

**IBN HALDUN UNIVERSITY  
SCHOOL OF GRADUATE STUDIES  
DEPARTMENT OF PHILOSOPHY**

**MASTER THESIS**

**MUSLIM PERSPECTIVE ON EXTRATERRESTRIAL LIFE**

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**THESIS SUPERVISOR  
ASSOC. PROF. ENİS DOKO**

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**MUSLIM PERSPECTIVE ON EXTRATERRESTRIAL  
LIFE**

**by  
SELEN FETTAHOĞLU**

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fulfillment of the requirements for the degree of Master of Arts in  
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ÖZ

## DÜNYA DIŐI YAŐAMA MÜSLÜMAN BAKIŐ AÇISI

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İnsanlık, antik dönemlerden beri Dünya dıőı yaşam hakkında fikirler üretmiőtir. Ancak yalnızca son birkaç on yıldır teknolojik cihazlarla Dünya dıőı varlıkları arayabiliyoruz. Yaőamın doğası hakkında bilmediklerimiz oldukça fazla olsa da bazı bilim insanları Dünya dıőı yaşamı bulabileceđimizi düşünüyor. Yaőamın varlıđını tespit etmek için biyolojik iőaretleri ve teknolojik iőaretleri kullanıyoruz. Eđer Dünya dıőı yaşamı bulabilirsek, bunun evrendeki yerimiz hakkında bazı imaları olacaktır. Dünya dıőı yaşama inanmak insanın sıradan olduđunu ima edecektir. İbrahimi dinler insanın eősizliđini savunuyormuő gibi anlaőtıldıđı için Dünya dıőı yaşamın din açısından sorunlu olacađı düşünülebilir. Ancak İslam insanın eősizliđini iddia ediyor gibi görünmemektedir. Hatta hayatın eősizliđini savunmanın Kuran'daki bazı ayetlerle zıtlık oluőturacađı görünmektedir. Çünkü Kuran'daki bazı ayetler Dünya dıőı yaşamı, hatta Dünya dıőı akıllı yaşamı ima ediyormuő gibi görünmektedir. Burada Kuran'ın Dünya dıőı yaşamın varlıđına dair imaları savunulacađından yaşamın oluőtma ihtimaliyle ilgili farklı bilimsel düşünceler önem taşımaktadır. Ancak hem yaşamın oluőtunun düşük ihtimalli olduđu görüşü hem de yüksek ihtimalli olduđu görüşü İslam'la uyumludur. Benzer bir şekilde, bilim insanları arasında karmaőtık yaşamın oluőtumu konusunda da fikir ayrılıđı vardır ve yaşamın kompleksliđinin beklenmedik olduđu hem de yakınsak olduđu görüşleri de İslam'la uyumludur. Son olarak, Dünya dıőı akıllı yaşamın olası dini incelenmesi gereken bir konudur. Dünya dıőı varlıkların İslam'la aynı mesaja sahip bir vahiy almıőt olmasını bekleyebiliriz. Ancak eđer vahiy almadıklarını gözlemlerse bile bu durum İslam'la uyumlu olacaktır.

**Anahtar Kelimeler:** Dünya dıřı yařam, Dünya dıřı akıllı yařam, Din, İřlam



## ABSTRACT

### MUSLIM PERSPECTIVE ON EXTRATERRESTRIAL LIFE

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Since antique times, humankind has had ideas on extraterrestrial life. However, only in the last decades, we have been able to search for extraterrestrials via technological equipment. While there are many unknowns about the nature of life, some scientists think that we may find extraterrestrial life. We are looking for biosignatures and technosignatures as the signs of extraterrestrial life. If we find extraterrestrial life, this would have some implications for our place in the universe. Belief in extraterrestrial life implies the mediocrity of humankind. Because Abrahamic religions are understood as they are declaring the uniqueness of humankind, one may surmise that extraterrestrial life would be problematic for religion. However, Islam doesn't seem to claim the uniqueness of humankind. Furthermore, belief in the uniqueness of life seems to be in contrast with some verses in the Quran. Because, Quran has some verses that seem to imply extraterrestrial life, even extraterrestrial intelligence. Since the Quran's implication for the existence of extraterrestrial life is defended here, the scientific opinions on the probability of the emergence of life have significance. However, both low probability and high probability views of life are compatible with Islam. Likewise, there are contrasting opinions among scientists on the emergence of the complexity of life, and both contingency and convergency claims about the complexity of life are compatible with Islam. Finally, the possible religion of extraterrestrial intelligent life needs examination. We may expect extraterrestrials to be revealed by God with the same message of Islam. However, even if we find out that they are not revealed by God, this would also be congruent to Islam.

**Keywords:** Extraterrestrial life, Extraterrestrial intelligence, religion, Islam





To my mother Serap and father Alican...

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Adı Soyadı: Selen Fettahođlu

İmza:

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# CHAPTER I

## INTRODUCTION

In all of its history, humankind has tended to think of existential questions. Whether we are alone in the world is one of the existential questions humankind has been asking since ancient times. Now, we are closer to answering this question with the help of the developments of technology and science. The question has enormous implications on the worldview of humankind. If we are alone, this implies that humankind is special and we are privileged in the universe. However, if we are not alone and there are other living beings in the universe, this may denote that we are not special and there may be other living beings above us. Beyond question, these two opposing views have an effect on one's understanding of the world. Since religion is related to existential questions, the understanding of humankind's position in the universe is strongly associated with religion. Therefore, humanity's attitude towards the possibility of extraterrestrial life is affected by religion. Whereas some people tend to think of the universe as we are alone, others are ready to believe that there are extraterrestrial life forms because of the background of their religions. Besides religion's effect on people's approach to the possibility of extraterrestrial life, any possible discovery of extraterrestrial life may influence religion. If one's religion makes her believe in the specialty of humankind, any discovery of extraterrestrial life forms can make her question her religion.<sup>1</sup> Thus, the perspective of religions on extraterrestrial life needs to be examined.

Religion affects the understanding of humankind's position in the universe. And the perspective we have about humankind's position has implications for ethical decisions and scientific discoveries. If we are inclined to believe that we are alone, we are free to launch probes to any planet and take resources for us. If we are not, we need to

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<sup>1</sup> Herein, the case mostly applies to the finding of extraterrestrial intelligent beings. But I think even if we find extraterrestrial primitive life forms, this would still imply the mediocrity of the biology of humankind, therefore the mediocrity of humankind.

ponder ethical issues for space missions in case there may be unicellular life forms. Also, if our supposition is that we are alone, we may not tend to spend funds for researching extraterrestrial life forms. Whereas we have projects to search for extraterrestrial life forms there are more options to search for technosignatures of extraterrestrial life. Whether new projects which require more funds to search for extraterrestrial life should start is partly up to our expectancy of finding extraterrestrial life forms. If we don't believe that we can find extraterrestrial life, we don't need to spend funds for it. I believe, religion may affect scientific discoveries in this regard.

Because of the relationship between religion and the possible extraterrestrial life forms, any kind of scientific discovery in support of the existence of extraterrestrial life can affect religious views. We hear news about findings of exoplanets, possible biosignatures, and even technosignatures of life. If scientists confirm for sure that extraterrestrial life exists, one may question her religion. And since religion affects one's understanding in many aspects of life, one should evaluate the possibility ahead of time. Thus, evaluation of extraterrestrial life from the perspective of different religions has high importance. Herein, I investigate the attitudes of Islam towards extraterrestrial life. Most of the researches about the relationship between extraterrestrial life and religion are concentrated on Christianity (McAdamis 2011). However, the possibility of extraterrestrial life has to be evaluated from the perspective of other religions.

To investigate the possible attitudes of Islam on extraterrestrial life, I will first mention the history of the query for extraterrestrial life. Then, in the second chapter, I will cover how we search for extraterrestrial life along with different opinions on extraterrestrial life. Afterward, in the third chapter, I will delve into the approach of Islam towards the possibility of extraterrestrial life.

## **CHAPTER II**

### **HISTORY OF THOUGHTS ON EXTRATERRESTRIAL LIFE**

Humankind has an extensive imagination, which made perfect presumptions possible. The imaginative power of humanity made people capable of conceptualizing intelligent beings other than us. Although the term extraterrestrial life is relatively new (Dick 1982, 2), the search and contemplation on it go as far back as antique times. There were people including philosophers who thought of extraterrestrial living beings since ancient times among Greek and Latin philosophers (Crowe 1997, 148). Many of the thinkers who thought on the issue were atomists, such as Leucippus (fifth century B.C.E.), Democritus (460 B.C.E. – 361 B.C.E.), Epicurus (342 – 270 B.C.E.), Metrodorus (fifth or fourth century B.C.E.), and Lucretius (99 – 55 B.C.E.). The atomist tradition paved the way for the views of the mediocre<sup>2</sup> world which leads to thoughts on extraterrestrial life.

#### **1.1. Atomism**

The atomist philosophy which is constructed by Leucippus and Democritus claimed that our universe contains an infinite number of unchanging and indivisible atoms swirling in the void. With the bumping of atoms to each other, what we see in the universe are constituted. The infinite number of atoms can collide with each other in an infinite number of combinations. The infinite number of possibilities implies that there may be other worlds<sup>3</sup> (Roush 2020, 18). In that case, there is no reason to suppose that Earth is unique (Wilkinson 2013, 17). Following the atomist tradition, Epicurus spoke of many worlds: “There are infinite worlds both like and unlike this

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<sup>2</sup> In this thesis, I use “mediocrity” and “uniqueness” concepts. By uniqueness, I signify being the most special in creation, and by mediocrity, I signify the absence of uniqueness.

<sup>3</sup> Although the understanding of the world is very different than what we understand present day, the world seems to encompass Earth.

world of ours. For the atoms being infinite in number . . . are borne far out into space” (Quoted in Crowe 1997, 148). Like Epicurus, some other philosophers suggested that there are other worlds (Tipler 1981). For example, Metrodorus -a pupil of Democritus- denoted the absurdity of believing that there is only our world: “It seems absurd, that in a large field only one stalk should grow, and in an infinite space only one world exist” (Quoted in Roush 2020, 18). Also, the Roman poet Lucretius is another example to show that the discussions that we are not alone in the universe are not new: “In the universe, nothing is only one of its kind. In other regions, surely there must be other Earths, other men, and other beasts of burden” (Quoted in Wilkinston 2013, 18). As it may seem from the examples of the philosophers, if we would be following this ancient tradition, the mediocrity of our world would be acknowledged afterward.

## **1.2. Thoughts of The Unique World**

If the atomist tradition would win the day, we would witness more examples of contemplations on the mediocrity of the world, which makes way for the thoughts of extraterrestrial life forms. But atomist tradition did not dominate in Europe. Instead of atomist tradition, followers of unique world views won the day. While atomist philosophers were adopting the “Principle of Plenitude” (Crowe 1997, 148) regarding the infinite potentiality of possibilities, there were other ancient philosophers who comprehended our world as if it is the only and unique one.

