Extraterrestrial life

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1. The Question of Extraterrestrial Life: An Interdisciplinary Approach

The observation of the starry sky has always provoked many questions. Perhaps one of the most common concerns the possibility of the existence of life on other planets similar to our own. From a historical perspective, however, the question about life in the cosmos appears to arise within a context different from that of the great questions regarding its origin and all that characterizes the "cosmological problem." If it is true that the ancient theogonies predisposed human beings to imagine the presence of anthropomorphic divinities in regions other than the Earth, the issue of a plurality of worlds and whether they are habitable acquires force only when new speculative visions and discoveries radically change mankind's understanding of his place in the universe. Generally speaking, this theme was not central to philosophical thought, but its development in the natural sciences and, more recently, in space technology has influenced various cultural sectors (literature, customs, and cinema) besides having a significant impact on religious and theological spheres. The hypothesis that life exists on worlds other than our own is found in human culture [2] from the Ancient Age until our day. There is no doubt that to find forms of life on other planets and, above all, to communicate with extraterrestrial intelligence would represent one of the most extraordinary experiences in all of human history.

1. A Brief Glance at History. The historical debate about a possible plurality of inhabited worlds has been

widely documented (cf. Crowe, 1988; Dick, 1982 and 1996; review articles by Crowe, 1997, and Dick, 1993). In the Ancient Age the atomists were probably the first to hypothesize the existence of extraterrestrial life. Their mechanistic philosophy assigned to the infinite number of atoms in the cosmos the capacity to give rise to an infinite number of bodies in a multitude of possible combinations, hence also beyond the Earth. Epicurus (341-270 B.C.), and then more importantly Lucretius (99-55 B.C.), affirmed a kind of "Principle of Plenitude," according to which all the potentialities of matter [3] were destined to be realized sooner or later, in this way giving rise to a world the perfection of which would be proportional to the richness of the existence it contained. The question regarding possible inhabitants of the moon —a question intuitive and spontaneous given the proximity and the large apparent size of our satellite —appears in the works of various classical authors, including Plutarch (45-125). Within his *De facie quae in orbe lunae apparet*, a small treatise of philosophical cosmology on the difference between the properties of the Earth and the moon, the Greek writer presents a debate about the origin of the shadowy spots apparent on the lunar surface. Philosophical thought descending from Aristotle (384-322 B.C.) will find greater difficulty in speculating about the presence of inhabitants of other worlds as the heavenly sphere progressively becomes marked by the characteristics of eternity, immutability, and incorruptibility. That sphere is radically distinct from our terrestrial environment (the so called "sub-lunar" world), to which belongs instead change and contingency. The lunar sphere, in which some mutations were also observed, will thus remain halfway between the two.

In the Middle Ages, Christianity was not opposed to the idea that God could have created other worlds, even ones more perfect than our own, but the theme did not directly concern the possibility of their being inhabited. In the cosmology of *De docta ignorantia*, Nicholas of Cusa (1401-1464) alludes to possible inhabitants of other worlds (which he naïvely placed on the stars). He also tried to systematize from a philosophical point of view the relations such worlds would have with the Earth and its perfections, as well as that between the nature of their inhabitants and our intellectual nature. In a reflection shared by many of our contemporaries, the Cardinal-philosopher concluded that we simply cannot know anything about such comparisons: "The inhabitants of other stars, wherever they are, do not have any proportion with the inhabitants of our world, also if their whole region is in a concealed proportion with our own, for the finality of the universe [...]. But, since this region remains unknown to us, also its inhabitants remain completely unknown to us." (Book. II, ch. 12). Giordano Bruno (1548-1600), the renaissance interpreter of the "Principle of Plenitude," hypothesized the presence of life diffused throughout the whole universe, not only in the form of inhabited stars and planets, but also as a vital principle able to provide a soul to the stars, planets, comets, and indeed to the whole universe. Galileo (1564-1642) and Kepler (1571-1630) never addressed the theme directly, but understood that the heliocentric system placed the Earth in a condition of greater similarity with other solar planets. As had Plutarch and not without irony, both of them asked themselves whether the visible and regular spots on the surface of the moon could have been the work of intelligent inhabitants (cf. C. Sinigaglia, *Lo "scherzo" di Plutarco e il "sogno" di Keplero*, in Colombo et al., 1999, pp. 155-168).

By the middle of the 17th century, thanks to the use of the optical telescope as a scientific instrument for astronomical observation, an immense number of stars invisible to the naked eye were now revealed, and thus interest in the theme of life in the universe experienced a rebirth. The rapid diffusion of works in favor of a plurality of inhabited worlds stands as proof. For example, the work of Bernard le Bovier de Fontenelle (1657-1757), *Entretiens sur la pluralité des mondes* (1686), appeared in dozens of editions and translations, and the posthumous work of Christian Huygens (1629-1695), *Kosmotheoros, sive de terris coelestibus earumque ornatu conjecturae* (1698), was quickly translated into five languages.

The progressive widening of horizons caused by the scientific observation of the cosmos stimulated astronomers to publish works concerning the possibility of forms of life beyond the confines of the Earth.

Initially William Herschel (1738-1822), well-known for his studies on the spatial distribution of stars aimed at drawing the overall structure of our Milky Way, then Richard Proctor (*Other Worlds Than Ours: The Plurality of Worlds Studied under the Light of Recent Scientific Researches*, 1871), and above all Camille Flammarion (*La pluralité des mondes habités*, 1862), contributed to the debate within the scientific world throughout the 19th Century. The work of the French astronomer experienced an extraordinary diffusion, with over 30 editions in fewer than twenty years and in print without interruption until 1921. It was again an astronomer, the Italian Giovanni Schiaparelli (1835-1910), who provoked interest in the possibility of intelligent life on the planet Mars with his famous observations of "channels" on the red planet's surface, regular structures to which attention had earlier been drawn by Angelo Secchi (1818-1878), a Jesuit astronomer. The writings of Schiaparelli on the planet Mars, (re-edited in Italian with the title *La vita sul pianeta Marte: tre scritti su Marte e i marziani*, Milano, 1998), together with those of Proctor and Flammarion, brought about a cultural phenomenon that ended up generically identifying inhabitants of other worlds with the term "Martian." The position of a non-astronomer, Alfred R. Wallace (1823-1913), a naturalist and an original supporter with Darwin of the theory of evolution [4] by natural selection, must also be recalled as part of the debate between the 19th and 20th centuries. In his work, *Man's Place in the Universe: A Study of the Results of Scientific Research in Relation to the Unity or Plurality of Worlds* (1903). Wallace prepared a vigorous defense of an anthropocentric universe, in open disagreement with the pluralist position. This essay, which enjoyed wide diffusion due to the scientific environment where it originated, provided a number of arguments in defense of the uniqueness of human life within the cosmos.

