

# THE EVOLUTION OF INTELLIGENT LIFE ON THE EARTH AND POSSIBLY ELSEWHERE: REFLECTIONS FROM A RELIGIOUS TRADITION

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History records many instances in which scientific thought has influenced religious thought and vice versa. Newton required God so that his infinite, static universe would not collapse. He also would not accept that there was an active principle in the attractive force of gravity, because that would detract from God's omnipotence. Leibniz, on the other hand, made his monads active because it would be unbecoming of God to have to step in and keep things going in the universe.<sup>i</sup>

In fact, it has been proposed<sup>ii</sup> that religious thought in the 16th and 17th centuries, at the very time when modern science was being born, was deceived by trying to establish its own rational foundations with the same rigor that characterized the sciences. Has our current scientific world view been so influenced by religious thought that, as Smolin (chapter ) has suggested, there may be hidden influences from which we must be liberated in order to advance beyond Newton and Einstein to the unification of relativity and cosmology with quantum theory? I doubt that such is the case but, since the influences are suspected to be hidden, there is little we can do about it until they are uncovered.

There is, however, one overriding detrimental influence which science has had upon religious thought and which in turn infects scientific thinking, namely, the assumption that God is Explanation, that God is needed to explain what we cannot otherwise explain. In recent times there has been a growing body of literature in which the religious implications of cosmology have been discussed. This has even led to the coining of a phrase, "to know the mind of God", as the ultimate attainment of scientific cosmology.<sup>iii</sup> Scientific discussions of the evolution of intelligent life are particularly prone to exerting this influence on religious thought. The evolution of intelligent life at least once here on earth and possibly elsewhere, considered within the context of expanding universe cosmologies, is today one of the most poignant topics upon which scientific and religious thought interpenetrate. The extra-terrestrial intelligence debate is a salient example of the temptation to religious thought offered by the rigorous rationality of the scientific method and of the failure, in turn, of science to realize that the God of religious faith is not in the first place an explanation of as yet unanswered human queries.

## *Intelligent Life: The Scientific Issues*

Let us gather together, as a source for later reflection, those scientific ideas about the evolution of intelligent life which are most subject to religious implications.<sup>iv</sup> Scientists are still groping for a clear understanding of how life began. Dawkins,<sup>v</sup> for instance, proposes the need for a chance event which initiated the cumulative selection process which led to intelligence. De Duve<sup>vi</sup> (chapter ) argues that life is essentially chemistry and that, given enough opportunity for chemistry to work, it will inevitably lead to something like the human brain. Since astrophysics has found that the primordial chemistry required is abundant in the universe,<sup>vii</sup> so must intelligent life be abundant. While the human brain is the most complex organism we know, all of life is one since it is based in ever more complex systems upon the same genetic code.

Astrophysicists have noted that the universe is fine tuned towards life.<sup>viii</sup> Leslie discusses this explicitly (chapter ). Life is thought to have emerged about three billion years ago in its first microscopic forms. This was about twelve billion years after the Big Bang and about seven billion years after the formation of the first stars. Why did it take so long for life to emerge? In order to provide the chemical abundances required for life it is estimated that three generations of stars were required. It is only through nucleosynthesis in stellar interiors that the heavier elements can be created and at the death of a star this material is regurgitated to form the matrix for a new generation of stars. The lifetime of a star depends upon its total mass and can vary from several millions of years for a very massive star to tens of billions of years for lower mass stars. At any rate it took about ten billion years of stellar evolution to produce carbon, nitrogen, oxygen, etc. The universe had to evolve to be big and old before it could contain us. Considering the fine tuning of the constants of nature and of physical laws that was required for life to emerge, we might ask how did it emerge at all. Life would have been impossible should anyone of several physical quantities had a different value.

It is important to note that, as best we know, the value of each of the constants of nature is empirically determined. They are, in a manner of speaking, determined in the laboratory. There is no overriding physical theory that requires that they have precisely the value they have. And if any one of them had been slightly different, life could not have come to be. A tentative explanation of this fine-tuning towards life is reviewed by Rees (chapter ) with his discussion of a "multiverse", an ensemble of many universes. An explanation is given of the fine tuning in our universe as an accident which happened (even had to happen statistically speaking) in one of the many universes of the multiverse.