Plato (428 – 348 B.C.E.) and Aristotle (384 – 22 B.C.E.) are two key figures in ancient times who contemplated the world as unique, for various reasons. Plato, who was no doubt an influential figure in many aspects, thought that one Creator signifies that there is only one world (Roush 2020, 20). As it may seem, his theological views were influential on his views about the plurality of worlds.

Also, Aristotle’s theological views influenced his ideas on the plurality of worlds. According to his theology, there is a Prime Mover who starts all movements and doesn’t move himself. He thought that if there is more than one world, then there must be more than one Prime Mover, which was not compatible with his theology (Roush 2020, 20). But besides the theological concerns of antique philosophers, Aristotle also had cosmological reasons to oppose atomist tradition and the plurality of worlds.

According to Aristotle's cosmology, there can be only one planet harboring life on it. Whereas there are elements which seek the center, according to Aristotle, the plurality of worlds would cause the existence of more than one center. Since objects are moving towards only one center, the plurality of worlds was impossible for Aristotle's cosmology (Weintraub 2014, 11). In Aristotle's cosmology, there is only one center in the universe, which is our world. We call this view "geocentric".

### **1.3. Dominant Perspectives**

In the long run, instead of atomist tradition, Aristotle and Plato's views had more influence on their descendants, especially in the Western tradition. Although these thinkers lived before the beginning of Christianity, their thoughts of the unique world merged into the religion. Christian thinkers who shaped the minds of the next generations preferred Aristotle and Plato's views over the atomist tradition (Crowe 1997, 149).

For example, Thomas Aquinas –a prominent Christian philosopher who was under the influence of Aristotle's teachings- opposed the views of the plurality of worlds. He refused the ideas of atomist tradition and stuck to Aristotle's ideas along with the scripture. He believed that there is only one world (Weintraub 2014, 14). Although there were exceptions, such as Nikolaus of Cusa (1401 – 1464), the Western tradition was under the influence of Aristotle and Aquinas' philosophy until the enlightenment period in the sixteenth century (Traphagan 2015, 22).

The case was not much different among philosophers in the Islamic world as well. Many Islamic philosophers such as al-Farabi, Ibn Sina, and Ibn Rushd were under the influence of antique Greek philosophers Plato and Aristotle. The Muslim philosophers adapted the ideas of Aristotle and Plato into their philosophy. But in Islamic tradition, the exercise of philosophy is performed by two parties: kalam scholars and philosophers. Whereas we can categorize both of the parties in the group of philosophers in the present day, they were named differently back then. The kalam scholars operated as much intellectual exercise as philosophers. But the kalam scholars took the Quran -the Holy book of Islam- as their basement. They opposed taking the ideas of antique philosophers as a presupposition. While many performers of kalam

were stuck to atomist philosophy (Zamboni 2021, 199), many philosophers were defending the uniqueness of our world. Kalam scholars were closer to acknowledging the mediocrity of the world. For example, a kalam scholar al-Ghazali (11th century C.E.) was open to the ideas of inhabited worlds (Mahmood [1987] 2010, 175). This is not an exceptional view among kalam scholars. Also, kalam scholar Fakhreddin al-Razi (1149-1210 C. E.) discoursed ideas in line with al-Ghazali and criticized the advocations of the unique world, for the sake of defending the plurality of worlds (cited in Setia 2004).

As it can be seen from the examples, the Islamic world and Western milieu had some different perspectives on the mediocrity of the world. With the influence of the kalam scholars, the intellectual atmosphere in the Islamic world was open to acknowledging the mediocrity of the world. Although there were Muslim philosophers under the influence of Aristotle and Plato's philosophy, their claims on the uniqueness of the world were not based on theological reasons. Whereas, kalam scholars, who took the Quran as the basis of their philosophy, were open to the possibility of mediocrity of the world and extraterrestrial life.

Contrary to the situation in the Islamic world, in the Western tradition, the views of Aristotle and Plato were merged into Christianity. The opinions of the philosophers became as if they are the requirements of Christianity. We see the importance of these opinions for the church by some incidents in the enlightenment period, as I will mention in the next section. The church had taken Aristotle's views as if they were essential for Christianity and harshly objected to opposite views.

#### **1.4. The Enlightenment Period in Europe**

The medieval catholic church was impinged by Aristotelian teachings. Therefore, the ideas contrary to Aristo's unique world views were threatening the church (Theodosiou et. al. 2010, 52). Two incidents can be presented to show the strong attachment of the church to the Aristotelian cosmology: the imprisonment of Galileo Galilei (1564 – 1642) and the burning of Giordano Bruno (1548 – 1600). But after these incidents in the 16th century, the unique world views started to change in Europe.

The enlightenment period in Europe has been started by the contributions of well-known scientists. One of them is Nicolaus Copernicus (1473 – 1543). He made an important step towards leaving Aristotle's geocentric view. According to him, our Earth was not at the center of the universe. Earth was just a planet in the vicinity of the Sun and the planets around the Sun were rotating around it. He presented the model in his book "De Revolutionibus Orbium Coelestium (On the Revolutions of the Heavenly Spheres)" in 1543. We call the model in which Sun is at the center and planets revolve around it the "heliocentric model." While this model has no opposition to our common sense in the present day, this was not the case when Copernicus expressed his ideas. His scientific studies were putting humankind in an ordinary place. Instead of inhabiting the center, humans became located in an ordinary place in the universe. The mediocrity of Earth was implying the possibility of the existence of extraterrestrial life. Although Copernicus never mentioned the issue (Crowe 1997, 150), followers of him brought up the ideas of extraterrestrial intelligence. In the long term, Copernicus created a revolution and takes the responsibility of ending the dominance of Aristotelian cosmology (Wilkinson 2013, 20).

Following Copernicus, Giordano Bruno (1548-1600) expressed the ideas of the plurality of worlds. Although he was not a scientist but a monk, his queries pushed him for having some opinions about science. As a religious thinker, he was affected by the implications of Copernicus' heliocentric model. He proposed that there are other worlds and our world is just one among others. Moreover, he suggested the existence of extraterrestrial beings. In the infinite universe, there were other inhabited worlds, according to Bruno (Weintraub 2014, 16-7). Because of the attachment of the church to Aristotelian cosmology, his suggestion about extraterrestrial beings was not welcome by the church. The church was discoursing that the universe is created for only humans (Roush 2020, 25). Because of his contentious views that were seen as heresy by the church, the Roman Catholic Church burned him at the stake in 1600 at Campo de' Fiori. There is no doubt the church is to be blamed in Bruno's case. But there are faulty statements about Bruno's case. Bruno is usually presented as the first martyr of the belief in extraterrestrial life. However, the truth is more complicated than this. Bruno had other opinions about religion that were consequently seen as heresy by the church (Crowe 1997, 150-151). However, even though his ideas about

extraterrestrial life were not the only reason, I think the case is still an example of the conservative attitude of the church against heliocentric views.

Another incident as an example of the church's conservative approach towards Aristotelian cosmology is the house arrest of Galileo Galilei (1564-1642). There is no doubt that the Italian scientist was an influential figure in the period of the transition of the geocentric view towards the heliocentric view. He showed that Aristotle was not right in all issues. For example, according to the physics of Aristotle, heavy objects fall faster than lighter objects. Aristotle's claim had been accepted for many centuries without question. But in the sixteenth century, Galilei decided to experiment to examine whether Aristotle was right. He ascended to the Leaning Tower of Pisa and dropped two objects, one was light and the other was heavy. After the observations, he concluded that the calculations were not vindicating Aristotle. This experiment was a sign that Aristotle was not right on every subject he handled. Also, it was a sign of the importance of experimentation for generating knowledge.

Galilei's observations and scientific studies were opposing Aristotle in certain aspects. As a matter of course, his contributions to astronomy were igniting the questionings of Aristotle's cosmology. He had a telescope to observe space and observed the moon and other celestial bodies. He discovered the moons of Jupiter. By his thorough investigations, he concluded that contrary to Aristotelian cosmology, the Earth was not at the center of the universe and it was orbiting around the Sun. His studies were supporting Copernicus and he was put on trial because of his allegedly heretic ideas. As a result of the court, he was punished to be under house arrest until his death.

As in Bruno's case, the truth is more blurred than what has usually been told to us. It is usually mentioned that Galileo Galilei was put under arrest just because of his support for the Copernican system. But this was not the only reason. Galilei insulted the Pope and he was working on the commentary of the Bible. Whereas we shouldn't ignore other effects to put Galilei to the trial, it cannot be denied that both in Galileo's and Bruno's case, their denial of Aristotle was probably a factor for their punishment.

A point worth considering is that whereas these thinkers were not welcome by the church, all of them were religious Christians. None of them gave up on their religion

because of the ideas contrasting the statement of the church. Also, Johannes Kepler (1571 – 1630), another scientist who contributed to the enlightenment period was religious and saw no contrast between his views and Christianity.

Johannes Kepler supported heliocentric views as well. He explained the motions of the planets by his three well-known laws and also contributed to the field of optics. Besides his support for the model of Copernicus, he made bold claims on the issue of extraterrestrial life. He believed that there were living beings on the Moon. Also, Galileo's discovery of the moons of Jupiter was implying the existence of life on Jupiter, according to Kepler: "It is improbable, I must point out, that there are inhabitants not only on the moon but on Jupiter too" (Quoted in Weintraub 2014, 19). He was open to acknowledging other beings: "How can all things be for man's sake? How can we be masters of God's handiwork?" (Quoted in Wilkinston 2013, 138).

After the endeavors of these scientists, the Enlightenment in Europe flourished. The Aristotelian cosmology lost its strength. With the raised opinions on the mediocrity of the world, the way towards the ideas on extraterrestrial life made in Europe. In the seventeenth and eighteenth centuries, there were numerous examples commenting on extraterrestrial life. I will talk about some of the figures who handled the issue of extraterrestrial life and opinions about religion, in the next section.

### **1.5. After the Enlightenment Period**

After the Copernican revolution in Europe, many thinkers including scientists talked about extraterrestrial life. One of the important scientists who mentioned the issue was Christiaan Huygens (1629-1695). The Dutch astronomer worked on Saturn's rings and moons. He thought that the plurality of planets around other stars was a sign of the plurality of life (Wilkinston 2013, 22). He addressed extraterrestrial life in his book *Cosmotheoros* which is translated to English as *Celestial Worlds Discover'd*. His expressions escalated the interest in extraterrestrial life among further generations (Crowe 1997, 152). Similar to the thinkers of enlightenment I mentioned so far, he was attached to theistic views (Crowe 2008, 86-108). Contrary to the attitude of the church, his theological convictions allowed him to contemplate extraterrestrial life. He believed that since we cannot see other stars, there may be creatures to see them for the glorification of God:

Since then the greatest part of God's Creation, that innumerable multitude of Stars, is plac'd out of the reach of any man's Eye; and many of them, it's likely, of the best Glasses, so that they don't seem to belong to us; is it such an unreasonable Opinion, that there are some reasonable Creatures who see and admire those glorious Bodies at a nearer distance? (Quoted in Crowe 2008, 89).