From the middle of the 20th century, the progress of radio-astronomy and the initiation of space research, together with physical images of a universe of unsuspected dimensions of space and time, offered a vision of man's place in the cosmos that logically raised the question of the possibility of extraterrestrial intelligence. Works by scientists such as H. Shapley, *Of Stars and Men* (Boston, 1958), and of Shklovskii and Sagan, *Intelligent Life in the Universe* (San Francisco, 1966), exercised great influence, for example, the texts of General interest in the theme, however, has been sustained above all through other phenomena, such as science-fiction literature and the cinema [5].

In the more narrowly scientific realm, the 19th century's enthusiasm for a possible "close encounter" with other inhabitants of the solar system has been replaced by the methodical research for elementary life forms or pre-biotic material in environments similar to our solar system, not to mention the initiation of long-term programs in radio-astronomic exploration of more remote environments (see below, II, nn. 2 and 3). At the same time, the opportunity was not lost to send "messages in a bottle," such as the plate with an image of a human couple and some coded scientific data placed on the automatic probes *Pioneer* 10 and 11 (launched in 1971), the first to venture outside the solar system; digitalized images and sounds of planet Earth on the similar *Voyager* probes (1977); and a radio transmission in binary code sent towards the galactic globular cluster M13 by the Arecibo radiotelescope (1974).

2. Interdisciplinary Aspects of the Debate. The theme of cosmic life is brought to today's culture by science, not philosophy. It reaches the public mostly through the mass media, literature of different genres, and certain other artistic expressions. It suffices to think of the science-fiction novels of H.G. Wells, author of *War of the Worlds* (1898), which continue to inspire, even after a century, films like *Star Wars* (from 1977 onward) by George Lucas. Consider also the diffusion of novels by Isaac Asimov, some of which have also been reproduced on the screen. Other forms of inspiration also exist, like the novels of C.S. Lewis in his *Ransom's Space Trilogy* (1938-1945), also known as *Perelandra*, where the visit to worlds other than our own involves the themes of virtue and sin, of liberty and redemption, of the diversity of creatures and their dependency on a common Creator. The great question regarding the significance of human life in the universe and its relationship with transcendence is one of the central

themes of *2001: A Space Odyssey* (1968), written by Arthur C. Clarke and directed by Stanley Kubrick.

The peculiarity of the subject of life beyond the Earth's confines entails an inevitable meeting point in which the great themes of anthropology, philosophy and religion are expressed sometimes unconsciously, sometimes more explicitly. The implications of possible contact with other intelligent forms of life can easily be grasped. It is certainly expected that after communicating with other intelligent forms of life one would desire to check our knowledge of the laws that govern the physical universe (some of which could be unknown to us), get some information regarding the cosmic context of the human species, gain insight on the origin and diffusion of life, including the possibility of its survival in a technological era. However, "the man on the street" (and likely all of us) would certainly ask civilizations different from our own about the meaning of conscious free life and the knowledge they have of a possible Creator. Humans would ask *the others* about the existence of God [6].

The humanistic and religious significance of the theme is easily noticed when observing that in many works of literature, art, and cinema, the "cosmic space" context (or the "heavenly" context, if you prefer) provides implicit references to the great everlasting questions, such as the mythical fight between light and dark, the choice between good and evil, human inquiry about life after death and the way to reach or merit it. Extraterrestrial life contexts re-propose the intervention of mediators from faraway worlds, the delivery of moral messages that awaken in human beings the existential questions that ordinary terrestrial life has made dormant. Moreover, it is frequent that the contact with civilizations different from our own is there represented as a powerful conceptual place in which the human family returns to wisdom and self-understanding. On the other hand, as shown by some movies, it also happens that humankind rediscovers its unity of origin and its common aims when prompted by the search for defenses against possible cosmic perils or when urged by the necessity to achieve some efficacious and coordinated behavior on a planetary scale.

As Paul Davies has intelligently pointed out, an implicit religious dimension is concealed within research for extraterrestrial life. This dimension expresses itself in a precise literary fashion and aims to explore human spirituality in relationship to meeting "the other." To quote from the conclusions of his book, *Are We Alone?*: "The powerful theme of alien beings acting as a conduit to the Ultimate—whether it appears in fiction or as a seriously intended cosmological theory—touches a deep chord in the human psyche. The attraction seems to be that by contacting superior beings in the sky, humans will be given access to privileged knowledge, and that the resulting broadening of our horizons will in some sense bring us a step closer to God. The search for alien beings can thus be seen as part of a long-standing religious quest as well as a scientific project. This should not surprise us. Science began as an outgrowth of theology, and all scientists, whether atheists or theists, and whether or not they believe in the existence of alien beings, accept an essentially theological world view" (Davies, 1995, pp. 137-138).

The religious resonance just highlighted, of course, is not foreign to systematic theology. Christian theology would particularly be involved in light of its "register of uniqueness." This "register" seems to regulate the relationship between God and man, with its apex reached in the mystery of the Incarnation of the Son of God [7]. For theology, to widen the horizon and consider intelligent beings other than humankind could represent the last possible consequence of a kind of "extended Copernican Principle," that first deprived human beings of the geometric center of the known universe, then of the uniqueness of their biological history on the Earth, and finally of the centrality of their consciousness within the cosmic panorama. Although theology has not dedicated special reflection to this point, it possesses the resources to confront this issue thematically. The general idea shared by the public and the mass media, however, is that a "close encounter of the third kind" would drastically call into question some important principles of theological *establishment*. As outlined in another article of this Encyclopedia when speaking of the

relevance of the natural sciences for the work of theologians [8], if theology is not obliged to give an account for all that is merely possible, its discourse on God and human beings —once developed within a contemporary scientific context— nonetheless cannot ignore at least some of the questions that the presence of extraterrestrial life would provoke.

II. The Research on Extraterrestrial Life in the Scientific Context

The analysis of our theme within a scientific context must begin with an important clarification. The debate concerning the actuality of unidentified flying objects (UFO) and their possible extraterrestrial origin does not pertain to the object to which science intends to refer when speaking of extraterrestrial life (ETL) and extraterrestrial intelligence (ETI). That debate is outside the boundaries of the scientific and interdisciplinary perspective here assumed. Moreover, the impossibility of having public, scientifically-ascertained knowledge, of the data claimed by UFO's supporters prevents our being able to consider the subject with adequate rigor.

1. Life in the Framework of Cosmic Evolution. We do not know if life is a unique event within cosmic history, one which happened only on this remote planet of one of 10^{11} stars of our Milky Way, only one of the 10^{11} or 10^{12} galaxies that likely populate our universe; or, on the contrary, if it is a rather widespread phenomenon. We certainly know that its appearance requires an incredible series of delicate steps and conditions within space and time, the consideration of which cannot be avoided when we desire to evaluate the possible diffusion of life on a cosmic scale.