As to the presence of inhabitable planets elsewhere in the universe, our scientific knowledge is very limited.<sup>ix</sup> Planets, and even planetary systems, have been discovered in recent years about nearby stars but, due to detection limits, no planet like the earth about a star like the sun has been detected. Protoplanetary disks, in which there is indirect evidence, that planets are forming, have been observed with the Hubble Space Telescope.

Our knowledge of star formation and of the subsequent formation of planets is rather well established.<sup>x</sup> A large interstellar cloud, typically containing  $10^3$  masses of the sun, fragments due to an interplay of kinetic, gravitational and magnetic energy. Each fragment that is sufficiently compact and stable begins to collapse by self-gravity and, like any normal gas, as it collapses it heats up. If it is sufficiently massive (more than about 0.1 the mass of the sun), it will raise the temperature in its interior sufficiently high, so that thermonuclear burning begins. At this point a star is born. For a star with a mass equal to that of the sun this process takes about  $10^7$  years. For more massive stars it is shorter, for less massive stars longer. The sun will keep shining as it does today for about  $10^{10}$  years and then it will explode and become a white dwarf. Note, therefore, that a star like the sun is born relatively (relating "gestation" to "lifetime") fast, about ten times faster than the birth of a human being!

About the new born solar-like star we also have a rotating disk of hydrogen gas and dust. Planets form within this disk. As the disk continues to rotate the material in it begins to separate out into rings according to the mass distribution. Within each ring conglomerates begin to form due to elastic collisions, gravity and electrostatic binding. Eventually larger conglomerates, called planetesimals, of the order of 100 kms in extent are formed and then from these the planets are formed. Thus, for a star like the sun we have after about  $10^9$  years a stable star with a planetary system about it.

Since there are about  $10^{11}$  stars in the Galaxy and  $10^{11}$  galaxies in the universe, there are  $10^{22}$  stars in the universe. From our knowledge of the distribution of stars by mass in the Galaxy, we can estimate that about 30% of stars are solar-like. We know that about 30% of stars are double or multiple, a fact which may, for dynamical reasons, exclude the formation of planets. It would be difficult to estimate the percentage of solar-like stars that would have developed a planetary system, but from our knowledge of the formation of the solar system we know that the probability is neither zero nor one hundred percent. Let us say it is 10%. How many of these planets would be like the Earth: its mass, distance from the Sun, an

atmosphere, etc. This may be even more uncertain, but, again, from geological knowledge of the formation of the atmosphere, we know that there is a finite probability. Let us say it is 2%. Now, if we put all of these considerations together we have, from these statistical considerations,  $10^{17}$  Earth-like planets in the universe.

It is important to note the nature of this conclusion. It is based upon scientific facts combined with reasonable estimates which are themselves based upon scientific facts. Unless our scientific thinking is drastically wrong, this conclusion is acceptable and merits our further considerations about what it implies. I take it to mean at a minimum that the macroscopic physical conditions for life (an earth-like planet in a "habitable zone" about a solar-like star) exist elsewhere in the universe.

### *First Reflections*

If we consider both how little we know of the origins of life and how much we know of the fine tuning of the physical universe and the intricate interplay in the world of chemistry of deterministic and chance processes in a universe prolific with the opportunities for ever more complex chemistry, then life is truly a scientific marvel. It is awesome. If life has occurred only once in the universe, it is still marvelous. In fact, the verification of a second independent genesis of intelligent life elsewhere would add little to this marvel. It would, however, surely provide suasive evidence that, in whatever way it originated, it is most likely not a rare and unusual event in our universe.

An alternative to invoking a multiverse to explain the anthropic principle would, of course, be to invoke God who fine tuned the universe with an intention that there be life. In addition to the fact that from the scientific point of view this is a purely arbitrary answer, from a religious point of view it provides an arbitrary God. God would be somewhat like a master cook whose pinches of salt, sugar, paprika and other ingredients are just right so as to produce the pudding, intelligent beings. It appears to me that this inevitable inclination to a certain arbitrariness in the religious concept of God-Creator could be removed only if the appropriate cosmological model had built into it all that was necessary to explain scientifically the actual combination of physical laws and constants of nature that we observe. God would, in such a model, not be needed to select the ingredients. Quantum gravity models which exclude initial boundary conditions are an attempt in this direction but they have not succeeded in explaining the fine tuning. The religious thinker might, of course, be tempted to see such models as a threat to the very existence of God, or at least as the establishment of a solipsistic God, completely divorced from the universe. This would only be the case if one seeks to find God exclusively, or even

primarily, through science or seeks to understand the universe through religious thought alone. I will discuss this confusion of science and religion shortly.

