past event. It is rather the continuing and total source of the existence of whatever exists.

The doctrine of creation cannot, therefore, be as such in conflict with any scientific explanation of origins. The natural sciences seek to account for changes and the origins of change. Whether the changes described are biological or cosmological, have a beginning or not, are unending or temporally finite, they remain processes. Creation accounts for the existence of things, not for processes which bring about changes in things. So, given that something exists, how did life originate from this

⁴ I am indebted to Carroll for much of the discussion in this section.

something is a scientific question. Why there is something rather than nothing is not a scientific question.

The notion of time necessarily enters into the discussion of creation and origins. We conceive of the creator as prior to what is created, but the priority is metaphysical not temporal. To be created out of nothing does not mean that the creature is *first* nothing and *then* something. It means that the creature has a dependent existence. The question as to whether the universe had a beginning in time or is eternal in the sense that it had no beginning is not relevant to understanding creation. In either case the universe is created, i.e., is dependent for its existence. Cosmologists consider space and time as intrinsic parameters of the universe and some propose that the very notion of temporality is a subsidiary concept. Some even propose that there is “eternal inflation,” an endless series of universes within universes. All of these universes would be dependent for their existence and would, therefore, be created. The universe might have no beginning and no end. It is still created. Creation fundamentally expresses the dependence of all that is, whether its existence is eternal or temporal, on a fundamental source of being.

The natural sciences speak of origins and not of creation. The Big Bang described in various ways by modern cosmologists is not creation. The evolution of life in the universe is not creation. A search for the ways in which the universe itself or life in it might have come to be is a search for origins and is the proper task of the sciences. Creation speaks to the ultimate reason for the existence of all things. It is mistaken, therefore, to conclude that there are implications for a creator if the universe is eternal, is completely self-contained, with no singularities or boundaries, and completely described by a unified theory. To use scientific theories to deny creation or a creator is a fundamental failure to distinguish between existence and changes in existing beings.

9. THE LIMITS OF OUR KNOWLEDGE AND THE QUEST OF CHRISTIAN FAITH

The best scientists are usually well aware of the limitations of their knowledge. Religious thinking also has its limitations. The excessively dogmatic approach which sometimes characterizes theology would do well to recognize this as it seeks for the understanding which truly nourishes Christian faith. Theology must deal with the linguistic interpretation of written documents; it must interpret oral traditions; it must reconstruct history. It must establish a rational basis for accepting witnesses to historical events and it must determine when authority alone can be the source of certain truths. Above all there are the serious epistemological problems that arise from the relationship of theology to faith. Although theology is a science, a rational way of knowing in its own right, it is

said to proceed from faith and to lead to an understanding of the faith (*fides quaerens intellectum*). This makes it subject to all of the false illusions that can arise from purely subjective behavior, and it must always struggle to separate those illusions from what is objectively true. It must above all in today’s world confront our scientific knowledge of the evolution of life in an expanding universe.

If we were to pursue the dialogue outlined in this paper, we might soon come to see that a teleology and design in the universe, derived from a religious point of view, are not incompatible with our scientific knowledge of life’s origins and evolution. Or we would come to realize that the inevitable tendency in the physical universe towards more complex structures is an invitation to think beyond science to a deeper synthesis of our understanding of scientific evolution and our Christian faith. The important thing to realize is that in both the scientific and the religious approaches to understanding we are searching for the truth, which we do not yet possess. But it is clear that evolution is an intrinsic and proper characteristic of the universe. Neither the universe as a whole nor any of its ingredients can be understood except in terms of evolution. And evolution is a daily happening. We, for instance, are constantly exchanging atoms with the total reservoir of atoms in the universe. Each year 98% of the atoms in our bodies are renewed. Each time we breathe we take in billions and billions of atoms recycled by the rest of breathing organisms during the past few weeks. Nothing in our genes was present a year ago. It is all new, regenerated from the available energy and matter in the universe. Our skin is renewed each month and our livers each six weeks. In brief, human beings are among the most recycled beings in the universe.

How are we to interpret the scientific picture of life’s origins in terms of religious belief? Does our knowledge of scientific evolution affect the semantics of Christian faith? It would be a mistake to require a belief in God to provide a scientific explanation of origins of the universe and of evolution. In fact, to need God would be a very denial of God. God is not the response to a need. One gets the impression from certain religious believers that they fondly hope for the durability of certain gaps in our scientific knowledge of evolution, so that they can fill them with God. This is the exact opposite of what human intelligence is all about. We should be seeking for the fullness of God in creation. We should not need God; we should accept her/him when she/he comes to us.