Another articulation about extraterrestrial life comes from Gottfried Wilhelm Leibniz (1646-1716 C.E.). The famous mathematician is known by the calculus controversy with Sir Isaac Newton (1643-1727), who was also pondering extraterrestrial life (Crowe 2008, 109-115). Leibniz contributed to philosophy and hypothesized on the possibility of extraterrestrial life. He stated that the possibility of extraterrestrial life implies the existence of it (Weintraub 2014, 20). According to Leibniz, we as intelligent beings were just a small part of God's creation (Murray 2013).

After the seventeenth century, the mediocrity of Earth became a reasonable opinion for many thinkers. With the raised notions on extraterrestrial life, also the implications of extraterrestrial life from the aspect of religion became clearer. Therefore, there were comments of two opposing views. While some people were believing that it is possible to believe in both religion and extraterrestrial life, others were defending the opposite. Let me call the latter view the "contradiction view".

An example of the view that religion and extraterrestrial life can be reconciled was David Rittenhouse (1732-1796 C.E.), who was an eminent astronomer. He talked over extraterrestrial life and the issue of the alleged conflict between Christianity and the plurality of worlds and claimed that there is no conflict between science and religion (Weintraub 2014, 21). In the *Oration*, he pointed out the plurality of creation:

When we consider this great variety so obvious on *our* globe, and ever connected by some degree of uniformity, we shall find sufficient reason to conclude, that the visible creation, consisting of revolving worlds and central suns, even including all those that are beyond the reach of human eye and telescope, is but an inconsiderable part of the whole. Many other and very various orders of things unknown to, and inconceivable by us, may, and probably do exist, in the unlimited regions of space. And all yonder stars innumerable, with their dependencies, may perhaps compose but the leaf of a flower in the creator's garden, or a single pillar in the immense building of the divine architect (Quoted in Crowe 2008, 215).

However, history was not dominated by those who think religion is compatible with extraterrestrial life. Some thinkers held the contradiction view and they were satisfied by the opinions on the plurality of worlds. Thomas Paine (1737-1809) is an influential figure who held the contradiction view. He expressed his ideas in his book *The Age of*

*Reason.* His book had been read by a big number of people and he took part in the tension between Christianity and extraterrestrial life. He stated that one can believe in either Christianity or extraterrestrial life, believing in both was contradictory. Since he was not in doubt that current scientific findings were indicating extraterrestrial life, he preferred to leave religion. He thought that some teachings of Christianity, including the death of Jesus as God for the atonement of the sins of humankind, cannot be in agreement with extraterrestrial life, and became a deist (Wilkinson 2013, 25). His opinions on the contradiction between extraterrestrial life and Christianity had a huge impact on society (see Crowe 1997, 153-154). His contradiction view was caused by his satisfaction that Christianity could not be accommodated with the plurality of worlds: “But, in the midst of those reflections, what are we to think of the Christian system of faith, that forms itself upon the idea of only one world, and that of no greater extent, as is before shown, than twenty-five thousand miles?” (Quoted in Crowe 2008, 228).

Together with all discussions about religion, the considerations on extraterrestrial life took an important place in the eighteenth and nineteenth centuries. Besides these names, philosopher Immanuel Kant (1724-1804) contributed to the views of extraterrestrial life. He expounded plurality of worlds in his writings and adopted the “principle of plenitude” for his thoughts (Crowe 2008, 139). He expressed that he believed in other living beings in other worlds: “... it is not merely an opinion but a strong belief ... that there are also inhabitants of other worlds” (Quoted in Weintraub 2014, 23).

Also, William Herschel (1738-1822) is another historical example to demonstrate that many high-profile thinkers believed in extraterrestrial life in the eighteenth century. He was one of the most important astronomers of the eighteenth century and besides his other outstanding contributions, such as the map of the Milky Way, his works on stars, and the exploration of infrared light; he is widely known for his discovery of Uranus. He worked on making better telescopes to help him observe celestial bodies. It may be the case that he was in the hope of detecting life on the Moon by his telescope (Crowe 1997, 152). Despite it was known in his era (Crowe 2008, 175) that the Moon doesn't have an atmosphere, he believed that his observations were signing life on the Moon: “I hope, and am convinced, that some time or other very evident signs of life

will be discovered on the moon” (Quoted in Crowe 2008, 176). He asserted that other planets such as Mars, Saturn, Jupiter, and Uranus had life forms inhabiting them (Weintraub 2014, 24). Besides, he was even believing extraterrestrial life on the Sun:

The sun, viewed in this light, appears to be nothing else than a very eminent, large, and lucid planet, evidently the first, or in strictness of speaking, the only primary one of our system; all others being truly secondary to it. Its similarity to the other globes of the solar system with regard to its solidity, its atmosphere, and its diversified surface, the rotation upon its axis, and the fall of heavy bodies, leads us on to suppose that it is most probably also inhabited, like the rest of the planets, by beings whose organs are adapted to the peculiar circumstances of that vast globe (Crowe 2008, 180-181).

During the eighteenth century, it was common among scientists and intellectuals to believe in some form of extraterrestrial life. NASA's historian Steven Dick claims that in the middle of the eighteenth century, the majority in the West were expecting extraterrestrial life (Vainio 2018). Also, there were many Christians in support of extraterrestrial life partly motivated by religion (Crowe 1997, 152). However, beginning with the publishing of Paine's book, the views started to change. In the nineteenth century, the contradiction view was the common view in Europe. While the science of these days was signaling the view in the existence of extraterrestrial life, religion has affected the contemplations in Europe. Two intellectuals can be presented as an example of the effect of the contradiction view: Ralph Waldo Emerson (1803-1882) and William Whewell (1794-1866). Both intellectuals were religious but concerned about extraterrestrial life.

Ralph Waldo Emerson was a writer who was interested in philosophy and astronomy. He had a religious background and he was a pastorate. His religious notions were influenced by astronomy and he was in the expectation of the existence of extraterrestrials: “Each of the eleven globes, therefore, that revolve round the sun must be inhabited by a race of different structure” (Quoted in Crowe 2008, 320). Despite his previous religious convictions, he was affected by the discussions triggered by Thomas Paine (Crowe 1997, 154). Strikingly, in the September of 1832, he resigned and left the pastorate because of his difficulty in the reconciliation of some Christian teachings such as atonement (Crowe 1997, 154) with astronomy. While refusing atheism, he also criticized some teachings of Christianity (Crowe 1997, 154).

Paine's views affected intellectuals other than scientists as well. Evidence indicates that former U.S. president John Adams was also impressed by the contradiction view.

His sympathy for the possibility of extraterrestrial life made him question his religion (Crowe 2008, 207). Also, famous writer Mark Twain was under the influence of Paine's contradiction view (Wilkinson 2013, 26).

As it can be seen, there was a disposition towards the contradiction view in the nineteenth century. Also, William Whewell (1794-1866), who was a religious Christian and priest in the Church of England, was affected by the contradiction views. As Master of Trinity College, he contributed to science, philosophy, and religion by his writings. While he expressed his ideas in support of extraterrestrial life in his work *Astronomy and General Physics* in 1833, he dramatically changed his opinions in the following years. Whewell changed his opinions after realizing some problems between his religion and extraterrestrial life. He believed that it is not simple for some teachings of Christianity to be reconciled with extraterrestrial life (Crowe 2008, 333). He published his modified opinions anonymously in his *Of the Plurality of Worlds: An Assay* in 1853.

Whewell was not arguing without basis. He was not in agreement with the religious people who are motivated by their faith to believe in extraterrestrial life. Also, he believed that the current scientific information they had was not enough to conclude the existence of extraterrestrial life (Wilkinson 2013, 27). He had scientific justifications to oppose extraterrestrial life. He assessed the "temperature zone", the tight area in which life can be maintained, to dispute extraterrestrial life. The conditions were too tight to allow life, and other planets in our Solar system were not friendly for harboring life, according to him. For example, the Moon had no atmosphere, the planets farther than Jupiter were not getting enough light to support life, Jupiter had too much gravity also Mercury and Venus were too close to the Sun and therefore too hot (Roush 2020, 31). The idea of the temperature zone is similar to what we call the habitable zone in the present day (Crowe 2016, 440-441).

Besides scientific concerns, he also objected to the plurality of world claims originated by religious concerns. While the principle of plenitude was implying that we should be expecting more creation from an omnipotent God, he thought that geological evidence was not in line with this expectancy. Humans being the only intelligent life in the universe was compatible with religion, according to him. There was not any intelligent life in the past of Earth for a long time. Similar to the example in Earth, we

may be the only example of the intelligent life in the universe. God could create places without intelligent life, as he withheld intelligent life from Earth for a long time (Crowe 2016, 441).

As it is evident, Whewell endeavored for reconciling the astronomical evidence with his religion, after realizing the troubles between some teachings of Christianity and extraterrestrial life (Crowe 2016, 442-443). After seeing this tension, instead of leaving religion as Thomas Paine did, he preferred religion over the belief in extraterrestrial life. His choice was justifiable because even though the tendency of scientists was to believe in extraterrestrial life back then, there were not many scientific data to support the belief in extraterrestrial life. After almost two centuries, we are still not sure whether there is extraterrestrial life. There is no doubt that he had many reasons to question the scientific data of his day.

As these examples signify, after the Copernican revolution, intellectuals in the Western world started to consider the tensions between extraterrestrial life and religion. However, we cannot talk about an equivalent effect of the Enlightenment period in the Islamic world. As I mentioned above, there were kalam scholars who held the atomist view before the Enlightenment in Europe. Therefore, we don't witness a sharp transition in the Islamic world, unlike in Europe, towards the mediocre Earth views.

### **1.6. The Decrease of the Expectancy of Extraterrestrial Life**

After the second half of the nineteenth century, the tendency towards the expectancy of extraterrestrial life began to change, in line with the questionings of William Whewell. The acknowledged signs of extraterrestrial intelligence were not as strong as they were first presented.

At the beginning of the nineteenth century, extraterrestrial life was the expectation for many scholars. For example, there was a belief that Mars has intelligent life on it. One of the reasons was the observation of surmised canals on the planet. Italian astronomer Giovanni Schiaparelli (1835-1910) and American astronomer Percival Lowell (1855-1916) created a tremendous interest in Mars by their observations of supposed canals. It was thought that the canals were artificial and Martians were using them to carry water. However, the observations were not canals in reality, and these astronomers were mistaken (Crowe 2016, 447).

Another anticipation of extraterrestrial life was originated from the discourses of life on the Moon. Society was interested in extraterrestrial life with the influence of news suggesting that the astronomer John Herschel -son of the astronomer William Herschel- observed intelligent life on the Moon. The news was published in New York Sun Newspaper in 1835 by Richard Locke (1800-1871). Although it was known that the Moon has no atmosphere, this claim was believed by the public. The newspaper even published an image of the alleged extraterrestrial life. The disappointing incident is known as “The Great Moon Hoax” today (Crowe 2016, 437).