Multiverse theories would appear to be more compatible with the religious concept of God. God would have seen his image and likeness emerge in one or many of the ensemble of universes and he would have marvelled, loved, and taken special care of it as he told us he did in his self-revelation in Scripture and Tradition. Let us explore this self-revelation.

### *A Religious Tradition: God is Love*

The fundamental problem with all of attempts to use the rational processes of science to either assert or deny the existence of God or to limit his action is that they primarily view God as Explanation. We know from Scripture and from tradition that God revealed himself as one who pours out himself in love and not as one who explains things. God is primarily LOVE. Let us review the history of the tradition which leads to this assertion.

At the very beginning of human reflection on the universe there dominated a primitive view which saw the universe as full of personal forces, the gods and superpowers of nature. We should, however, be careful not to attribute an exclusively negative character to the attribute, "primitive". Such "primitive" notions are typically very pregnant with meaning and, when purified of what is patently false, frequently serve into the future to achieve an integrated and unified view of our place in the universe.

With the civilizations that flourished around the Ionian Sea for more than a half century there was a growing consensus that, rather than innumerable personal forces acting somewhat capriciously in the universe, the universe had an intrinsic rational structure, that all parts of it were inter-related to form a complex totality to whose rational structure human intelligence was attuned. But how precisely did this tuning come about?

Copernicus and those who followed within the century after him made a significant contribution to answering this very important question, a question which has a great deal to do with how we view ourselves as part of this complex universe. Relying on the intellectual traditions of Archimedes and Aristotle, Copernicus claimed that, through careful observations and mathematical analysis, we could come to understand how the universe really worked, how its parts were really related to the whole. It was not enough to have mere hypothetical constructs as an expedient to

understand the appearances. Furthermore, no single view of how the universe really works could dominate forever by the sheer force of having prevailed for a very long time. If Copernicus was correct, Aristotle's physics was wrong, even though it had reigned for two thousand years.

At the crucial moment when mathematics and physics were maturing to the point of becoming the essential ingredients of the sciences, we note an increasing tension, concretized in the persons of Descartes and Newton but already noted many times before, between what we might in simple terms describe as the downward and upward movements in our knowledge of the universe and ourselves in it. Do we come to a true understanding by starting, like Plato and Descartes, with clear and certain ideas, an eternal, preexisting, immutable, rational structure of all that exists? And do we then seek to find the revelation of this world of ideas in the adulterated concreteness of the visible universe to which we are consigned to wander in search of who we are in this seemingly complex and complicated agglomeration of concrete particular beings? Or is there a rational structure imbedded in the universe which we see and touch and breath? Were the apple on Newton's head and his knowledge of Galileo's observations of Jupiter's satellites necessary for him to have come to the discovery of the universal law of gravity? There appears to be no definitive answer to this question and, perhaps, the very posing of the question is somewhat inaccurate and tendentious. And yet we sense a kind of unavoidable impulse to ask it, because we feel within ourselves this same tension between ideas and lived experiences. We seek to unify and bring meaning to all that we experience in the universe. And this tension seems to be present in all of our experiences, especially in those which we call religious.

In parallel with these diverse ways of thinking, religious experiences were becoming more structured and institutionalized, evolving into what are today the world's major religions. These identifiable religious institutions, such as Islam, Buddhism, Judaism, Christianity, differ among themselves as to the relative emphasis they place on the two sides of the tension described above, between the "downward" and the "upward". All of the world's major religions are revealed, i.e., they lay claim to have received from elsewhere the content of their beliefs. The Judaeo-Christian religious tradition emphasizes from its very beginnings the workings of God in human history. God speaks in human beings chosen by him, the patriarchs and the prophets, and he also speaks in a burning bush, in water from a rock and eventually in his own Son, who, having abided eternally with the Father, at a certain moment in human history becomes man. This is the assertion of religious faith.

A study of the Old Testament<sup>xi</sup> shows that the first reflection of the Jewish people

was that the universe was the source of their praise of the Lord who had freed them from bondage and had chosen them as his people. The Book of Psalms, written for the most part well before the Book of Genesis, bears witness to this: "The mountains and valleys skip with joy to praise the Lord"; "The heavens reveal the glory of the Lord and the firmament proclaims his handiwork". But if these creatures of the universe were to praise the Lord, they must be good and beautiful. Upon reflecting on their goodness and beauty, God's chosen people came to realize that these creatures must come from God. And so the stories in Genesis in which at the end of each day God declares that what he had created is good (beautiful). The stories of Genesis are, therefore, more about God than they are about the universe and its beginning.