Neither are we able to comprehend whether the whole of these delicate conditions must be considered as a highly improbable event or as a sort of cosmic imperative, linked to the action of a process or of a law that inevitably guides the various steps of the history of the universe (cf. de Duve, 1995). In other words, we do not know if life is a universal and quasi-inevitable phenomena, reproducing itself everywhere that the conditions permit it to do so, as has been suggested by Christian de Duve or Manfred Eigen; or if life is equivalent to a mere probabilistic number, the result of chance at the roulette wheel of cosmic evolution and a phenomenon that does not have any significance, as laconically sanctioned by Jacques Monod and Steven Weinberg. But the philosophical perspective intuits that the richness of life's complex phenomenology, the teleology of its processes, and its absolute singularity in comparison to inorganic matter all tend to imbue the incidence and the possible significance of life with categories must go beyond a simplistic dichotomy between chance and necessity.

Abstracting from the physiochemical conditions related to the formation of environments adequate for life, which in turn depend on the numerical values of the constants of nature that regulate and determine the intrinsic structure of the universe —conditions that are usually discussed as related to the Anthropic principle [9] — I will briefly summarize here some of the main steps that must precede any possible appearance of life in the cosmos.

First of all, the elements necessary for life (e.g., oxygen, carbon, potassium) are present only after at least one or maybe two generations of massive giant stars. At the end of the thermodynamic and thermonuclear evolution of such stars, the products of their explosions as supernovae make available an adequate abundance of these elements in cosmic space. Within this environment enriched by heavy chemical elements —the universe begins its evolution composed almost essentially of the lightest element, hydrogen, with a small fraction of helium— other types of stars (main sequence dwarfs) such as our sun must then form, which are more stable and have a longer evolution. Only these stars have an average life long enough (at least several billion years) to give orbiting planets a dependable source of energy for a

time sufficient to permit the slow development from very simple to more complex forms of life.

Candidate planets to host a biosphere must then be of a mass sufficiently large to retain a gaseous atmosphere gravitationally, but also sufficiently small to grow cool in a reasonably short time. Planets with a mass such as those of Jupiter or Saturn, for example, have not yet concluded their cooling and therefore have not yet formed a solid surface, even though their birth was contemporary with the Earth's (around 4.6 billion years ago). In addition, the planet's distance from the central star must be optimal, so that the planet receives from its star a necessary but not excessive quantity of heat. Hence the star cannot belong to a binary or multi-stellar system (the incidence of which is statistically quite high), because these systems cannot guarantee sufficient stability for the planetary orbit.

Moreover, evolution [4] of life on a planet fit to host it also has its own growth times. Not to mention the time necessary for the formation of life's indispensable chemical compounds, such as water, numerous compounds of carbon and oxygen, and, as far as possible, those necessary to form a liveable atmosphere, it is also necessary to wait for the patient diffusion of the more simple life forms. With the products of their biochemical processes, simple life forms supply the biosphere with necessary substances for superior life forms, which are organically more complex. We know that the time elapsed on Earth from the formation of the first micro-organisms to the appearance of mammals was not less than three billion years. If we consider that the time separating the universe today from its earliest phases of very high density and temperature is certainly not less than 13 billion years, we must conclude that a cosmic time significantly less than this would very probably have been insufficient in any place of the cosmos to allow for the development of forms of life similar to those known today on Earth.

In 1961, Francis Drake attempted to formalize at least some of the preceding conditions in order to estimate what chance there might be to enter into communication (plausibly by radio) with other forms of intelligent life, at least within our galaxy. The use of what will later be called "Drake's equation" concerns the computation of a series of restrictive probabilities, which are multiplied with each other in order to estimate the number, N, of civilizations in the Milky Way Galaxy possibly able to communicate with us. In the formula proposed by Drake, $N = R^* fp\ ne\ fl\ fi\ fc\ L$, the value R^* indicates the rate of formation of the central stars with adequate energetic properties; *fp* the fraction of them that could have associated planets; *ne* the number of them with conditions similar to those of the Earth; and *fl*, *fi*, and *fc* the fractions that could develop, respectively, life, intelligent life, and intelligent life at a level of technological civilization. The last factor, *L*, regulates the "average life" of a technological civilization on a planet. The estimates for N are, as one might expect, very diverse. To Drake's original calculation that resulted in an approximate value for $N = 100{,}000$, other scientists oppose a value around $N=100$, but still other experts have very different opinions, according to some of whom there would be only one active and technologically developed civilization for every 300 galaxies, i.e., ours would be the only such civilization in the Milky Way and in the nearest 299 galaxies surrounding it (the more critical estimations are by Rood and Trefil, 1981).

As some authors have opportunely pointed out (cf. McMullin, 1980, pp. 83-84), the principal limit of this type of equation is the lack of a realistic model that satisfactorily describes the processes whose fractions of probability of occurrence are to be calculated. For example, to know the fraction of stars that could have planets similar to the Earth, we must have a precise model for planet formation from star clouds. This model should also have parameters describing the various characteristics of the formed planets, in order to select how many planets would be suitable. Unfortunately, however, we do not possess until today such a model. Things get even more complicated when we consider that we know very little of the "why" of the origins of life on a planet and even less with respect to intelligent life. Therefore we do not have a realistic model to evaluate whether or not this must happen a certain number of times or never at

all. The logic of a statistical theory (for example, the kinetic theory of gas) is to deduce an average behavior for a larger scale on the basis of one's knowledge of known smaller-scale processes (for example, the principles that regulate the motion of a particle). A statistical theory for the formation of planets with a biosphere, but above all a statistical theory for the formation of life, is not rigorously possible because we do not know the modality of these processes, that is, a complete and reliable theory to interpret them with a sufficient level of accuracy. Moreover, in nature we have a *unique known* event, namely us terrestrials, and we cannot securely distinguish what is necessary for our appearance from what might not be necessary. In short, we have insufficient information.

Inevitably, the scientific disciplines that tackle the theme of life in the universe try to use deduction as far as seems reasonable, attempting to link our inferences with what knowledge we have of the cosmos and its environments. At the same time, I believe that in a theme such as ours the attitude better methodically grounded will always be induction, together with the patience to wait and discover.