The realization of the false beliefs started a rightful questioning of the evidence and ideas in support of extraterrestrial life. The mistakes became a warning for the evaluation of claims for extraterrestrial life. In the late part of the nineteenth century, the belief in extraterrestrial life was diminished (Crowe 1997, 159). Besides the fallacies, also the developments in understanding life were another reason to leave the expectancy of extraterrestrial life. Once scientists became aware of the difficulties in harboring life for a planet, the prevalent opinion converted to not believing in extraterrestrial life.

The difficulties for life were realized with the developments in the evolutionary explanations. The theory of evolution which is at the center of biological science was systematized by two scientists: Alfred Russell Wallace (1823-1913) and Charles Darwin (1809-1882). The theory was signing the difficulties for the evolution of intelligent life forms. Therefore, it wasn't probable to expect extraterrestrial intelligent life. Wallace, the co-discoverer of natural selection, assessed the probability of intelligent life as very low (Wilkinson 2013, 27). He published his claim in his book *Man's Place in the Universe: A Study of the Results of Scientific Research in Relation to the Unity or Plurality of Worlds*. He thought on the opinion that humankind was unique and special (Crowe 2008, 428):

I submit, therefore that the improbabilities of the independent development of man, even in one other world—— and far more in thousands or millions of worlds, as usually supposed——are now shown to be so great as to approach very closely, if not quite to attain, the actually impossible (Quoted in Crowe 2008, 436).

To sum up, the developments in astronomy and biology was implying our loneliness. The trend continued to change in support of the nonexistence of extraterrestrial life until the dawn of a new scientific area called *Astrobiology*. Modern science supplies

us with the materials it never did before, to consider the possibility of extraterrestrial life. The thinkers I mentioned in this chapter and many more who are not introduced here had various opinions on extraterrestrial life. But in fact, none of them had enough materials to have a conclusion. They didn't have more information about the possibility than Aristo or atomists did in the antique times (Weintraub 2014, 24-25). However, we have much more data in the present day. In the next chapter, I will discuss *Astrobiology* and the current scientific knowledge in the area.



## CHAPTER III

### MODERN SCIENCE ON EXTRATERRESTRIAL LIFE

As it is seen from the discussions I mentioned in the previous section, humankind has a questioning mind to wonder whether we are alone in the universe. In the present day, we have advanced technology that allows us to contemplate the issue better than we had before. While there were many thinkers who had strong conclusions on the question of whether there is extraterrestrial life, we still cannot have a certain conclusion supported by scientific evidence even with present day's developed technology. But there are some hopes that can supply us with answers to the question. In this chapter, I will discuss the emergence of a new field for the search for extraterrestrial life, and delve into our scientific questionings about extraterrestrial life. Also, I will mention different opinions on extraterrestrial life and its evolution.

#### 2.1. Raised Interest in Astrobiology

In this section, I will present some incidents in the 90s that increased the expectancy of finding extraterrestrial life and consequently gave rise to the field of *Astrobiology*. Astrobiology is the scientific area that encompasses issues from both astronomy and biology. The origination, evolution, and fate of life in the universe are studied by this field (Catling 2013, 2). After the incidents I will mention, the interest of society in extraterrestrial life increased dramatically. The view of the public stating our loneliness in the universe for most of the nineteenth century started to change with the effect of the popularized interests.

One incident that raised hope for extraterrestrial life was the possible signs of unicellular life on Mars (Catling 2013, 2-3). While the anticipation was abated after the surmised observations of canals and the disappointment that came with the realization of the fallacy, a meteorite that came off Mars reawakened the discussions again. Although hardly anyone was expecting to find an intelligent life form on Mars, unicellular life could be possible.

The meteorite that increased the hope was ALH 84001, which was found in Antarctica in 1984. The scientific examinations on the meteorite with 1.9 kg weight showed that this object did not belong to Earth and came off Mars about 16 million years ago. It was located on the Earth around 13,000 years ago and had a crystalline structure on it. This meteorite was an opportunity to search for signs of life without leaving our planet. In 1996, it was claimed that the meteorite could be carrying signs of Martian life on it. Biological activity similar to bacteria's was possible, according to the examinations of the meteorite (McKay et. al. 1996). Needless to say that this news created intense interest.

However, after more than two decades, scientists are still not in agreement whether the meteorite was carrying signs of bacteria-like life. While the structures resembling fossils are very small to contain nucleic acids, some scientists still think that the meteorite presents us previous life forms on Mars (i.e. Tyson, 2010).

Although this meteorite took much interest in society, it is not the only sample we have from Mars. Since the two planets are close to each other, it is highly probable to find rocks coming off Mars to our planet. An asteroid may take some rocks off Mars and they may end up on our Earth. Therefore, we need to examine meteorites more carefully to search for signs of Martian rocks on Earth.

However, even if we were sure about the structures to be signs of life, still we wouldn't be sure about their implications. Because if the life we find on Mars is similar to the life on Earth, we may not be sure that they have a different origin. While the second origination of life would have an enormous impact on our understanding of life, if the origination of any kind of life we find on another planet is not independent from that of Earth, the influence would be less. Although the discussion on whether ALH84001 contained fossils on it doesn't have a powerful conclusion, it ignited an interest in extraterrestrial life and contributed to scientific investigations in this regard.

Besides the claims about Martian life on ALH84001, also understanding some biological limits of life increased the hope to find life (Catling 2013, 2-3). The examinations of life showed us that some microorganisms can maintain life in hostile conditions such as high salinity and extreme temperature, PH, radiation, and pressure conditions. We name the organisms which live in extreme conditions compared to our

conditions as *Extremophiles*. The discovery of extremophiles escalated motivations for astrobiology. Because it was implying that seemingly harsh environments could harbor life on it. Therefore, we could extend the definition of habitability. After researching extremophiles for the last half-century, we know that the conditions for life are not as limited as we once thought. For instance, living organisms can be found in volcanic vents. Also in 2007, while they are not included in the group of extremophiles, tardigrades -which are organisms famous for their ability to survive, were sent to space by European Space Agency on FOTON-M3 for 12 days and they managed to survive (Rebecchi et. al. 2009).

The realization of extremophiles has been initiated by some observations in the last decades. For example, a unicellular life form was discovered in a hot spring of Yellowstone National Park in 1965 by Thomas Brock. The temperature in this hot spring was warmer than the limit of life had been thought of back then. Therefore, the data Brock supplied added information to life sciences. This implies that very hot and seemingly hostile planets could support life. On the opposite, Lake Vostok in Antarctica which has extremely cold conditions, has indications of unicellular life. Because its conditions are similar to this extremely cold place, it is possible that Europa -a moon of Jupiter- also may harbor life in its subsurface oceans (Catling 2013).

Another incident that increased the motivation for astrobiology was the findings indicating subsurface oceans in Europa. The surface of the moon of Jupiter is enclosed by ice and the results of the Galileo Project of NASA pointed to the existence of an ocean under the icy shell (Catling 2013, 2-3). By examining the data sent by Galileo which was in orbit around Jupiter for about eight years, it has been concluded that Europa may have more subsurface water than Earth's total water. Since water is crucial for the biochemistry of living organisms on Earth, the project raised hope for finding life in the Solar system (NASA 2021m). Although Europa doesn't take enough sunlight energy to support chemical reactions, it may support life by radiation (NASA 2021g).

The exciting discoveries that gave rise to astrobiology are not restricted to our Solar system. Besides the data coming from Mars and Europa, also the developments in technology led to the detection of planets far from the Solar system (Catling 2013, 2-

3). To date, as I am writing this, there are 4375 exoplanets confirmed. Among the huge number of planets, 165 of them are terrestrial as our Earth is (NASA 2021d). The first exoplanet detection occurred in 1992 (Wolszczan & Frail 1992). After this date, we had new methods to search for them and the speed of discovery increased exponentially.

The realization of the exoplanets made scientists think about how common life is in the universe. There is no doubt that the discoveries changed the mind of humankind. While before the observations of Edwin Hubble (1889-1953) in 1924 scientists were thinking of the universe as only the Milky Way Galaxy, now we know that our galaxy is just one of many and there is a huge expanding universe beyond it.

All these factors that contributed to the dawn of astrobiology motivated both scientists and the public for searching for life. This brings some questions to the mind of the researcher. In the next section, I will review these challenges.

## **2.2. Likelihood of Life**

These factors may sign the existence of life on a distant planet. However, there is a limit in our search for life because we have to search for life as we know it. There may be other signs of life as different biochemical structures. Since we have never seen another example of life originated by a different ancestor, we don't know which conditions are necessary for the emergence of life. Because we don't know enough about life, we are not able to find a noncontentious definition of life. Different parties define life differently.

To give some examples of differences; while NASA defines life as “a self-sustaining chemical system capable of Darwinian evolution” (NASA 2021), eminent physicist Schrödinger assessed life with respect to entropy (Schrödinger 1992), and biochemist Albert Szent-Gyorgyi defined it as: “Life is nothing but an electron looking for a place to rest.” (Quoted in Camprubi et. al. 2019) Also, a chemist Addy Pross defines life as “a self-sustaining kinetically stable dynamic reaction network derived from the replication reaction” in which dynamic kinetic stability refers to persistence (Pross 2012). As it can be seen from the different explanations, there is no general agreement on the definition of life (Machery 2012). Because we still don't know how and where

life emerged, finding a noncontentious definition is troublesome. These unknowns foreshadow some different opinions about the questions of life, such as the likelihood of life.

For a motivation to search for life, we think of life as it emerges whenever and wherever conditions are appropriate. However, this may not be the case and not all scientists agree on the issue. Every knowledge we gain in biology increases the contentious nature of the subject of how life emerges. Jacques Monod mentioned the issue:

The discovery of the universal mechanisms basic to the essential properties of living beings ought, one would think, to have facilitated solving the problem of life's origins. As it turns out these discoveries, by almost entirely transforming the question (today posed in much more precise terms) have revealed it to be even more difficult than it formerly appeared (Monod 1972, 140).

Whereas some scientists think that life is highly probable, others are convinced that life is almost a miracle-like chance. Monod takes the chance account on this issue: "The universe is not pregnant with life nor the biosphere with man" (Monod 1972, 145-146). He also said: "Man at last knows that he is alone in the universe's unfeeling immensity, out of which he emerged only by chance" (Monod 1972, 180). Also, Nobel laureate Francis Crick had a similar view on the emergence of life "The origin of life appears at the moment to be almost a miracle, so many are the conditions which would have had to have been satisfied to get it going" (Quoted in Davies 2010). Likewise, paleontologist Simon Conway Morris asserts that the emergence of life may be highly improbable. Despite his claim that once life emerged having some human-like features is inevitable, he mentions that the emergence of life can be low probable:

...life may be a universal principle, but we can still be alone. In other words, once you are on the path it is pretty straightforward, but finding a suitable planet and maybe getting the right recipe for life's origination could be exceedingly difficult: inevitable humans in a lonely Universe (Morris 2003).