They are not, in the first place, speaking of the origins of the created world. They are speaking of the beauty of the created world and the source of that beauty, God. The universe sings God's praises because it is beautiful; it is beautiful because God made it. In these simple affirmations some have traced the roots of modern science in the west.<sup>xii</sup> The beauty of the universe invites us to know more about it and this search for knowledge discovers a rationality innate in the universe.

There are two implicit assertions in the Book of Genesis which set the faith of these people apart from their predecessors, the Canaanites, upon whose stories they rely. First, God is one and there is no other god; there is no struggle between God and some equal, even malevolent force. Secondly, everything else is not God, but depends for its beauty upon him. He made everything and declared it beautiful. It is very important to note that created things are first of all beautiful because God says that they are; it is only upon reflection in a second moment that they are seen as understandable, as having a rational structure.

Early Christian reflection upon these lived, historical events, especially those recorded in St. John's Gospel, sees in them the insertion of God's plan, thought, word (St. John uses the word "logos", inherited from the Greeks) into our universe.<sup>xiii</sup> "The Word of God became flesh". This revelation, which the Judaeo-Christian tradition believes is spoken by God through his chosen spokespersons, has enormous consequences for assuaging the tension between the "downward" and "upward" we have described in our scientific knowledge of the universe. There are surely similarities in the tension present in both the religious and scientific experiences. The Judaeo-Christian experience affirms emphatically the enfleshment of the divine and, since God is the source of the meaning of all things, that meaning too becomes incarnate.

As noted above, some see in this religious belief the foundations of modern science. A rigorous attempt to observe the universe in a systematic way and to analyze those observations by rational processes, principally using mathematics, will be rewarded with understanding because the rational structure is there in the universe to be discovered by human ingenuity. Since God has come among us in his Son, we can discover the meaning of the universe, at least it is worth the struggle to do so, by living intelligently in the universe. Religious experience thus provides the inspiration for scientific investigation.

What are we to make of these assertions? Have we succumbed to a too facile assimilation of religious and scientific experiences? Or, on the other hand, is there truly at the origins of modern science the religious inspiration that God and his plan for the universe are incarnate? At a minimum, these two experiences are not incompatible; and the history of religions and of the origins of modern science certainly appear to support the connection we have presented.

This, however, makes ever more poignant the temptation which we have already addressed, namely, that religious belief be led astray to seek the same rational certitudes that we strive to obtain in the natural sciences. While religious belief may have played a key role in the inspiration of modern science, we now know that religious experience cannot be limited to that which science can discover. To use the concepts coined by Galileo, both the Book of Nature and the Book of Sacred Scripture can be sources of coming to know God's love incarnate in the universe. We might extend the Book of Scripture to include all that is contained in the lived experience of the believing community. But knowing God's love through rational means is not sufficient; his love must be experienced. Such experience of God exceeds the content of the Book of Nature, just as any author is much more than what he/she can put into a book. Such experience also exceeds the Book of Scripture, taken even in the broader sense, if we approach the Book of Scripture only as an exercise in reason. We know that there are many ways whereby we come to know the universe and ourselves as part of it. To seize upon one experience to the exclusion of others or to confuse them by failing to realize their diversity is a betrayal of all experience. While religious experience in the Judaeo-Christian tradition may have inspired the birth of the rational process peculiar to the natural sciences, it is mistaken to assume that rational processes exhaust the primordial experience of God, the source of both the Book of Nature and the Book of Scripture.

This brings us back to questions about intelligent life in the universe. Whether life is unique to the Earth in all the universe is insignificant to the following questions. Had we been given the initial physical parameters in an expanding universe at some time



near the Big Bang (a few Planck times) could we have predicted that life would come to be? I assume that the honest quest for a unified theory means that we could have predicted the emergence and the exact nature and strength of the four fundamental forces and such fundamental physics as that. But is life the result of so many bifurcations in non-linear thermodynamics that we could not have predicted, even if we possessed the Theory of Everything and knew all the laws of microscopic and macroscopic physics, that it would come to be? I am asking questions somewhat different than those raised by the anthropic principle, whether taken in the weak or strong sense. The questions there have to do with interpreting and/or explaining the fine tuning of all of the physical constants and conditions required for the emergence of life. I am asking whether, given antecedently all of the physical constants and conditions necessary for life from our *a posteriori* knowledge of it, could we have predicted that it would have come to be? Did life happen to be or, given the conditions for it, did it have to be?