2. Scientific Projects on the Research of Life. Contemporary science confronts the theme of life in the cosmos in various thematic contexts. They include the research and the study of organic compounds and of biological structures possibly present in interstellar space or on the surface of heavenly bodies (comets, asteroids, satellites or planets) adequately hospitable to them; the research for at least some elementary form of life in particular places within our solar system; the detection and the study of planetary systems formed around other stars in a manner similar to our solar system; the theoretical and experimental reconstruction of the processes that might have given origin to life on Earth in order to better understand such mechanisms on a cosmic scale; and finally, the research for possible radio signals of intelligent origin by means of radio-telescopes partially or totally dedicated to the sounding-out of the sky in centimetric and decimetric wavelengths. All this activity has entered the panorama of scientific research as a new discipline called *exobiology*, *astrobiology*, or also *bioastronomy*. The status of knowledge in this area and the main research programs devoted to seek extraterrestrial life, are easily found in many published books and reviews, including Proceedings of International Conferences (cf. for instance Papagiannis, 1985; Shostak, 1995; Batalli Cosmovici et al., 1997; Grady, 2001; Goldsmith and Owen, 2002; Dick and Strick, 2004; Meech et al., 2007). Since 1982, the international scientific community has granted such research activity official status within its international bodies establishing the "Commission n. 51" of the *International Astronomical Union*. A good number of websites run by scientific Institutions, among which there is the official NASA website for astrobiology [10]also supply an ever wider public with updated information.

From a historical perspective, the first official entry within a strictly scientific environment of the theme of extraterrestrial life dates back to the second half of the 19th century, namely, the observation of the channels on Mars by Schiaparelli. Beginning in August, 1877, their possible intelligent origin was the object of dispute throughout the world for about thirty years. The mysterious images were then recognized to be natural structures thanks to the use of observational instruments with a high power of resolution. The "red" planet, on which Herschel had indicated two polar caps thought to be formed from frozen water (but which today we know to be formed from solid state anhydrous carbon), remained almost until today a potential candidate for the presence of some elementary life forms. Mars became the object for space missions immediately upon the birth of astronautics [11], first with the passing flight of a number of probes (*Mariner*, 1964-1971), then with soft landings on its surface (*Viking* in 1976), and finally with reconnaissance missions starting with self-propelled automatic probes (*Pathfinder* in 1997). Both the *Viking* probe and the *Pathfinder* mission conducted experiments to verify the existence of possible forms of life, reporting negative results. During the first decade of the third millennium more perfected space missions have been projected and carried out. Projects for Mars exploration include the European *Mars Express*, launched in 2003, and NASA's rovers Spirit and Opportunity, successfully

landed on January 2004, the orbiting probes *Mars Odyssey* and *Mars Reconnaissance Orbiter*, and the complex *Phoenix* mission, which landed on May 2008.

Water was almost certainly present on Mars in the past, and water ice evidences have been announced in Summer 2008 by *Phoenix* lander, but the results acquired within the first decade of the 21st century tend to exclude the possibility of life forms on planets within our solar system due to the prohibitive chemical and physical conditions present within their atmospheric envelopes or on their surfaces. By the end of 20th century, scholarly interest has shifted to some of the massive satellites of solar system's bigger planets. Images obtained in the 1970s and 1980s from the *Pioneer* and *Voyager* probes, and later from the missions *Galileo* (launched in 1989, released a probe to Jupiter in 1995) and *Cassini-Huygens* (launched on 1997, began orbiting Saturn in 2004), have attracted researchers' attention to some of the satellites of Jupiter and Saturn. Particular attention has been paid to the Jupiter satellite Europa due to the discovery of the presence of water there, and to Enceladus and Titan in orbit around Saturn, which also exhibit very interesting morphological characteristics.

Thanks to the development of Earth's observational technology and above all to the use of orbital instruments such as the space telescope *Hubble*, many star systems have been identified in the last few years which show a star encircled by one or more planets. So far, the planets discovered have masses comparable or greater than that of Jupiter, the majority of these being too close to the central star and therefore ill-suited for life. An updated information on extra-solar planetary systems is available on the website *Planet Quest*, edited by the Jet Propulsion Lab and the NASA [12]. It must be taken into account that present observations tend to pick out only the more massive planets, due to instrumental constraints. Thanks to a new generation of technology, such as that of the *Next Generation Space Telescope*, which will be operative in orbit during the second decade of the 21st century, we will probably be able to identify planets with a small or intermediate mass, and make more accurate measurements to acquire information on the possibility that such bodies host a chemistry suitable for life. From a theoretical point of view, it appears the formation of planets orbiting around a star is a relatively frequent phenomenon, although the physical characteristics that would make them hospitable for life are rather restrictive, as we have already seen.

Objects of interest for contemporary bioastronomy are not only planets and satellites, but also very small bodies, such as asteroids and comets, and, in general, the vast regions of interstellar space. With radio frequency observations and infrared spectroscopy, it has become possible to discover the presence of over one hundred different types of molecules in interstellar space, including water, carbon monoxide and dioxide, ammonia, methanol, formaldehyde, and various carbon, silicon and nitrogen compounds, as well as a certain number of amino acids. Many of these molecules, some of which have been found directly on meteoric residues or observed on comets, are identical to those that characterize the chemistry for living organisms and therefore raise questions about their possible role in pre-biotic processes and about their possible origins from biological processes already in existence. Presently, however, no nucleic acids or other biochemical structures of a cellular origin have been observed —not even within the vast environment of interstellar space— that lead us to think micro-organisms are present beyond Earth.

Notwithstanding the absence of results that might have demonstrated traces of life, past or present, in environments other than those of our own planet, we must recognize that scientific activity confronts us with a new way of considering life, a way that for the first time fixes coordinates on the cosmic dimensions and no longer solely on the terrestrial.

3. The Search for Extraterrestrial Intelligence. Within the context of the relationship between scientific activity and the research of extraterrestrial life, the SETI program (*Search for Extraterrestrial*

Intelligence) deserves special mention. The idea of dedicating radio-telescopes to listen for possible intelligible signals coming from places beyond our solar system derives from the suggestion of Cocconi and Morrison (1959). At the dawn of radio-astronomy, this suggestion demonstrated the theoretical possibility of terrestrial instruments receiving from space, even at enormous distances, electromagnetic flux densities comparable to those that we emit here on Earth when transmitting ordinary radio programs. The authors' advice was to begin listening to frequencies adjacent to the neutral hydrogen emission line at 21 cm (1420 MHz), which could easily be chosen as a reference point for other technological civilizations, given its intensity and diffusion throughout the cosmos. In 1967, an echo of a possible radio contact with extraterrestrial civilizations sounded in public opinion when Burnell and Hewish discovered the first *pulsar*. Until Goldreich and Julian definitively demonstrated in 1969 that such regular and intermittent signals were produced by neutron stars in rapid rotation, some believed it was possible these signals were of an intelligent origin, jokingly calling them *little green men.*

Beginning in 1961, a progressive involvement on the part of researchers and the employment of new instruments gradually brought about the formation of the SETI Institute [13], which provides a good amount of online documentation. Today the Institute has its own projects and researchers, but works in collaboration with NASA, as also with other major radio-astronomy research institutes on the planet. In the context of an interdisciplinary discussion, the *Seti Academy Committee* is also worth mentioning. In collaboration with other scientific institutions, this committee of the International Academy of Astronautics (IAA) dedicates part of its activity to the study of the social and cultural consequences of a possible contact with other civilizations and to preparation of possible protocols for communication. Some international procedures have already been established; in case an event of this type were to be verified, they foresee independent confirmations of the discovery, international bodies to be informed, and priorities to follow.