However, Ernest Schoffeniels proposed the opposite view in his critique of Monod: "The origin of life and evolution were necessary because of conditions on Earth and the existing properties of the elements" (Quoted in Hazen 2017). Also, Nobel laureate biochemist Christian de Duve believed that life is a cosmic imperative and there may be extraterrestrial life forms:

The conclusion emerging from this summary analysis is that the origin of Earth life, being dependent on deterministic chemical reactions and on frequently optimizing selection processes, must have been close to obligatory under the physical–chemical conditions that obtained at the site of its birth (de Duve 2011).

Likewise, Stephen Jay Gould was holding a similar opinion on the emergence of life: “I do not, by the way, view the origin of life itself as a chancy or unpredictable event. I suspect that given the composition of early atmospheres and oceans, life's origin was a chemical necessity” (Gould 1990, 309).

As it may be seen, some scientists hold opposite opinions on the likelihood of the emergence of life. The contentious structure of the discussions on life makes it harder to contemplate life elsewhere. In the next section, I will discuss some clues for recognizing extraterrestrial life along with some candidate places to harbor life.

### **2.3. Candidate Places to Harbor Life in the Solar System**

To search for life elsewhere, scientists use some information about life on Earth. We believe that necessary habitability conditions for the life to survive ought to be maintained in the candidate planets to harbor life. Water is crucial for the chemical processes of life as we know it. Therefore, search for life includes a search for water, because it is an appropriate solvent for biochemical reactions. Also, a convenient temperature is required for biochemical reactions of life. Moreover, an energy source is necessary such as light energy or a different source. Besides; elements such as carbon, hydrogen, nitrogen, oxygen, phosphorus, and sulfur are prevalent for life as we know it, and their existence may be important for habitability (Cockell et al. 2016).

To detect life on distant planets, we should search for signs that indicate the existence of life on a planet. The indicators of life are named *biosignatures* and they help us to recognize life without actually seeing it. By examining biosignatures on the atmospheres, we can notice life even without having missions that land on the planets.

Although there are many unknowns about life, we still have the ability to search for life as we know it. As I mentioned in the section “Raised interest in astrobiology”, there are some candidate celestial bodies to support life. Herein, I will discuss the modern astrobiology data on the candidate places to harbor life.

Our Solar system consists of planets and moons that orbit around the Sun. Although there are many other stars along with their planets and moons, we cannot study them in detail except using the exoplanet research techniques I will mention in the next section. However, we have missions to visit candidate places to harbor life in our Solar system. Whereas the Solar system is just a tiny part of the gigantic universe, because of the long distances, we cannot have landing missions to distant planets. Although the case seems despairing, space missions recorded some hopeful data.

Mars is the planet that most of the speculations about life disclosed. It is the first planet after Earth, according to the distance from the Sun. The planet has common features with Earth. For example, one day of Mars is approximately 24 hours and it is a rocky planet like Earth is. However, it has many different features than Earth and also has hostile characteristics for life. Whereas Earth has a thick atmosphere which is mainly composed of nitrogen and oxygen to support life, Mars has a thin atmosphere that 96% of it is carbon dioxide. Besides, the planet is very cold and dry, which properties contribute to its unfriendliness for life (NASA 2021j; NASA 2021i).

Despite these seemingly hostile characters, scientists thought the planet was worth searching for life on. In 1975, NASA had the Viking Mission which was the first mission to detect life on Mars (McKay 2020). Some scientists were anticipative of life on the planet including famous astrobiologist Carl Sagan: “The possibility of life, even large forms of life, is by no means out of the question” (Quoted in Shostac 2015, 11).

The spacecraft landed on Mars and sent pictures to us. The pictures were not encouraging to hope for life on the planet. It seemed like a dry and dead planet which has no macro life forms on it (Ferris 2010, 9). Within the mission, there were biological experiments. The experiments measured the usage of nutrients and analyzed whether there is metabolism in the soil. Despite Mars had all the necessary elements to support life (McKay 2010, 167), there was no unambiguous sign of life from the mission. On the other hand, in the present day, we know that this method is not very efficacious and there are microorganisms which are not detectable by the method Viking mission used. Searching for biomolecules that living organisms produce is preferred over this method to detect life (McKay 2020).

Although Mars is probably not a suitable place for life in the present time, it had some necessary conditions in its past. Whereas it is a dry planet now, there are signs of former liquid water on it (McKay 2020). By searching for metabolism, we checked whether living organisms exist on Mars in the present day. However, there could be signs of life in its past. Checking metabolism is not the best option to detect ancient life.

To test whether life has ever been on Mars, NASA has another Mission called Perseverance. The rover has landed on Mars on February 18, 2021. It will stock some samples taken from deep parts of the surface for further missions to bring them back to Earth. This mission is an extensive contribution to astrobiological research. It will help us to determine whether Mars was habitable in its past and also search for biosignatures (NASA 2021k).

Another candidate place to harbor life is Enceladus, which is one of the moons of Saturn. Saturn is the largest planet after Jupiter. It is not a terrestrial planet and is composed of hydrogen and helium gases. You cannot find a planet with that much ostensible rings in the Solar system other than Saturn. Its rings are made of pieces of ice and rock. While Saturn is not considered as a proper place to support life, two of its 82 moons (NASA 2021n) are candidates to support life: Enceladus and Titan (NASA 2021e).

Enceladus is composed of a rocky body surrounded by an icy shell. NASA's Cassini spacecraft examined the moon and it has been brought to light that the moon has salty liquid water beneath the icy shell. Besides, gravitational attractions supply energy to Enceladus (NASA 2021a) and there are organic materials which may be originated by biological activity (McKay 2020). This moon may be a suitable candidate to harbor unicellular life. Future missions may enlighten us on the issue.

Another moon of Saturn which is a candidate to harbor life is Titan. Titan is the biggest moon of Saturn. It has a cold temperature because it is far from the Sun. Along with Cassini, which orbits Saturn, Huygens spacecraft of the European Space Agency gave data about Titan. It is believed that Titan has an ocean beneath its surface. Its atmosphere contains organic materials. Although there is no evidence to suggest the

existence of life on it so far, the subsurface ocean may contain life in it and the moon may have habitable environments (NASA 2021o).

Likewise, Jupiter's moon Europa is another candidate to harbor life, as I mentioned in the section "Raised interest in Astrobiology". Jupiter is the biggest planet in the Solar system and like Saturn, it is a gas giant composed of hydrogen and helium. Scientists think that Jupiter has 79 moons (NASA 2021h).

Europa has an icy shell around its core and it is believed that there is liquid water beneath the surface. The first evidence of liquid water was supplied by the Voyager, which spacecraft passed around Jupiter and sent photos to us. And other data supplied by Galileo spacecraft strengthened the thought. Since the moon has liquid water and required chemical materials for life, there is hope to come across life in Europa (NASA 2021b). The information we have about Europa is restricted. However, NASA has another mission called Europa Clipper to examine whether life can be maintained on it (NASA 2021c).

Also, Venus, which is the planet that hasn't been counted as suitable for life for a long time, may have life on it. Venus is the hottest planet in our Solar system because of the greenhouse effect of its thick atmosphere composed of carbon dioxide. Even lead can be molten on Venus. It is the second planet according to its closeness to the Sun. While we get sunlight in eight minutes after light leaves the Sun, Venus gets the light in six minutes. Its spin is opposite to that of Earth and all other planets in the Solar system. The planet has active volcanoes and harsh conditions for life to survive (NASA 2021f).

A planetary mission can be an example to display the harsh conditions on Venus. The Soviet Union's spacecraft Venera 13 landed on Venus in 1982. Because of the harsh conditions, the spacecraft couldn't survive long. But we have data it sent for 127 minutes about the environment of Venus. Also, other missions around the planet contributed to the knowledge about the conditions of Venus. NASA's Mariner 2 launched in 1962 and the Magellan mission launched in 1989 provided data to understand survivability on it.

While the surface temperatures are not friendly to life, clouds may be a convenient candidate. In the last years, Venus' clouds have been considered as potential places to harbor life. The clouds of the planet are made of sulfuric acid. Since there are unicellular life forms that can maintain themselves in acidic conditions, we may expect to find life in there. Also, there are nitrogen and carbon as the necessary elements of life on the planet (McKay 2020).

In September 2020, an article published in *Nature Astronomy* increased the hope for finding life on the clouds of Venus (see Greaves et. al. 2020). The article claimed that there is phosphine gas in the atmosphere of Venus. The presence of phosphine couldn't be explained by nonbiological processes. The gas is known as it is produced by biological processes. Whereas the presence of phosphine on Venus is considered a sign of life, there are questions about whether the gas is phosphine. It is claimed that the purported phosphine may be sulfur dioxide, by which sulfuric acid is produced (Lincowski et. al. 2021). The possibility of life on Venus needs further examination.

As it can be seen, there is no conclusive evidence of life in our Solar system. However, there are other star systems and we can also search for them. In the next section, I will talk about planets orbiting stars other than the Sun.

#### **2.4. Searching for Exoplanets**

We can use a spacecraft to land on the planets or visit their vicinity to explore their features, as has been done by several missions to the planets or moons within the Solar system. However, the Solar system is just a tiny part of the whole universe, and our chance to find life increases dramatically if we can look for life on other star systems. Therefore, we are looking for the signs of life by technological equipment that let us investigate farther planets. We have various methods to research exoplanets.

To detect the exoplanets, there are four main methods. Each method has some positive and negative features. In one of these methods, scientists take a picture of the planets for detecting some exoplanets. This is called the direct imaging method, in which they extract the blaze of the star that planets orbit. The method is not effective compared to others and only %1.2 of the discoveries have been made by this method so far (NASA 2021d).

Another method used to observe exoplanets is called the microlensing method. This method takes into account the bending of light caused by the gravitational effect. The bending can be measured only if the mass of the planet is high. Therefore, it is not a highly sensitive method. (Wilkinson 2016, 421). Of the discoveries, 2.4 % have been made by the microlensing method (NASA 2021d).

A more effective method used to detect exoplanets is the radial velocity method. This method has been used to detect 19.1% of the exoplanets confirmed so far (NASA 2021d). In this method, the wobbling caused by gravitation while orbiting the planet's star is evaluated (Wilkinson 2016, 416).

However, 76.2% of the detected exoplanets have been discovered by the transit method (NASA 2021d). The method is very preferable because once a planet is detected, its orbit and mass can be calculated. In this method, the dimming caused by the planet blocking the light of its star is measured. By calculating the luminosity change, the planet's size can be measured. In NASA's Kepler Mission, which examines Earth-like planets in the universe, the transit method is used (Wilkinson 2016, 418). These examinations can help us to identify habitable planets.

The technological developments led to the discovery of Earth-like planets. One of the Earth-like planets is Kepler-22b. Also, another discovery is Kepler-452b, and the planet is in the habitable zone of a sun-like star too. Along with these examples, there are other candidates for being habitable (Wilkinson 2016, 420).

Kepler and its second mission K2 helped us to determine Earth-like and habitable planets. In 2018, NASA launched another mission, TESS, for exploring exoplanets in transition. The transition method is used for observation in this mission too. The mission is a further step of Kepler mission for searching planets that may have the potential to harbor life (Garner 2021).

