

RESEARCH ARTICLE

Frontiers of astrobiology and the humanities

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Abstract

One of the main objectives of astrobiology is to understand the distribution of life in the universe, for microbial life, as well as for the search of extra-terrestrial intelligence, both of which would force upon us new problems in philosophy, including ethics and theology. The question of astrobiology and the humanities being such a broad topic, in the present paper we have limited our discussion of the Frontiers of Astrobiology and the Humanities to the single topic: ‘Independence of science (astrobiology) from philosophy and theology’. We have argued along the lines of this narrower thesis, but restricting our theological discussion strictly to a Judeo-Christian perspective.

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Introduction

Astrobiology and its frontiers with the humanities

Astrobiology is a science consisting of four chapters: origin, evolution, distribution and destiny of life in the universe (Chela-Flores, 2011). As an illustration of the wide range of scientific disciplines that contribute to astrobiology, we could raise the question whether the disciplinary nature of astrobiology is

multi, inter or transdisciplinary. This question has been carefully discussed earlier in this journal (Chon-Torres, 2021). To sum up, astrobiology is a ‘transdisciplinary form of research, above the multi and interdisciplinary levels, although this does not necessarily mean discarding them’. A specific example is provided by stable isotopic geochemistry and oceanography. These subdisciplines have developed in a terrestrial context. But in order to attempt to give an answer to astrobiology’s first chapter for the Jovian moon Europa with a specific space mission –JUICE– these two areas go beyond each other to form a new holistic approach to be tested in the near future on the chemical elements on the icy surface of this satellite (Riedo *et al.*, 2021).

Astrobiology’s frontiers with the humanities have been widely discussed in the past (Ćirković, 2012; Mix, 2016; Traphagan, 2016; Vainio, 2018; Chela-Flores, 2019; Pryor, 2020). In the more restricted context of this paper, we have also focused on philosophical and theological issues raised by non-human species beyond the Earth, taking as a first step both microbial and intelligent species (Chela-Flores, 2021a, 2021b).

This relatively new science that emerged in its full spectrum at the beginning of this century, is based on what used to be called ‘exobiology’. It is supported by other disciplines, such as: space, life, earth and basic sciences (physics, chemistry and biology). Astrobiology has, in addition, been raised to the centre of philosophy (Aretxaga-Burgos and Chela-Flores, 2012; Dick, 2012). One of the advantages of focusing on astrobiology with the tools of the philosophers is that they add unexpected advantages (Duner, 2012; Mix, 2018).

Why philosophy and theology? As in all philosophical pursuits, philosophy investigates basic concepts underlying human activities. Even though the pursuit of philosophy does not provide new data, unlike scientific experiments and astronomical observations, new perspectives arise from ethics, semiotics and the philosophy of theology. All of these frontier disciplines will be given some attention in the present work (Sections ‘Philosophy its frontiers with astrobiology, Ethics its frontiers with astrobiology and Frontiers of theology and of astrobiology’).

Horizons and limits of astrobiology and the humanities

There is a clear formulation of the boundaries between the main areas of astrobiology and humanities, which we intend to discuss in some detail. Fortunately, they were highlighted by Bertrand Russell, who had in mind science in general (not astrobiology in particular) in his major work on popularization of philosophy: *History of Western Philosophy and its Connection with Political and Social Circumstances from the Earliest Times to the Present Day* (Russell, 1991):

Philosophy, as I shall understand the word, is something intermediate between theology and science. Like theology, it consists of speculations on matters as to which definite knowledge has, so far, been unascertainable; but like science it appeals to human reason rather than authority, whether that of tradition or that of revelation...But between theology and science there is a No Man’s Land, exposed to attack from both sides; this No Man’s Land is philosophy.

In this citation, the remarkable English mathematician, philosopher and literature Nobel Laureate expressed clearly the need to recall the precise horizons and limits of any scientific endeavour (e.g. in our case, astrobiology) and two of the main components of the humanities. An earlier contribution in this direction (Martini and Chela-Flores, 1999a), which is discussed more fully here, is an objective of the remaining part of this work.