Beyond any optimistic interpretation of Drake's equation, there is an important factor that provides motivation to sustain SETI research. As time goes on, the volume of space in which the terrestrial radio signals are journeying increases proportionally to the cube of the distance covered by the speed of light (the velocity of radio signals) during that same time. Thus, the probability for receiving a possible extraterrestrial response likewise increases as time progresses. At this time, terrestrially produced radio waves have reached the stars (and possible planetary systems associated with them) inside a sphere with a radius of approximately 70-80 light years, allowing us for the moment to conclude that extraterrestrial civilizations do not exist within a distance of around 30-40 light years from the sun (computing the time a possible radio answer needs to travel back), or, if they do exist, they are not capable of responding or perhaps do not have the intention to reply to our signals. In this context, one may refer also to the fact that the great radio-telescope of Arecibo (Puerto Rico) was deliberately used in 1974 to send toward the globular cluster M13 a radio message of 1679 bits in binary code, decodable in a black and white image containing information on Earth and human biology. The research projects for the 21th century involve interferometric radio-telescopes in orbit around the Earth or on the concealed face of the moon (i.e., in the shadow of signals coming from the Earth) in order to increase the power of resolution and the sensitivity for reception of possible intelligent extraterrestrial signals.

For the more optimistic, such as the radio astronomer Ron Bracewell, the many technological civilizations that might populate the universe would already have a communicative network in place, a kind of *Galactic Club* (Bracewell, 1979), which humans must enter sooner or later. But the hypothesis that advanced civilizations may have very diffuse presence has often been contested, because there has not yet been contact with any of them, neither in the present nor in the historical past. If there were a million such civilizations in our galaxy, they would be separated by a distance of approximately 100 light years from each other. Historically known as the "Fermi Paradox" for the Italian physicist who, almost as

a joke, made this type of calculation for the first time in 1950 during a lunch at Los Alamos, this problem is often posed in a colloquial fashion with the question *where are they?* The proposed responses have varied, ranging from the suggestion that such contacts may have already happened in ages when humans were not in a position to appreciate them, to the fact that there would be a certain resistance to the establishment of such relationships given the enormous technological or even cultural differences, differences that could also account for a sort of "invisibility" of their presence in our midst. The variables of the problem, many of which certainly come from outside the scientific sphere, are such that the Fermi Paradox serves as a useful admonition, albeit it is not an apodictic argument. Considerations similar to Fermi's and equipped with opportune solutions were made around 1930 by Kostantin Tsiolkovsky (1857-1935) within a philosophical climate known as "Russian Pancosmism" (cf. Lytkin et al., 1995).

III. The Religious and Theological Debate

The probable presence of life, particularly of other intelligent creatures, in environments different from the Earth has never constituted a specific topic of theological speculation. Concerning the Magisterium of Roman Catholic Church [14], it has no official teachings regarding ET life. Holy Scripture, even when it presents the relationships between God and humans in a cosmic context, does not mention it. Some writers love to cite as a possible exception a verse from the Gospel of John: "I have other sheep that do not belong to this fold. These also I must lead, and they will hear my voice, and there will be one flock, one shepherd" (*Jn* 10:16); however, though certainly suggestive, it does not in reality offer any serious ground for exegesis in such a sense. Throughout history, theological reflections that could offer possible references to the ET debate are very few and fragmented. However, a number of reviews about different theological positions are now available. Throughout history, theological reflections that could offer possible references to the ET debate are very few and fragmented. However, a number of reviews about different theological positions are now available (cf. Dick, 1996; Crowe, 1997; Corbally, 1997; Dick, 2000; Russell, 2001; George, 2002).

1. Historical aspects of the relationship with Christian thought. Of the earliest texts concerning our issue is a letter by Pope Zachary (741-752), in which he mentions that the priest Virgil taught a doctrine on the plurality of inhabited worlds. Zachary disapproved the idea that there were inhabitants at the poles, on the moon, or on the sun (*quod alius mundus et alii homines sub terra sint, seu sol et luna:* cf. *Epistula XI ad Bonifacium*, PL: 89, 946-947). The doctrinal motive for such reprimand was to prevent the introduction of elements of novelty that, by calling into question the unity of the human family, would have made it more difficult to understand the relationship to God of men who were not descendants of Adam, including their moral position with respect to original sin. In 1277, with the intention of protecting the freedom and omnipotence of the Creator, the bishop of Paris, E. Tempier, condemned a proposition of the Aristotelian tradition according to which the First Cause could not have created many worlds. However, this censure did not mention anything about their possible inhabitants. Some years before, Thomas Aquinas (1224-1274) had responded in his *Summa Theologiae* to the question of whether other worlds existed, affirming that only one world existed (cf. pars I, q. 47, a. 3). But we cannot make direct use of the medieval debate on the multiplicity of worlds to know the position of Christian theology on extraterrestrial life. The medieval concept of "many worlds" was not equivalent to what we use today when referring to different planets that could be inhabited. By the "oneness of the world," medieval authors were referring rather to the unity of the universe [15], which derived from the unity of its Creator and from the unity of His final causality for all that exists. In the question of the *Summa* cited above, Aquinas in fact associated the idea of a plurality of worlds with the supporters of chance who, like Democritus, denied an ordering wisdom. The warning of Tempier, in which the concept of *mundus* (world) did not totally coincide with the usage of Thomas Aquinas, was intended only as a corrective of

an academic nature rather than as an ecclesiastical intervention in the strict sense. It was aimed at maintaining unaltered the characteristics of the Creator, and this not so much within the sphere of the real but rather within the sphere of the possible. The correct way to understand a plurality of systems, all depending from an unique Cause, was also maintained later by Thomas Campanella, remembering in his *Apologia for Galileo* (1622) that the observations of the new worlds made by the telescope of the Italian scientist did not contradict any religious tenet (cf. *Apologia pro Galilaeo*, ch. III, *ad nonum*).