As we have noted, it is not unusual for cosmologists to speak of the "mind of God". In most cases, it appears, this is taken to mean that ideal Platonic mathematical structure from which the shadow world we live in came to be. Should we be able to fathom "the mind of God", develop, that is, a unified theory and thus an understanding of all physical laws and the initial conditions under which they work, would we also fundamentally understand life? As I understand it there is no intentionality associated with the "mind of God" of the new physics. Can life be understood without that intentionality?

In our age, perhaps more than at any other time, the scientific view of the world has been the principal spur to a more unified view of the world. It has opened our minds to the vast richness of the universe which cannot be appropriated by any one discipline alone. Science invites us to that vision. It also cautions us not to absolutize scientific results. We must beware of a serious temptation of the cosmologists. Within their culture God is essentially, if not exclusively, seen as an explanation and not as a person. God is the ideal mathematical structure, the theory of everything. God is Mind. It must remain a firm tenet of the reflecting religious person that God is more than that and that God's revelation of himself in time is more than a communication of information. Even if we discover the "Mind of God" we will not have necessarily found God. The very nature of our emergence in an evolving universe and our inability to comprehend it, even with all that we know from cosmology, may be an indication that in the universe God may be communicating much more than information to us. Through the limitations of science we might come to see the universe as a unique revelation of God, that He is Love.

On the other hand, the principal difficulty with revealed religions is not so much that they go beyond what human reason alone can attain, but that they are by necessity anthropocentric. God's revelation is to us; it could not be otherwise. The possibility of extra-terrestrial intelligence strains these anthropocentric revelations of God to his people. The history of theology has shown, however, that anthropocentrism does not necessarily imply exclusivity. The anthropocentric revelation of Christianity is resilient. An example of such resilience is given by McMullin's (chapter ) discussion of Augustine's notion of *rationes seminales* to explain the origin of the vast array of material beings.

From the scientific evidence, presented in summary above, the existence of extra-terrestrial intelligence must be taken as a serious possibility with all of its consequences. Let us look at some of those consequences for Christian theology. At the very beginning human beings did something bad. They revolted against the God who had made them. Theologians call this "original sin". Even if we do not accept the Scripture story of Adam and Eve as historically true, "original sin" is an essential element in the theologians' view of the relationship of humans to God. Did our extra-terrestrials sin in this way? God freely chose to redeem human beings from their sin. Did he do this also for extra-terrestrials? Now we are getting ever more hypothetical, since we are determining what God, who is absolutely free, would freely choose to do. In fact, there are serious theological implications here for our understanding of God. If God is good and passionate, the answer is "yes, God did save them". How could he be God and leave extra-terrestrials in their sin? After all he was good to us. Why should he not be good to them? God chose a very specific way to redeem human beings. He sent his only Son, Jesus, to them and Jesus gave up his life so that human beings would be saved from their sin. Did God do this for extra-terrestrials? Or did he choose another way to redeem extra-terrestrials? The theological implications about God are getting ever more serious. Surely God is completely free to choose his methods. He certainly did not have to send his Son to us. But once he chose to do so, did he have to choose to redeem extra-terrestrials in the same way. There is deeply embedded in Christian theology, throughout the Old and New Testament but especially in St. Paul and in St. John the Evangelist, the notion of the universality of God's redemption and even the notion that all of creation, even the inanimate, participates in some way in his redemption.

After this whole sequence of hypotheses, increasingly more difficult to make, theologians must accept a serious responsibility to rethink some fundamental realities within the context of religious belief. What is the human being? Could Jesus Christ, fully a human being, exist on more than one planet at more than one time?

We are obviously very limited today in our ability to answer such questions. We cannot rely, even theologically, solely upon God's revelation to us in the Scriptures and in the Churches, since that revelation was TO US and was received, therefore, in a very anthropocentric sense. But God has also spoken in the Book of Nature. While we may not need him, in fact should not need him, as a source of rational explanation, we can learn much about the manner in which he loves and, indeed, much about ourselves, from the best of science, both the life sciences and the physical sciences.

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