Issues that are relevant for astrobiology

Questions that come within the scope of astrobiology

We can raise a series of questions that we would recognize to have philosophical, semiotic, ethical or theological content, and yet be relevant for the astrobiologist. Amongst them, we should mention:

- (i) *Epistemology*: Does it make sense to construct a new science on life's origins, not as a terrestrial phenomenon, but rather as a cosmic distribution of life of which, so far, we have no evidence?
- (ii) *Issues on the philosophy of theology*: The main debate on ethics is between transcendentalists and empiricists. Nevertheless, we must not exclude, but instead we should pay special attention to some religious aspects of morality, such as Jesus's 'Sermon on the Mount' (Mathew, 5, 1–14, written c. 85 AD), as mentioned earlier (Chela-Flores, 2021a).
- (iii) *Public policy*: What are the right policies for implementing public power in order to respect, preserve and improve the quality of life on Earth, and beyond?

A question concerning frontiers of philosophy and astrobiology

Within astrobiology's third chapter, the distribution of life in the universe, a major objective since the 1960s has been the search for extra-terrestrial intelligence (SETI). Such contact is expected to be in terms of signals received by means of specialized radio-telescopes that should be equipped to participate in SETI projects. In the 1960s, the American astronomer Frank Drake suggested the 'SETI Project'. Drake suggested that whoever attempted to communicate via radio would choose a familiar wavelength. The radio telescope was pointed towards two stars near the Sun (Epsilon Eridani and Tau Ceti). The SETI Project has multiple options for searching beyond the original Epsilon Eridani and Tau Ceti. Indeed, the Kepler and subsequent missions, have been able to find possibly habitable Earth-size planets, or moons around other stars.

The opinion of Drake on the profound philosophical questions that are raised by the search for other intelligence in the cosmos has been clearly expressed (Drake and Sobel, 1992):

SETI promises answers to our most profound questions about who we are and where we stand in the universe. SETI is at once the most technical of scientific subjects, and also one of the most human.

Philosophy its frontiers with astrobiology

When philosophy meets astrobiology

In the 19th century it was evident that deep issues were widespread in the nature of human beings, not least of all the Darwinian theory of evolution. However, at present both philosophy and astrobiology is recognized to be central in questions related to our humanity and concerned with the position of humans in the universe. But since the methods and training of both philosophers and astrobiologists are so different, it is tactful to address the philosophical foundations and the main issues that are involved in the common frontier between these two sectors of modern culture. Our aim is to discuss the relevant issues when astrobiology meets philosophy.

Intelligibility of nature

The question whether Nature can be intelligible is of paramount relevance across the frontiers of astrobiology, especially beginning with philosophy (Chela-Flores, 2009, Chapter 14). Intelligibility, does not end with a preliminary understanding of the emergence of life, but is linked with the evolution of life (Dear, 2006). Intelligible means the capability of being understood.

Alternatively, intelligible can signify to be apprehensible by the intellect alone. A third aspect of intelligible, closer to the significance of the term in the context of the present work, is related to something that is beyond perception. An 'intelligible universe' can be the starting point of a prolonged and systematic discussion amongst astrobiologists, as well as philosophers and theologians. The intelligibility of the universe raises questions that lie on the frontier between science and the humanities. Steven Weinberg felt that (Weinberg, 1977):

It is very hard to realize that this all is just a tiny part of an overwhelmingly hostile universe. It is even harder to realize that this present universe has evolved from an unspeakably unfamiliar early condition, and faces a future extinction of endless cold or intolerable heat. The more the universe seems comprehensible, the more it also seems pointless.

This statement reflects a specific philosophical trend – existentialism stimulating the dialogue of science and religion. Discovering a second Genesis anywhere else in the universe should contribute to clarify the intelligibility of nature.

Ethics its frontiers with astrobiology

Astrobiology and bioethics

As with the two previous frontiers of astrobiology, it is worthwhile to discuss astroethics, when we extend our concepts related to humans to other forms of life that eventually may be in contact with us in the long term. We begin with the question (Chela-Flores, 2021a):

Can ethical behaviour be extended into a cosmic context?