The debate about the heliocentric system raised in the 15th and 16th centuries had no official repercussions for our theme. Some ecclesiastics expressed their private opinion that to lower the Earth to the level of other planets could lead some innovative spirits to go still further, even to the point of supposing the existence of inhabitants on those planets, with the consequences foreseen by Pope Zachary in the 8th century. Just so, the idea was manifested in a letter by the abbot Giovanni Ciampoli to Galileo sent on February 28, 1615 (cf. Galileo, *Opere*, edited by A. Favaro, Florence 1968, vol. XII, p. 146) and in a letter sent to Pierre Gassendi (1592-1655) by the abbot Le Cazre (cf. P. Gassendi, *Oeuvres*, Lyon 1658, vol. VI, p. 451). The 17th century was characterized by a general attitude of prudence, as also indicated by the fact that Fontenelle's essay, *Entretiens sur la pluralité des monds*, was placed on the Index of Prohibited Books in 1687.

In the 18th century, the theological climate seemed to change. No specific solutions were offered to frame or solve the dogmatic problems that extraterrestrial life could pose for Christianity, but the entire theme was regarded with greater openness and without any particular fear. In the first place, theologians seemed to underline more the greatness of the Creator and the incomprehensibility of his plans for the universe. Anglican apologetics offered a connecting point by inserting the possibility of extraterrestrial life into its natural theology, that in the pages of William Derham became an *Astro-theology* (1714). Of greater significance, however, was the reaction of many Christian authors against the work of Thomas Paine (1737-1809), *The Age of Reason* (1793), a text that for the first time directly proposed a radical incompatibility between the Christian religion and the existence of intelligent extraterrestrial life. According to Paine, the discovery of non-terrestrial life would inevitably lead to a repudiation of religion: "Are we to suppose that every world in the boundless creation had an Eve, an apple, a serpent and a redeemer? In this case, the person who is irreverently called the Son of God, and sometimes God himself, would have nothing else to do than to travel from world to world, in an endless succession of death, with scarcely a momentary interval of life" (*The Age of Reason*, in "Paine. Representative Selections", ed. by H. Hayden Clark, New York 1961, p. 283). Paine's criticism was not endorsed by sincerely believing astronomers who were also favorable to a pluralist hypothesis, as were T. Wright, J. Lambert and the prestigious William Herschel, and moreover it gave rise to theological works aimed at refuting that thesis, as T. Chalmers' *Astronomical Discourses* (1817), T. Dick's *The Christian Philosopher* (1823), and T. Dwight's *Theology Explained and Defended in a Series of Sermons* (1818).

In the 19th century the essay of the German theologian Joseph Pohle, *Stellar Worlds and their Inhabitants* (*Die Sternenwelten und ihre Bewohner*, Köln 1884), re-edited many times for approximately twenty years, plainly favors the hypothesis of a plurality of inhabited worlds. Given that the physical universe is so vast and that the reason for creation is to give glory to God, Pohle deduces that such glory must be bestowed by many intelligent beings dispersed throughout the cosmos and that have a direct relationship with the material universe, unlike the multiplicity of angels, whose nature is purely spiritual. An echo of this conclusion can be found in one of the most widely diffused European theological textbooks of the 20th century (cf. M. Schmaus, *Katholische Dogmatik*, Munich 1957, vol. II, n. 109). Pohle's position will be shared by various scientists of his era, among them the Italian priest-astronomers Angelo Secchi and Francesco Denza.

2. Some Theological Positions. Apart from a few exceptions, today's theological literature does not give specific attention to our theme. Theological textbooks present only fleeting glimpses of it, usually following a line of prudent openness to a possible occurrence that, in the end, must be a factual event and not a theoretical deduction. In the second part of the 20th and in the beginning of 21st centuries, explicit references to the theological import of ETL can be found, among others, in Grasso (1952), Perego (1958), Davis (1960), Zubek (1961), McMullin (1980), Corbally (1997), Russell (2001), George (2002), Peters (2003), Delio (2007), and in a number of contributions collected by Dick (2000). The issue received attention also by E. Milne (*Modern Cosmology and the Christian Idea of God*, Oxford 1952), E. Mascall (*Christian Theology and Natural Science*, London 1956), and above all K. Delano (1977). Paul Tillich complains of the absence of such reflection within the theological field (cf. *Systematic Theology*, vol. II, Chicago 1957, pp. 95-96). Teilhard de Chardin dedicates only a brief essay to our topic (*La multiplicité des mondes habités*, 1953), to which he added an even shorter, but interesting, footnote. Karl Rahner maintains an open position and does not refuse to tackle the problem, but intuiting the major Christological import of the subject preferred not to offer apodictic solutions (cf. Fisher and Fergusson, 2006).

The point of departure for most theological reflections basically remains Pohle's thesis: the Creator's greatness and glory are compatible with the gift of life and of intelligent life in the cosmos, also in numerous environments other than the Earth, although we do not know what God's plans are for these creatures. Thereupon, theology immediately offers a clarification already present in all the works of the writers who replied critically to Paine: redemption from original sin regards the human family and cannot be transposed into the life of other creatures. The same consideration was made centuries earlier by the Franciscan William Vorilong (1390-1463), but it constitutes only a first approach to the problem (cf. McColley and Miller, 1937).

Some writers have gone still further. According to Mascall, it would not be difficult to acknowledge the possibility of various hypostatic unions of the Incarnate Word if this were judged opportune by the universal God's will of salvation, a position possibly shared also by Rahner. On the contrary, Milne suggests that the uniqueness of the Incarnation could be compatible with the fact that radio communication between civilizations would become the vehicle of informing other intelligent creatures about the history of salvation God realized on behalf of terrestrials and extending to other creatures a sort of "redemptive information" capable of moving them to give thanks to God or to believe in Him. The position of Kenneth Delano, who approaches the question within a Catholic perspective, shows a notable flexibility. After recalling the fittingness of associating the greatness of God with a creation much richer than one could imagine, he indicates the necessity for genuine humility with respect to the transcendence of divine plans, a humility that should lead one to avoid geocentric or anthropocentric attitudes, thus respecting the silence of Scripture on the topic. Without placing limitations on any possible history of revelation or salvation, Delano holds that any of the three divine Persons could become incarnate on any planet. According to Delano, such positions are preferable to a sort of "Cosmic Adam," in which the single redemptive act of Christ on Earth would apply to the whole universe. In any case, also according to Delano, a redemptive pluralism does not impede humans from spreading to other intelligent beings the evangelical message and the love God shows us. In my opinion, the positions of Mascall and Delano regarding possible multiple incarnations of the Son or of other divine Persons seem hardly compatible with a genuine Christian understanding of Revelation, as it will become clear in the following discussion.