The examination of distant planets is crucial because by deducing their atmospheric contents we can understand whether the planet harbors life on it. We can use the spectroscopy technique to monitor atmospheric composition. The chemicals we are looking for are biosignatures of life as we know it. For instance, if we deduce the existence of ozone, which is produced by oxygen in the presence of UV radiation, this

implies photosynthesis reaction, therefore life (Wilkinson 2016, 423). Since it is troublesome to detect oxygen, searching for ozone is preferred. If we identify methane together with ozone, this entails the existence of life on a planet (Catling 2013, 118-119). Oxygen and methane are simply reacted. Therefore, if we conclude their presence on a planet together, this suggests that the reason is life on it producing these. We can detect life by examining these conditions. However, by searching for biosignatures, we can only deduce the existence of life without knowing its quality. We wouldn't understand whether life is primitive or intelligent. All to the good, we are looking for signs of intelligent life independently. So far, I mentioned biosignatures to detect life, but to identify extraterrestrial intelligence, we also search for *technosignatures*. Margot et. al. define technosignature as follows:

We define a “technosignature” as any measurable property or effect that provides scientific evidence of past or present technology, by analogy with “biosignatures,” which provide evidence of past or present life. The detection of a technosignature such as an extraterrestrial signal with a time-frequency structure that cannot be produced by natural sources would provide compelling evidence of the existence of another civilization (Quoted in Pass 2019).

In the next sections, I will mention technosignatures for the search of extraterrestrial intelligence.

## **2.5. Contemplations on Intelligent Life**

We are currently looking for biosignatures of life both in and out of the Solar system. So far there is no conclusive evidence for life besides Earth. However, we are also looking for signals of intelligent life in a different way. If there is intelligent life beyond Earth, they may have signatures that they can't hide or signatures that they send us deliberately. By contemplating possible signs of intelligence, we can be able to detect their existence. If they are intelligent, they could produce technology. If they produce technology, there must be signs of it.

There is no doubt that we would be contented to find intelligent life, at least if it is not hostile. There are examples of the imagination of humankind on the issue. As I mentioned in the first chapter, there were examples of thoughts on extraterrestrial intelligent civilizations since the antique times. Also, films and novels on the issue show our considerable interest in extraterrestrial intelligence. For example, the film

“Contact” in 1997 which is based on a novel written by astronomer Carl Sagan had significant interest from the public, especially philosophers. This film was about a contact with technologically developed extraterrestrial intelligent civilization. Also, “Arrival” is another film that occurred in 2016 and captured the interest of the public. We also see how interesting the possibility of extraterrestrial life is by the fake news on UFOs. Whereas there is no evidence that our planet is visited, the claims are very popular among laypeople. There is an urge in us to believe in other intelligent beings. No doubt that a possible contact or at least detection of the existence of extraterrestrial intelligence would have a big impact on us. Whereas this possibility causes excitement, our hope for finding intelligent life is less than finding unicellular life.

As it seems from extremophiles, that I talked about before, unicellular life has a tremendous ability to adapt to extreme conditions. Unicellular life can be found in very hostile environments on Earth. Also, they outnumber other life forms. Their prevalence implies that their number would be more in the universe as well. Therefore, we expect to come across unicellular life firstly (Santos et.al. 2016, 257). Nevertheless, finding unicellular life may still mean something about intelligent life. If the chemical structure is very similar to the life on Earth, we may expect them to develop intelligence in the future. However, this is the next stage after finding unicellular life. Currently, we do have research to detect exclusively intelligence in the universe. Before talking about searching, I will mention the questioning.

### **2.5.1. Fermi Paradox**

In the summer of 1950, Italian physicist Enrico Fermi and his co-workers on the work for the development of a hydrogen bomb had lunch as always. He was a brilliant physicist and contributed to astrophysics and quantum mechanics. At lunch, he had a conversation about flying saucers, which were popular back then. The discussion followed notions on extraterrestrials. During the thought-provoking discussion, Fermi asked a question to his colleagues, which became highly interested afterward: “Where is everybody?”. He was referring to extraterrestrials. The immensity of the universe was implying the existence of other intelligent beings. Some of them should have been more intelligent than us and developed advanced technology to colonize us. We must have been visited, but there was an inexplicable silence in space. This questioning of

Fermi is known as Fermi Paradox, although it is not a paradox in the philosophical sense. Even though there are claims about us being visited by aliens or aliens kidnapping humans, there is no conclusive evidence for them (Wilkinson 2013, 109-114). One may assert that our not being visited by extraterrestrials means there is no intelligent extraterrestrial out there. Yet, there may be other reasons for them to not colonize our Earth, such as the distances or their indifference towards us. Physicist Stephen Webb (2015) proposed seventy-five solutions to Fermi Paradox in his book *If the Universe Is Teeming With Aliens... WHERE IS EVERYBODY?* We don't know if any of the solutions represent the truth. The only thing we can do is to search for them in different ways we can imagine.

### **2.5.2. Drake Equation**

Enrico Fermi was not alone in expecting the existence of other civilizations. Frank Drake, who is a prominent astronomer, is also suggesting the presence of extraterrestrial intelligent beings. In 1961, he proposed an equation to calculate the numbers of the civilizations in the universe. Whereas the equation includes seven variables to calculate communicating civilizations, most of the variables are ambiguous and we don't have an absolute number. Therefore, all computations of civilizations using the equation remain just as an estimation. Simply put, his way of calculating the number of communicating civilizations is to multiply the number of communicating civilizations occurring every year with the average lifespan (Catling 2013). The number of communicating civilizations is dependent on various individualistic factors such as the rate of star-forming, how many of the stars have planets, how many of the planets support life, in how many of them life is generated, in how many of them intelligence occurs, how many of the intelligent beings produce the technology to communicate between stars and for how much time they remain noticeable.

However, although it has no certain number, the equation is important because it shows us what we should focus on to calculate communicating civilizations (Traphagan 2015, 50). The attempt contributed to SETI technology afterward, which I will talk about in the next section. Frank Drake is known as the father of SETI.

All these brainstorm remain to be without conclusive evidence. The only way to get close to the answer to the question of whether there is intelligent life in the universe is to look for it. By searching, we may find signs of it, and in the future, we can understand their features to answer our existential questions.

## **2.6. SETI**

While going to other planets as it is done within astrobiology missions for the bodies in the Solar system is an option to search for life, this is not an applicable strategy for vast distances. Besides the exoplanet searching methods I mentioned previously, we are also searching for signals from extraterrestrial intelligence. The search is done within SETI which is an acronym for “Search for Extraterrestrial Intelligence”. SETI is currently looking for signals coming from civilizations which developed similar technology to ours and send signals in a way that we can capture. Within SETI, scientists listen to radio waves by using sizable antennas to capture a signal that an extraterrestrial civilization might send to us.

Searching for signals in the form of the electromagnetic wave is based on a paper by Guisepe Cocconi and Philip Morrison in 1959 named “Searching for Interstellar Communications” which was published in the journal *Nature*. In the article, they proposed that the vicinity of the Sun should have been seen as a candidate place for the generation of civilization by other civilizations who had advanced technology. So, another civilization might send a coded message to us and expect us to receive the message by our technology. The scientists suggested that this message would be in the form of electromagnetic waves. Radio waves travel long distances at the speed of light without being destroyed by atmosphere and gas clouds. It was possible to separate other non-artificial noises because we needed to be sure that the source of the message was an extraterrestrial civilization. An extraterrestrial civilization would choose a frequency at the hydrogen line, according to the article.

If a civilization was able to measure our evolution of intelligence accurately and sent a signal to us, we may capture the signal sent to us millions of years ago. In the last paragraph of their pioneer article, Cocconi and Morrison mentioned the importance of searching:

The reader may seek to consign these speculations wholly to the domain of science-fiction. We submit, rather, that the foregoing line of argument demonstrates that the presence of interstellar signals is entirely consistent with all we now know and that if signals are present the means of detecting them is now at hand. Few will deny the profound importance, practical and philosophical, which the detection of interstellar communications would have. We therefore feel that a discriminating search for signals deserves a considerable effort. The probability of success is difficult to estimate; but if we never search, the chance of success is zero (Cocconi & Morrison 1959, 846).

With the collaboration of Cocconi, Morrison, Drake, and other prominent scientists, we have begun a new step in the search for extraterrestrial intelligence (Roush 2020, 49). In the present day, we are searching for a signal from a technologically advanced civilization. The search is not random and the candidate places to harbor life are prioritized (Cabrol 2016). While we have been listening to the universe since 1984, there is no clear signal so far. However, we haven't searched enough yet and the absence of a message is not a failure. We should continue to search, as Cocconi and Morrison encouraged.

Although we don't have conclusive evidence that extraterrestrials sent us a signal, we came across two incidents that might be signals from extraterrestrial civilizations: Wow! signal and the signal from Proxima Centauri.

Wow! signal which was in hydrogen frequency was captured by Big Ear radio telescope in 1977. Astronomer Jerry Ehman realized the signal and put a circle to the hard copy of the observation and wrote: "Wow!". The signal, which is known as Wow! after the handwriting of Ehman, was thirty times higher than the background noise. It was coming from the region of M55 globular cluster. Since the telescope was not movable, we detected the signal only for 72 seconds. Afterward, scientists listened to this direction again, however, the signal was gone and since then there has been no other signal. This was a fascinating discovery although we couldn't have confirmation that the source was extraterrestrial intelligence. There is no conclusive natural explanation of this signal. It may be the case that an extraterrestrial civilization sent us the Wow! signal. Nevertheless, if an intelligent civilization sent a message to us, we would expect them to send it again. Therefore, we don't know if Wow! was a message in the bottle (Roush 2020, 65-67).

The other signal was from our closest neighbor star in the universe. Proxima Centauri is a red dwarf which is about 4 light-years away from us. On 18 December 2020, a

radio signal coming from the site of the star is revealed in the media. The signal demands work on it to confirm whether it has a technological source. We are far from concluding whether the source is a civilization yet (Shostak 2020a).

Although we couldn't detect an unambiguous message, this is far from implying the nonexistence of technologically advanced civilizations. After all, despite our curiousness and eagerness to contact and satisfy our inquisitiveness, we are not currently transmitting signals by active SETI, although we did send signals before. We don't transmit signals because we need to be thoughtful for the sake of the safety of future human generations. Our intentional signals may be received by hostile intelligent beings (Webb 2015, 151) and they may harm us. Perhaps, it is better to stay silent and other civilizations may be in agreement with the idea. This may be the reason they don't send signals.

Another possibility is that they sent signals and we missed them. In the 4 billion year history of Earth, and as an approximately 200 thousand years old species, we just came to the level of using electromagnetic waves in the twentieth century. Considering this, it is highly probable that we may have missed the signal.

Some other reason for the silence may be that they are transmitting signals, but they don't know we are here and send them in another direction. If the signal is in another direction, we will never capture them. Also, there may be a huge distance between us for a signal to reach us. Despite the fact that the speed of light is extremely fast, it may not be enough for the distances in our immensely big universe.