To make sense of a rational approach to ethics with respect to non-human species, we should first clarify whether the cosmos is a well-determined ordered system, and hence intelligible to all observers (cf., Sec. ‘Intelligibility of nature’). If so, then our ideas of ethical behaviour can be extended into a cosmic context with no motivation for viewing the origin and evolution of the universe and life itself, as being absurd, or pointless. This existentialist point of view is a form of philosophical inquiry that explores the problem of human existence, including a sense of anxiety in the face of an apparently meaningless, or absurd world. This philosophical doctrine explores issues related to the *meaning* of human existence. This can be considered as yet one more example of the interdisciplinarity between philosophy, semiotics and astrobiology.

Strong support has been given to intelligibility: Darwin developed an explanation of the origin of humans based on natural selection and underlying random mutations. Clearly, this approach made it unnecessary, within the scope of the scientific method, to appeal to metaphysical concepts that cannot be rejected by experiments. The Darwinian new insights into randomness has allowed the substitution of the concept of necessity –determinism– for the concept of chance – probability – in order to explain both the existence of phenomena, as well as their type of structure.

Certain general ideas are clear, even before our technology will allow us to reach the possibility of developing instrumentation for the search of life on exoplanets. This possibility will inevitably present us with significant challenges arising from the ever-increasing pace of the exploration of the Solar System and, more generally, from the rapid progress of the space sciences. Amongst the priorities of astrobiology, we should consider the search for other lines of biological evolution in the universe. In the short term a possible solution can be provided with the missions (ESA, JUICE) and (NASA, Europa Clipper), both aiming at the exploration of the moons of the Jovian system (Chela-Flores, 2021b).

The overlapping of moral philosophy and astrobiology

Some of the deepest questions that humans have raised are not confined within the frontiers of science. Instead, philosophers, including ethicists, and theologians have approached such questions with their own expertise. One such example is provided by the question of the role of ethics in astrobiology, whether of transcendental or empirical origin. The question of ethics in the wider context of astrobiology has been given its proper significant position in a cultural context —astroethics– a branch of astrobiology that studies the moral implications related to the search of non-human life beyond the Earth (Cockell, 2008; Chon-Torres, 2018, 2021).

The foundational ethical principles for planetary protection in space exploration, whether for the extension of our knowledge of planetary science, or for the search for life in our local cosmic environment, has been extensively discussed in the literature. In particular, it has been noted that we need to examine with care the exploration of the Solar System taking into consideration our own environment, or other planetary bodies (Rummel *et al.*, 2012). Astroethics has been a central question in astrobiology, as the problem of backward contamination is a major problem in space exploration, providing strict financial and temporal limitations (Tánczer *et al.*, 1989). In other words, Planetary Protection should be kept in mind, while deciding the design of space missions. Its purpose is to prevent biological contamination of sample-return missions.

Frontiers of ethics: instrumentation and microorganisms

The possibility of exploring Europa's habitability was raised very early. Soon after, the Galileo mission was proposed to examine the Jovian system with a Europa Lander, equipped with a submersible called a 'hydrobot' that was coupled to an ice-breaker called a 'cryobot' (Trowell *et al.*, 1996; Horvath *et al.*, 1997). For valid reasons, sometime later, the hydrobot-cryobot proposal was rightly criticized and subsequently abandoned (Greenberg, 2005), even though a suggested improved proposal was later independently suggested (Zimmerman *et al.*, 2001).

The relevant question – a possibility that was not considered – was whether the cryobot was to be driven with nuclear energy in order to penetrate the European icy surface more efficiently. The question of considering nuclear-powered cryobots had arisen in the context of solar system exploration, including the European icy surface penetration with our previously suggested pair of cryobot-hydrobots. The levels of fission power and related harmful radiation are normally small for humans. A study was carried out in order to investigate whether a surface fission power system was applicable for landed missions. In the course of their study, it became clear that the application of such a power system was possible for a wide range of missions for the exploration of the Solar System (Ulamec, *et al.*, 2007), especially for Mars (Elliot *et al.*, 2003). Their study was concerned with fission electrical power of the order of a few kilowatts. This level is needed for payloads that are feasible, since the alternative of radioisotope power systems being too massive and expensive.