If the preceding considerations underline the flexibility necessary for a theme such as this, the position of Charles Davis (1960) seems much better defined. Starting from the biblical data of the cosmic centrality of Christ with respect to the whole material universe and of his headship over all creatures, including the angels, Davis concludes that the most correct theological position should be to maintain the uniqueness of

the hypostatic union (the assumption of human nature by the divine Person of the Son), which happened only once and only within the context of the earthly economy of salvation. The consequent privilege for human nature would not be an expression of anthropocentrism, but the consequence of a coherent Christocentrism. If the centrality of Christ, the Son of God made man, in the cosmos and in history were merely the effect of a geocentric horizon present in the modes of expression used in Scripture, the greater part of our theological understanding of creation [16] and of our relationship with God in Christ would inevitably be flawed. To leave the understanding of the headship of Christ, the God-man, unaltered in a "strong sense" means to continue to believe that the incarnation of the Word constitutes the greatest self-communication of God to creation, even against the background of all other possible creatures. It also means that we humans must assume the corresponding responsibility. A universe where, on the contrary, many possible incarnations of the Word would be possible, would no longer be a Christocentric universe. However, if this were to happen as a factual event, we would have to conclude that our understanding of Revelation until that moment had been largely imprecise and even ambiguous. Teilhard de Chardin holds the centrality of Christ in a strong sense, but at the same time he stresses the action of a third "cosmic" nature of Christ (a nature other than the divine and the human natures) and ascribes to it, and not to the human nature of the Word, the work of recapitulating in Him all creation and all the beings which participate in it (cf. "La multiplicité des mondes habités," in *Oeuvres*, Paris 1969, vol. X, p. 282). The French author can thus overcome the obstacle of anthropocentrism, but introduces an element that sounds extraneous to the commonly accepted Christological dogma, which teaches from the beginning the presence of only two natures, human and divine, in the divine Person of the Son-Word (cf. *Symbol of Chalcedon* [451], DH 300-303).

IV. Christian Theology and Extraterrestrial Intelligence: Some Possible Approaches

I believe that the theme of possible intelligent life of extraterrestrial origin, i.e., intelligent life outside the experience of unity of the human family as presented by the entire biblical message, represents one of the major speculative efforts facing Christian theology. It would therefore be no surprise if many questions are perhaps destined to remain unanswered. The only available analogy for our topic is the study of the relationship between Christianity and the other religions on Earth, a relatively young discipline, but one of growing importance in an age of globalization. Without a doubt, the study of that relationship provides useful guideposts for our problem, including the salvific universality of the Incarnation of the Word, the singularity of the hypostatic union, the necessity not to separate the richness (and in some way the unpredictability) of the creative and salvific action of the Holy Spirit from the mission and the role of the Son, to whom the Spirit must necessarily guide. The relationships among the religions of the earth become generally framed, not without noticeable effort, in what today's theology calls "inclusive Christocentrism," the attempt to re-read other religions in the light of the mystery of Christ (on this, see the document issued by the International Theological Commission, *Christianity and Religions*, 1997). However, such an analogy only serves as a first approach to the problem, since the theme of life in the cosmos would supplant the unity of the human family, created and redeemed in Christ, posing a problem with a wholly new aspect, as did, for example, the discovery of the American Indians, about whom Pope Paul III (1534-1549) did not have difficulty to recognize their belonging to the descendants of Adam (cf. DH 1495). Therefore nothing else remains for us to do but to approach the problem step by step, recalling some firm points.

1. The Absence of Prejudicial Arguments against the "Pluralist" Hypothesis and the Reasonableness of the "Classical" Position. A first fixed point is that there are no prejudicial arguments hindering the admission of the "pluralist" position, neither on the part of the magisterial teaching of the Church nor on

the part of theological reflection. The omnipotent will and unfathomable freedom of God the Creator continues to imply a valid relevant argument, as does the recognition of the intrinsic value of life, and in a special way the dignity of intelligent life, everywhere it is manifested. All life is in some way a participation in and a reflection of that Life, with a capital "L," that believers know subsists in God himself. To these may be added what the Judeo-Christian tradition professes about the existence of angels. This tradition shows that the meaning of creation is not completely based on the relationship between man and God, "but remains open to other creatures," which, although likewise dependent on God, have a history and an economy of salvation distinct from that of humankind. Thomas Aquinas, for example, gave arguments of fittingness to support a very high number of angels, surpassing any multiplicity of material entities whatsoever (cf. *Summa Theologiae*, I, q. 50, a. 3).

Nonetheless, to think that humankind is the only form of intelligent life in the cosmos would for theology represent a "classical" position (or a classical *solution*, as we would say in the language of physics) and one that would not require the re-interpretation of many aspects of Revelation . Such a solution is reasonable, and cannot be qualified as a priori or anti-scientific. Today we know that the very large size of the physical universe cannot be thought as a sort of "redundancy," but is linked to an anthropic necessity: a very large space inevitably corresponds to the long time necessary for the stellar production of chemical elements indispensable for life. As a consequence, both the probabilistic argument based upon the greatness of the cosmos and the theological argument regarding the fittingness that manifold intelligent beings are created to give glory to God in regions where man could not do so, are weakened. In an expanding universe —the only one that could lead to the formation of structures and environments adequate for life— the long time required for biological evolution necessarily means a large space and a large amount of matter already formed or in the process of formation. In this universe it is as reasonable to hold the simultaneous appearance of many civilizations as it is to hold the existence of only one. The teleology highlighted by the Anthropic principle [9] does not indicate conclusions about the multiplicity or the singularity of intelligent life, but only about the time necessary for its appearance and about the necessary relationships between life and the structures of the universe in its entirety. Not knowing the "ultimate reasons" for the origin of life, science cannot know if life is the result of a categorical imperative or of a highly improbable event. Consequently, Drake's or any other Drake-like equations are of their nature destined to calculate only "necessary" conditions, but not "necessary and sufficient" conditions for the presence of intelligent life. In the absence of scientific data that ask theologians for new solutions within a wider interpretative framework, a theology that wants to conserve its "classical" solution cannot be charged with unreasonableness on this account.

2. The Universality of the Image of the One and Triune God within a Cosmic Context. A second firm point is that the revealed image of God entrusted to the Judeo-Christian tradition is not geocentric, nor anthropocentric: it is absolutely universal and transcendental, subject of a creative omnipotence whose range is without doubt of cosmic order and certainly not only local. Moreover, the Trinitarian image of God professed by Christianity also presents itself with universal characteristics: the existence of a paternity and of filiation, whose intelligibility is in a sense associated with the generative process common to every living being, and the existence of a Love-Gift, the Holy Spirit, the understanding of which refers to the idea of communion, altruism, and donation, all that is certainly not extraneous to the dynamic of conscious life in itself, wherever we could know it. This suffices to reject the opinion that Christian theology, in order to open itself to the possibility of intelligent life in the cosmos, must inevitably set aside the image of the One and *Triune* God, accepting a sort of new "Copernican revolution" that would induce all civilizations of the universe to cease to recognize their own God, and together to begin to recognize a common but unknown God, analogously to what some evangelical authors ask the different religions of the Earth to do today (cf. J. Hick, *The Rainbow of Faiths: Critical Dialogues on Religious Pluralism*, 1995).