Likewise, considering the vastness of the universe, the part we searched is very small. This is no different than trying to find a black cat in a coal mine. In her TED talk, Jill Tarter who is a SETI pioneer said that: "All of the concerted SETI efforts, over the last 40-some years, are equivalent to scooping a single glass of water from the oceans. And no one would decide that the ocean was without fish on the basis of one glass of water" (Tarter 2009).

Furthermore, it is possible that maybe they are as much intelligent as us but the life span of them is not long and they cannot build the technology to transmit signal.

Moreover, their signals may be in a different form that we cannot understand (Traphagan 2015, 43). If they come up with a different technology than we know of, we will not be able to capture their signals. Additionally, although SETI is a big hope for us to detect extraterrestrial intelligence, there may be other signs of the technology of extraterrestrial intelligence. In the next section, I will discuss this issue.

## **2.7. Other Possible Technosignatures**

SETI researchers are traditionally focused on electromagnetic wave signals. However, if we look for other technosignatures, our chance to find extraterrestrial civilizations increases. Although financial requirements are hindering us to search technosignatures in the most efficient way, we should consider all ways to search technosignatures to improve our detection. To search for them, at first, we should think of the products of technology and then we can understand what are the signs of it. Also, what a technologically developed civilization would do is an important question. We should be able to detect signs of a technologically more developed civilization than us. Once we witness a peculiar phenomenon, we should consider the possibility of it being artificial technology. Unlike searching for electromagnetic signals in SETI, other technosignatures do not require them to send messages to us intentionally (Shostak 2020b). We can deduce artifacts of extraterrestrial intelligence.

Freeman Dyson, a prominent theoretical physicist, contemplated the issue and had a gripping idea about what a developed civilization would do. He published his speculation in the journal *Science* in 1960. We as Earthlings are increasing our demand for energy sources as our technology develops. Therefore, a more developed civilization may be in the need of more energy than we do now. After some time, the resources of their planet would be inadequate for them. To satisfy their exponentially increased huge amount of energy requirements, they could build a megastructure around their star to capture more energy from it. For the necessary material, they would probably disassemble a planet near themselves. Dyson explained: “One should expect that within a few thousand years of its entering the stage of industrial development, any intelligent species should be found occupying an artificial biosphere which completely surrounds its parent star” (Dyson 1960).

This kind of structure would create indications for us to detect. The structure would lose heat through time which would be detectable by observations. We would see infrared light as a sign of the sphere. He proposed that along with the radio signals that we are looking for in the SETI project, we should be searching for infrared light that is coming from an artificial source. Although we could find some candidate stars to be surrounded by the structure, it is hard to differentiate whether potential observations are of artificial structures or not (Rovrig 2021).

So far, there is no clear sign of the Dyson sphere. However, one candidate could be the star KIC 846285 whose brightness showed abnormality and was detected by the Kepler space telescope. The dimming of the star was implying the existence of some objects around the star to hinder its light. However, the abnormality of brightness could be caused by natural events (Shostak 2020b). Further research is required to understand how to differentiate natural sources from artificial structures and whether there are Dyson spheres around stars we observe.

What else would technologically developed civilizations do? A possible answer could be pollution. Unfortunately, damages in the environment increase as technology develops. However, we could use the vexatious side effect for the good of search for extraterrestrial intelligence. In 2014, theoretical physicist Avi Loeb et al. proposed that we should be looking for signs of air pollution. We are already looking for gases that would be produced by life, which are biosignatures as I mentioned before. For the search of technosignatures, we can search for waste gases produced by the industry of extraterrestrial intelligence. The authors proposed targeting chlorofluorocarbons (CFCs) for the search (Lin et. al. 2014). Finding this pollutant would imply alien technology and factories in that technology.

Air pollution would not be the only defect an intelligent extraterrestrial civilization would do. As we Earthlings used an atom bomb for destruction, they could destroy their kind too. An atomic bomb releases gamma rays and searching for them also can be used as a technosignature. Some huge disasters could leave signs which can be detected by us (Hadhazy 2016).

If we can improve our ways to distinguish signs of any possible technological artifact from natural events, this would be a big step for meeting extraterrestrial life. However, we may have met their technology in our home, the Solar system. Avi Loeb proposed that '*Oumuamua*, a bizarre object that came to our Solar system from another star system, can be an artificial product of an extraterrestrial civilization. The object was discovered in 2017 and there have been huge debates about its origin since then. Astronomers realized the object in its way out of the Solar system and tracked it for only a limited time. We have no photo of it and since it is already gone, we have restricted data about its strange features. The object is the first to be detected that came from outside of the Solar system. Evidence indicates that it is an oblong and cigar-shaped object and it was peculiarly bright. The object followed a different trajectory than expected when it met the gravitational effect of the Sun. Loeb suggested that it has some anomalies and this implies that the object cannot be a comet or asteroid. He believes that the properties of '*Oumuamua* can be explained by an artificial origin and since it is challenging to examine this object anymore because it has left the Solar system, we should be aware of any similar object coming to our neighborhood. If we have more information about an '*Oumuamua*-like object, we could test Loeb's hypothesis (Loeb 2021).

Both biosignatures and technosignatures are crucial for our search for extraterrestrial life. As it is seen in the previous paragraphs, the search which can answer our existential questions is not easy and we should improve our ways of searching. The failure to find an extraterrestrial life shouldn't cause a counsel of despair. Our search is not extensive enough yet. Also, our presumptions about them could be wrong, in that case, we may not find their technological productions. I will mention this issue in the next section.

## **2.8. Evolution**

All the technosignatures I mentioned assume a human-like intelligence in extraterrestrials. We presume that extraterrestrials are using electromagnetic waves, producing technology as we do, and think like us. However, this may not be the case. Our evolution is influenced by many contingent incidents such as catastrophic events. If an incident that was effective in our evolution didn't happen in other places, they

may not be developing a human-like intelligence. In that case, our search for technosignature may never be successful. There are two different opinions about the possible structure of extraterrestrials. While one party thinks that contingencies are dominant in evolution, the other party takes convergences as dominant and claims that evolution produces similar organisms elsewhere. Herein, the former party will be called contingent evolution, and the latter as convergent evolution.

Evolution has many contingent events that affect future outcomes. And if the events are different, the resultant body may develop differently. Different from other scientific areas such as physics, evolution has difficulties predicting future outcomes. Evolutionary mechanisms are well studied. And it is known that the first variation occurs by chance, then natural selection takes part to establish adaptation. I believe the main difference between two parties, contingent and convergent evolution, comes from how much weight they give to natural selection. While defenders of convergent evolution suppose that similar organisms would manage to evolve although the underlying incidents are different and they would become selected by natural selection, contingent evolution prioritizes chance.

Convergent evolution holds the view that there are evolutionary constraints that limit the applicability of alternative evolutionary pathways that occurred by chance. Advocates of convergent evolution based their claims on the parallel evolution examples that occurred many times in evolutionary history. For example; flying, seeing, and swimming evolved independently in different organisms (see McGhee 2008). While we humans and octopuses have camera-eyes, our common ancestor didn't have developed eyes, and similar camera-eyes developed independently. The independent evolution of camera-eyes happened in at least five instances. Examples of convergence also can be found at the molecular level (Morris 2006).

The examples of convergence imply predictability in evolution, according to its defenders. The convergent evolution is held by many scholars such as Simon Conway Morris who is famous for his suggestions of the human-like extraterrestrial life. Morris stated that: "... the evolution of intelligence and cognitive sophistication (including numerosity), manipulative skills, tool-making and technology, not to mention the

increasing appropriation of resources are all evolutionarily inevitable because all are convergent” (Morris 2011).

Also, biochemist Christian de Duve’s opinion seems to have some commonalities with the convergent evolution. He believed that life forms could have similar features on different planets. He took the emergence of intelligence as probable:

My conclusion: We are not alone. Perhaps not every biosphere in the universe has evolved or will evolve thinking brains. But a significant subset of existing biospheres have achieved intelligence, or are on the way to it, some, perhaps, in a form more advanced than our own (de Duve 1995, 297).

On the other hand, the contingent evolution supposes that if we “replay the tape of life” the outcome would be different and the chance for us being in the form we are now is low. Stephen Jay Gould, who was in the contingent evolution party wrote:

Any replay of the tape would lead evolution down a pathway radically different from the road actually taken. . . . The diversity of possible itineraries does demonstrate that eventual results cannot be predicted at the outset. Each step proceeds for cause, but no finale can be specified at the start, and none would ever occur a second time in the same way, because any pathway proceeds through thousands of improbable stages (Gould 1990, 51).

If we acknowledge Gould’s view, our expectation to find extraterrestrial intelligence similar to ours will be low. Similarly, prominent biologist Ernst Mayr signified that intelligence would not occur on another planet. He thought that the conditions that paved the way for intelligent life on Earth would not repeat. Considering there is only one intelligent species on the Earth among numerous life forms, intelligence could not emerge easily:

How many species have existed since the origin of life? This figure is as much a matter of speculation as the number of planets in our galaxy. But if there are 30 million living species, and if the average life expectancy of a species is about 100,000 years, then one can postulate that there have been billions, perhaps as many as 50 billion species since the origin of life. Only one of these achieved the kind of intelligence needed to establish a civilization (Quoted in Di Muzio 2018, 3).

Also, another book can be given as an example of the low probability of the emergence of intelligence in the universe. The book *Rare Earth: Why Complex Life is Uncommon in the Universe*, defended that our Earth has unique conditions which enable the emergence of complex life. Since the unique and rare conditions cannot be achieved

easily, we will not find other developed life forms in the universe (Ward & Brownlee 2000).

To give an example and compare these two opinions, the Cretaceous event -the incident of bolide impact which weakened reptiles before the progress of mammals- can be examined. The event that occurred about 65 million years ago was key for mammalian evolution. If we assume that contingent evolution is dominant, the absence of the event would result in the absence of humans. On the other hand, if we assume that the convergent evolution party is right, the event shouldn't be necessary for the occurrence of humans. Simon Conway Morris claims that although the meteor wouldn't collide on Earth, hunter-gatherers would emerge at the end (Morris 2008, 48).

We don't know which party is right. But we can only detect technosignatures if any extraterrestrial would evolve convergently to us. Otherwise, we could be looking for something that we would probably never be able to find. In this chapter, I have discussed modern science. Different opinions of scientists may have something to say about religion. In the next chapter, I will delve into the religion.

## CHAPTER IV

### ISLAM AND EXTRATERRESTRIAL LIFE

If we find extraterrestrial life, this will have immense effects on our understanding of the universe. What is our place in the universe? Are we a unique and special creation of God? These existential questions have the potential to be influenced by any finding of extraterrestrial life. Islam is one of the three Abrahamic religions and has a predisposition for being affected by such a finding.