Even though the radiation levels are tolerable for humans, the possibility remains that once we envisage non-human species elsewhere in the Solar System, we are *a priori* ignorant of the harm we could make to other forms of life, especially microorganisms. Profound ethical arguments arise due to the use of innovative instrumentation that may not consider harming microorganisms:

What is wrong with killing with radiation a putative living community that is being searched?

We believed, and still do (a testable hypothesis), that living microorganisms are likely to dwell near hydrothermal vents on the European ocean floor. The need of searching for life on Europa had already been extensively discussed at that time, soon after the arrival of the Galileo probe in the Jovian System (Chela-Flores, 1998).

However, we should take care when going beyond the early proposal of cryobot technology that would need fission power to help cryobot penetration. This is another significant illustration of a frontier of astrobiology and moral philosophy.

Frontiers of theology and of astrobiology

Natural theology and the theology of nature

The distinction between natural theology and the theology of nature is relevant for interpreting correctly the dilemmas that may arise at the frontiers of astrobiology and the humanities (Haught, 2005). Natural theology was a truly remarkable movement. For Isaac Newton there was no reason for planets and their

moons moving in almost the same plane (Newton, 1692). This phenomenon led to Newton's own interpretation, at present not accepted to be within the frontiers of science:

The motions which the planets now have could not spring from any natural cause alone, but were impressed by an intelligent Agent.

On the other hand, closer to our own time, the theology of nature moves in the opposite direction. Accepting science, theology attempts to come to a more fundamental understanding. It relies on the unifying explanatory power of science (Coyne, 2006). The supposition is that there is a universal basis for our understanding and, since that basis cannot be self-contradictory, the understanding we have from one discipline should complement that which we have from all other disciplines. While remaining faithful to the strict truth criteria of one's own discipline, we are open to accept the truth-value of the conclusions of other disciplines.

These comments illustrate some inevitable conflicts and contradictions that must be seen as temporary and apparent. As professional scientists we cannot participate in purely theological arguments, although they can serve as an encouragement to search for deeper scientific insights.

Implications of the search for a second genesis

We continue our discussion by exploring two different questions at the border between science and the humanities: Firstly, what are the implications of the search for a 'Second Genesis'? (McKay, 2001). This concept that is at the basis of astrobiology is the search for traces and footprints of the emergence of biological complexity elsewhere in the universe. Secondly, a closely related uncertainty is: What are the implications of a positive answer to the significant question of life existing elsewhere in the universe? Indeed, the compatibility of a Second Genesis with science is the subject matter of astrobiology, while the compatibility of a Second Genesis with religious belief, especially with Christian belief, lies within the domain of natural theology (Chela-Flores, 2005). Christianity inherited the simplicity of Jewish theology. Monotheism does not present us with any particular stumbling stone for incorporating the emergence of life beyond the Earth. For making a dialogue between science and religion a constructive one, we should delineate clearly the frontiers and horizons of science with other cultural sectors, such as philosophy and theology. A large number of excellent writings have preceded us. From a long list of available texts, we highlight only a few of them (Polkinghorne, 1996; Coyne, 1998; Haight, 1998; Peacocke, 1998; Ratzinger, 2009).

Clearly, if astrobiology research concludes that we are not alone in the universe, there are some unavoidable ethical, and theological consequences for which we still have no answer. For instance, outstanding amongst them are those found in theologies of different traditions, which have made substantial progress in questions that are shared with the new science of astrobiology (Russell, 2001). They have also been considered by Christian thinkers of different traditions (Martini and Coyne, 1999b; McMullin, 2007) These authors expose the wide range of implications, in which astrobiology has influenced the cultural sector, including astrotheology.