Every believer in God would certainly see any eventual meeting with a non-terrestrial civilization as an extraordinary experience. A believer would be fundamentally inclined to manifest a sense of respect in such an encounter, to recognize our common origin and the new possibility of better understanding the relationship between God and the whole of creation. A similar encounter, and perhaps the ensuing dialogue, would have a “religious” dimension in the more natural sense of the term. At the same time, it seems important to note that a believer who is respectful of the requirements of scientific reasoning would not be obliged to renounce his own faith in God simply on the basis of the reception of new, unexpected information of a religious character from extraterrestrial civilizations. In the first place, human reason itself would suggest the need to submit this new “religious content” coming from outside the Earth to an analysis of reasonableness and credibility (analogous to what we are accustomed to do when any religious content is proposed to us, on Earth); once the trustworthiness of the information has been verified, the believer should try to reconcile such new information with the truth that he or she already knows and believes on the basis of the revelation of the One and Triune God, conducting a re-reading inclusive of the new data, similar to that which would be applied in an ordinary interreligious dialogue.

Generally speaking, such contact could not be considered a sort of “final validation or refusal” of the religious conscience of humanity. Let us remember that, despite the great majority of terrestrials who believe in the existence of a Creator of Heaven and Earth, we humans have not supplied any information of a religious type within the various “messages in a bottle” that until now have been sent out beyond the solar system (see above, I, n. 1). From a materialist perspective, the idea that a new entrance into the *Galactic Club* will free man from an infantile religious phase and definitely give us back the awareness of our true place in the universe could be suggestive, yet in reality is very naïve. The majority of the great existential, and hence religious, themes pertaining to human life on Earth, such as the meaning of sorrow and death [17] or the moral value associated to our free actions, would not be resolved by the friends of this *Club.*

3. The Cosmic, and therefore Creaturely, Headship, of the Mystery of Christ. If the mystery of the Incarnation refers to a Christocentric headship and not a geocentric one, then it can be explored and expressed with cosmic and universal, not necessarily anthropological, categories. The third firm point for our attention should therefore be the universal, and not only local, revealed and salvific value of the Incarnation. The headship of Christ, the God-man, over the angelic creatures (cf *Heb* 1:3-14 and 2,5-18) would be interpreted as revealing his headship over all possible creatures (cf *Eph* 1:10; *Col* 1:20). The grandeur of the hypostatic union, which in a sense has an infinite value, also gives the vicarious sacrifice of Christ an infinite meritorious value. The way in which this would apply to the whole universe remains a mystery to Christian theology, but it is enough to state that the efficacy of this sacrifice does not increase through multiplication. The celebration of the Holy Mass, for example, applies the fruit of the same historical event to different times and places without multiplying it. Contrary to what is suggested by other authors, I believe that a similar participation and efficacy of salvation on a cosmic plane —where this might be necessary for other intelligent and free beings— cannot depend on an interplanetary missionary impetus nor upon indirect communication (although these factors can, and perhaps must, be involved). It could only depend upon an economy guided by the Holy Spirit, even if accomplished in a way mostly unknown to us. It is certainly the only economy capable of securing the universality of salvation and its personal application to each individual. As in the earthly economy of salvation, the Holy Spirit would still lead to the Son and would in some way render Him present. This entire perspective reflects the logical conviction that the Creator has his own ways to make himself recognized everywhere and to make himself present within his creatures.

Concerning the personal history of other possible intelligent beings, responsible for their freedom before

God, Father and Creator of everything (cf *Eph* 4:6), we humans cannot say anything. We can affirm, however, that, as creatures, the mystery of Christ, the incarnate Word, is not extraneous to them. God has assumed in Christ a created nature, a finite will and freedom, making his own the experience of limits associated with any creaturely life, an experience that has a value that certainly extends beyond that of the "human" creature as such. But Christ has also taken onto himself the reality of death and has revealed its passing, non ultimate character, prefiguring in his risen body a destiny that belongs to the whole universe and not only to man. But what resonance or meaning would this have for other creatures of whose original and originating relationships with God we know nothing? From a perspective according to which human biological death is a consequence depending on a direct, total, and exclusive way upon Adam's original sin, then Christ's death seems to have nothing to add to non-human living beings, and further theological clarifications are expected to improve our understanding of things. From a perspective that instead leaves greater space for speculation, understanding death as the end of a cycle that all living creatures based on thermodynamical processes must necessarily experience, something not automatically linked to an original sin, then any conscious creature, wherever it may be, could see death as the place of its acceptance of finitude, of its being "a creature," not God. This is nothing but the place of a supreme experience to which Christ's true death on the cross, like his resurrection, would have much to say, precisely because of the creaturely humanity he assumed.

Concerning whether or not the grand theme of the relationship between sin and freedom may regard the personal history of other beings, I have already indicated that it is not possible to formulate deductive hypotheses. However, we are informed that the association between sin and freedom is verified in the only two cases that theology inductively knows, namely humankind and angelic creatures. If it is certainly true that sin does not belong to the perfection of freedom, the possibility of sin seems to be at least a condition for freedom; and this may render the Christian redemption less extraneous to any *free* creatures that did not descend from the first human beings.

I do not think that the debate regarding extraterrestrial life, which stands on a purely theoretical basis in the absence of experimental facts, constitutes the determinate touchstone for a critical evaluation of the truthfulness and coherence of Christian theology and belief, even if it represents an extraordinary stimulus to increase the intelligibility of some of its formulations. As indicated, there exist some fixed points for reflection and some possible approaches to the question. There exists a "classical" solution, that of the uniqueness of humankind. In the absence of compelling proof to the contrary, it would seem incorrect to consider this solution obsolete simply on the basis of the opening of horizons caused by contemporary cosmology [18]. A different, non-classical (in a sense, *relativistic*) solution would imply a work of re-understanding that, analogous to what happens in physics with quantum or relativistic solutions, is required in order to maintain many of the truths contained in previous classical solutions. The new solution clarifies that the theoretical framework in which the classical solution can be applied is narrower than previously known, helping to understand it within a more general context. The last word on the question of extraterrestrial life must not come from theology, but from science. The existence of intelligent life on planets other than Earth is neither required nor excluded by any theological argument. Theologians, like the rest of the human race, have to wait and see.

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