The religious believer is tempted by science to make God “explanation.” We bring God in to try to explain things that we cannot otherwise explain. How did the universe begin? How did we come to be? We seize upon God, especially if we do not feel that we have a good and reasonable scientific answer to such questions. She/he is brought in as the Great God of the Gaps. True belief

in God does not come about by proving God's existence through anything like a scientific process. God of religious faith is not found as the conclusion of a rational process alone. God gave herself/himself to us. But it does make sense that there is a personal God who deals with us and loves us. Faith consists in coming to love God because we have accepted the fact that she/he first made the move towards us. The claim that all things are created is a religious claim that all that exists depends for its existence on God. It says nothing scientifically of how things came to be, although beautiful stories are told in the Book of Genesis, to elaborate on the dependence of all things for their existence upon God.

It is unfortunate that creationism has come to mean some fundamentalist, literal, scientific interpretation of Genesis. Judea-Christian faith is radically creationist, but in a totally different sense. It is rooted in a belief that everything depends upon God, or better, all is a gift from God. The universe is not God and it cannot exist independently of God. Neither pantheism nor naturalism is true.

But if we confront what we know of origins scientifically with religious faith in God the Creator, in the senses described above, what results? The detailed scientific understanding of origins has no bearing whatsoever on whether God exists or not. It has a great deal to do with one's knowledge of God, should one happen to believe that she/he exists. Our scientific knowledge of evolution should definitely have a bearing on the semantics of Christian faith.

Take two rather extreme scientific views of origins: that of Stephen Jay Gould (Gould, 2002) of an episodic, totally contingent and, therefore, non-repeatable evolutionary process as contrasted to a convergent evolutionary process such as that of Christian de Duve (De Duve, 1995), in which the interplay of chance, necessity and opportunity leads inevitably to life and intelligence. In either case, it is scientifically tenable to maintain an autonomy and self-sufficiency of the natural processes in a natural world, so that recourse to God to explain the origins of all that exists, is not required. It is not a question of chance in nature, excludes God; destiny in nature requires God. In neither case is God required.

If, however, one believes in God then what nature tells us about God in one case is very different from what nature tells us about God in the other. Please note that we must not call upon faith to adjudicate between contrasting scientific viewpoints. It does appear, however, that convergent evolution is more consistent with God's revelation of himself in the Book of Scripture, so that, as Galileo was fond of stating, the Book of Scripture and the Book of Nature speak of the same God.

If we take the results of modern science seriously, it is difficult to believe that God is omnipotent and omniscient in the sense of the scholastic philosophers. Science tells us of a God who must be very different from God as seen

by the medieval philosophers and theologians. Could, for instance, God after a billion years in a fourteen billion year old universe have predicted that human life would come to be? Let us suppose that God knew all of the laws of biology, chemistry and physics, knew all of the fundamental forces. Even then could God know with certainty that human life would come to be? If we truly accept the scientific view that, in addition to necessary processes and the immense opportunities offered by the fertile universe, there are also chance processes, then it would appear that not even God could know the outcome with certainty. God cannot know what is not knowable. The theologian, of course, would have a different answer. God is transcendent, outside of space and time. All events are simultaneous to her/him. But if we stress God's immanence in a universe where our scientific knowledge of the origins of life is to be confronted, then that knowledge must have a bearing upon the semantics of our Christian faith.

This stress on God's immanence is not to place a limitation upon God. Far from it. It reveals a God who made a universe that has within it a dynamic sequence of natural events which led to us. It thus participates in the very creativity of God. Such a view of creation can be found in early Christian writings, especially in those of St. Augustine in his comments on Genesis (Augustine, 1982). If they respect the results of modern science, religious believers must move away from the notion of a dictator God, a Newtonian God who made the universe as a watch that ticks along regularly. In the semantics of religious faith God should perhaps be seen more as a parent or as one who speaks encouraging and sustaining words. Scripture is very rich in these thoughts. It presents, indeed anthropomorphically, a God who gets angry, who disciplines, a God who nurtures the universe. Theologians already possess the concept of God's continuous creation. To integrate the results of modern science with this notion of continuous creation would be a very enriching experience for theologians and religious believers. God is working with the universe. The universe has a certain vitality of its own like a child does. It has the ability to respond to words of endearment and encouragement. One disciplines a child but one tries to preserve and enrich the individual character of the child and its own passion for life. A parent must allow the child to grow into adulthood, to come to make its own choices, to go on its own way in life. Words which give life are richer than mere commands or information. In such wise does God deal with the universe.

These are very weak images, but how else do we talk about God. We can only come to know God by analogy. The universe as we know it today through science is one way to derive analogical knowledge of God. For those who accept that modern science does say something to us about God, there is a challenge, an enriching challenge, to traditional beliefs about God. God in his infinite freedom

continuously creates a world which reflects that freedom at all levels of the evolutionary process to greater and greater complexity. God lets the world be what it will be in its continuous evolution. He does not intervene, but rather allows, participates, loves. Is such thinking adequate to preserve the special character attributed by religious thought to the emergence not only of life but also of spirit, while avoiding a crude creationism? Only a protracted dialogue will tell.

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