Further care with the frontiers of astrobiology

Unlike astrobiology and astrobioethics, the significance of meaning in astrotheology is based on revelation, or tradition. Hence, there is an intrinsic novelty regarding the question of meanings: The basis of theology, or any of its extensions when the phenomenon of life is viewed from a cosmic perspective, is irreducible to an experimental approach, unlike bioethics. Consequently, from the point of view of theology meanings are intrinsically related to faith alone, since meanings would be interpreted in terms of revelation.

Understanding the above discussion, serves as a basis for avoiding misinterpretations in the dialogue of faith and reason. An example suffices to make this point clear: Questions regarding the implications of Darwinism are entirely within the domain of a scientific theory. Confusion is to be avoided, as no theory

can invalidate a theological belief, as it may be suggested by radical atheism. As opposed to this scientific fundamentalism, the opposite, religious fundamentalism is equally to be avoided; questions of creation should not be taken outside the boundaries of faith. Any attempt to suggest that a theory of creation could be opposed to Darwinism should be avoided. A second example of the implication of meanings from a theological perspective can be found in a recent article (Chon-Torres and Szocik, 2021):

When we speak of the meaning of life, [it] cannot be easily described, and must be experienced. This coincides with the fourth aspect of faith that theology studies, experience.

The authors were quoting the Lutheran theologian Ted Peters (Peters, 2018). Finally, regarding the question of meaning from the point of view of some philosopher-scientists (existentialists and radical atheists), the emergence of life are the results of improbable random events in an otherwise lifeless cosmos. Opposing this limited view, the American philosopher-theologian John F. Haught is of the opinion that a first contact would scarcely change the minds of ‘those already comfortable with the notion of an essentially mindless universe devoid of meaning’ (Haught, 2001).

Conclusions

With the few examples we have discussed, it is evident that time-honoured topics of philosophy, including ethics and the philosophy of theology acquire a special relevance when they address the search for life in the universe. This underlines the relevance of delineating the frontiers of astrobiology, as we have attempted to do in the present work.

As it was done in the past in moral philosophy for non-human animals on Earth, astrobiology’s frontiers are especially relevant when we consider life in other worlds. The limits and horizons of science in general, and astrobiology in particular, contribute to avoid incorrect approaches on both sides of the frontiers of astrobiology.

Firstly, we should reject fundamentalism in religion that ignores the well-defined scope of the basis of Darwinism, the epoch-making scientific basis of the life sciences, including astrobiology (Ayala *et al.*, 1999).

Secondly, fundamentalism in science, as well as in astrobiology should especially be avoided (Harris, 2004; Dawkins, 2007; Dennett, 2007). It ignores that the limitations of the scientific approach are constrained exclusively to theoretical statements that are subject to experimental verification. Any judgement on the philosophy of theology cannot be based on science, including astrobiology, as it would be using incorrectly the scientific method beyond its frontiers, as outlined in this work.

Glossary

ASTROBIOETHICS: Astrobioethics is the subsection within astrobiology that concerns itself with studying the moral implications of implementing practical applications of the search for extra-terrestrial life.

ASTROTHEOLOGY: A branch of theology providing a critical analysis of space sciences for the purpose of constructing an understanding of our human condition within a cosmic context.

CONVERGENT EVOLUTION: This is an independent evolution of similar genetic or morphological features.

ETHICS (MORAL PHILOSOPHY): A branch of philosophy, which is associated with economics, politics and sociology. It is concerned with what is morally good and bad with a given activity, right and wrong. Ethics is divided into metaethics, normative ethics and applied ethics.

NATURAL THEOLOGY: One aspect of theology (cf., definitions of theology and theology of nature) that focuses on rationalizing religious truths, or traditions independent of revelation.

PHILOSOPHY OF THEOLOGY: a branch of philosophy in which methods are used to analyse theological concepts. It includes natural theology.

THEOLOGY: A field that interprets faith and experience of a given religious group.

THEOLOGY OF NATURE: Accepting science, theology attempts to rely on the unifying explanatory power of science.

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