Followers of Islam believe in the monotheistic God who created the universe. Also, they believe that God revealed many messages throughout history. Muslims do believe that God revealed messages to Jesus and Moses. However, unlike Christianity, Islam doesn't attribute divineness to any human being. On this issue which has importance for evaluating extraterrestrial life as I will mention below, the Quran is separated from trinitarian Christianity. According to Islamic belief, God revealed his commands and messages to Prophet Muhammad, who is the last of the prophets. The revelation is the Quran, which is the holy book of Muslims.

Because Abrahamic religions have a common perspective and similar attributions of God, many scholars don't separate these two when they discuss about religion. This absence of separation is not problematic from many aspects since they have common statements, such as on the creation process of God, on the afterlife, and on the omnipotence of God. However, theological examinations should be considered independently on the subject of extraterrestrials. Because there is a noteworthy difference between these two: Islam doesn't place humans in the most privileged place in the universe.<sup>4</sup> Although I do think that Christianity can be accommodated to embrace the mediocrity of Earth and even extraterrestrial life, the absence of doctrines

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<sup>4</sup> My approach for examining Islam prioritizes the Quran. Although there are claims within the tradition of Islam which puts humankind into a unique position, I will not delve into these claims herein.

that are considered problematic gives an advantage to Islam for embracing extraterrestrial life easily. Therefore, I believe these two need to be evaluated separately.<sup>5</sup>

In this last chapter, I will present the Christian doctrines which are attacked by critiques of theism. Then, I will give some historical examples of Muslim scholars who thought about the mediocrity of the world, which entails the expectation of extraterrestrial life, and even extraterrestrial life. Also, I will present some Quran verses which are implying the existence of extraterrestrial life. And finally, I will evaluate different possibilities of life from the Islamic perspective.

### **3.1. Attacks Against Abrahamic Religions**

Many scholars take all Abrahamic religions together in their critiques of religions and presume that all of them have a geocentric view, as I will give some examples below. With this presumption, they seem to criticize Abrahamic religions as a whole and imply that there are problems between Abrahamic religions and belief in extraterrestrial intelligence.

To give an example that scholars don't take Islam independently on the extraterrestrial life issue, Paul Davies wrote that: "Undoubtedly the most immediate impact of an alien message would be to shake up the world's faiths. The discovery of any sign that we are not alone in the universe could prove deeply problematic for the main organized religions..." (Davies 2010).

Again Davies asserts that all mainstream religions will be harmed because of their basement on human uniqueness:

In fact, I would go so far as to say that the discovery of aliens would deal a severe blow not only to Christianity, but to all mainstream religions. I am not saying that what we may loosely call the spiritual dimension of human life would be eclipsed or belief in some sort of wider meaning or purpose in the universe negated. Buddhists would doubtless continue to seek the path of enlightenment through inner reflection, even when armed with the knowledge of intelligent life beyond Earth. What is clear, however, is that any theology with an insistence on human uniqueness would be doomed (Davies 2010).

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<sup>5</sup> Herein, I will shortly discuss Christianity but not Judaism because most of the academic discussions on the relationship between religion and extraterrestrial life look from the Christian perspective.

Although he doesn't mention Islam here, we see that he doesn't keep Christianity independent from other religions. However, let alone an insistence on human uniqueness, holding the uniqueness belief would be difficult for a Muslim, because of the verses implying the opposite, as I will exemplify in the following sections.

Likewise, Robin W. Lovin denounces that all Abrahamic religions have a human-centric view because they take for granted the claim that humans are created in the image of God (Genesis 1: 27): "Islam, Judaism, and Christianity all speak in these terms, taking as their starting point the first of the two creation accounts in the Hebrew scriptures, in Genesis 1:26–27" (Lovin 2015, 226).

The claim that Islam holds the "image of God" view is commonly held:

In my opinion, religions will adjust to these cosmotheological principles because the alternative is extinction. The adjustment will be most wrenching for those monotheistic religions that see man in the image of God (Judaism, Christianity, and Islam), a one-to-one relationship with a single Godhead (Dick 2000, 202).

However, these critiques are not based on solid claims. Muslims have different sects and schools within the general rules of Islam. Although there are differences in some religious explanations and applications (fiqh) between different schools, all Muslims take the Quran as their basis. Therefore, to encompass Islam in general one must discuss on the Quran, where there is no claim as "image of God". In these critiques, there is no reference to the Quran.

Another example, that takes Abrahamic religions in general:

The cultural and scientific innovations associated with the Enlightenment and the departure from Aristotelian/Abrahamic cosmology allowed for intellectual elites and eventually general populations to imagine a universe in which they were neither the center of creation nor alone (Traphagan 2015, 22).

In all these examples, the monotheistic religions are criticized as a whole despite huge differences between Islam and Christianity on the uniqueness of humankind. Although, as I mentioned before, I do believe that Christianity can be reconciled with extraterrestrial life, Islam shouldn't be criticized by Christian teachings. I believe, Christianity has two main doctrines that seem to be problematic for accepting extraterrestrial intelligent life, which are absent in Islam. In the next section, I will explain some problems for Christians that do not exist in Islam. I believe that because

of these differences, Christianity and Islam should be evaluated separately, about the uniqueness of humankind.

### **3.2. Why Christianity Should Be Evaluated Independent From Islam?**

The first problem is caused by the understanding of Jesus as both divine and human. The hypostatic union is the term described by Christians to express the unity of these two attributes in Jesus. The claim seems to lead to difficulties for Christians to believe in extraterrestrial life.

If Jesus is both human and God, which means God has humanness, this entails that humankind has been put to the most privileged place. Recall, extraterrestrial life claims are born out of the scientific observations removing Earth, therefore humanity, from the center. If humankind is in a privileged and supreme place, why is the scientific data signifying that neither Earth nor humankind is unique? Both the astronomical data and theory of evolution show that humankind is not special. That seems problematic for this doctrine.

In the case that we find extraterrestrial intelligent life, this will decrease the superiority of humankind even more than the previous scientific observations. Moreover, if there are extraterrestrial intelligent beings more intelligent than us, this will dethrone humankind forever. If God is human and there cannot be superior beings over God, how can there be other beings more intelligent than the species of God?

Therefore, I believe the hypostatic union belief causes difficulties for a Christian to acknowledge the existence of extraterrestrial intelligence. However, this is not the case for Islam. This is one reason for Islam to be evaluated independently.

Another reason why Islam should be considered separately is caused by the incarnation and redemption beliefs in Christianity. Christians believe that Jesus incarnated in the Earth for the redemption of the sins of humankind. In the case that there are extraterrestrial intelligent beings, a question emerges: is there one incarnation event that happened on Earth or are there many incarnations for all intelligent kinds in other

planets (Peters 2016). However, both of the possibilities can be criticized as they seem to have problems.

If we suppose that there is only one incarnation that happened and this incarnation saves all the sins of extraterrestrial intelligent beings, this can be understood as it implies the uniqueness of humankind. Again, any finding of extraterrestrial life will imply the ordinariness of humankind along with other implications of ordinariness from other scientific exercises. Therefore, it is not easy to reconcile the belief in extraterrestrial intelligence and one incarnation for the whole universe.

One may claim that the reason there is only one incarnation is that the other extraterrestrial intelligent beings are not sinning (Losch & Krebs 2015, 238). This may seem like a good explanation. However, I believe that this claim doesn't mean that humankind is not unique. Although Divine Jesus came to Earth because of an exigency, this doesn't change the fact that the Divine incarnated to the Earth and honored humankind. The other extraterrestrial intelligent beings will be abstained from being honored by Jesus just because they don't sin. Moreover, the assertion that other extraterrestrial beings don't sin needs an explanation. Why extraterrestrials don't sin and we humankind sin? If there are numerous intelligent life forms and just humankind sins, there must be an explanation for this situation (Fettahoğlu & Doko 2021).

Paul Davies comments on the focus of the incarnation on humankind:

The plausibility of such an extraordinarily focused divine mission was much easier to accept when most people believed – as they did two millennia ago – that there was only one Earth and one intelligent species, when nothing was known of the now vanished Neanderthals, and little thought had been given to the possibility of alien beings on other worlds (Davies 2010).

As a second option, one may claim that there are other extraterrestrial intelligent beings and Jesus incarnated in their planet in their form. The other forms of Jesus incarnated in their own planets and their sins are forgiven. However, I believe this option also has some problems. If Jesus is divine, which entails that he is perfect, the travels of him may be seen as it is in contrast with his perfection. As I mentioned

earlier, the contradiction views go as far back as Thomas Paine (1737-1809), and he said:

From whence then could arise the solitary and strange conceit, that the Almighty, who had millions of worlds equally dependent on his protection, should quit the care of all the rest, and come to die in our world, because they say one man and one woman had eaten an apple! And, on the other hand, 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 (Quoted in Crowe 2008, 229).

Also, philosopher Brian Hebblethwaite criticized multiple incarnation ideas: “One individual subject cannot, without contradiction, be thought capable of becoming a series of individuals, or, a fortiori, a coexistent community of persons” (Hebblethwaite 2001, 333).

As it is evident, in the case of holding the claim that there are many incarnations, one should modify the beliefs about the nature of Jesus. However, one may claim that there are many incarnations because of the mercy of God. Again, this claim has problems. Because if many incarnations are the sign of mercy, why is there only one incarnation throughout the whole history of humankind? David Wilkinston asks: “Second, if God’s nature is to reach out in love in embodied form, why should there not have been multiple incarnations in different cultures on the Earth?” (Wilkinston 2013, 158).

As it may be seen, some Christian doctrines can be understood as they have a problem with any possible scientific data which implies the mediocrity of humankind, such as extraterrestrial life and the Copernican system. In line with previous examples, Ralph Waldo Emerson (1803-1882) thought that the redemption doctrine has some problems with the Copernican system:

The second being in the universe, it was represented, undertook to save them, and in the vain imagination of man the scheme of his redemption, as it was called, occupied the attention of God and of angels, as if there were nothing in being but men. ‘The earth,’ in the strange language of an old divine, ‘was the scaffold of the divine vengeance.’ Now this system of theology was every way suited to the ancient system of the heavens. It could not but happen that the telescope should be fatal to both. I regard it as the irresistible effect of the Copernican astronomy to have made the theological *scheme of Redemption* absolutely incredible. The great geniuses who studied the mechanism of the heavens became unbelievers in the popular doctrine. Newton became a Unitarian. (Quoted in Crowe, 322)

There may be some explanations for these problems and I do believe that a Christian can believe in extraterrestrial intelligent life. But my claim is that because these

problems are absent in the Quran, one should evaluate Islam independent from Christianity. About the issue of human uniqueness, the main problems in Christianity are not found in Islam. Therefore, Abrahamic religions shouldn't be seen as if they are all claiming the uniqueness of humankind. The major factor that contributes to the understanding of the uniqueness of humankind is absent in Islam.

Because Islam has no problem with the mediocrity of neither humankind nor Earth, there are many Muslim scholars who handled the issue even in the first years of Islam. In the next section, I will mention Muslim scholars who spoke of the mediocrity of the world and even extraterrestrial life.

### **3.3. Muslim Thinkers on Extraterrestrial Life**

Since the first days of Islam, there were no huge problems among Muslims for belief in extraterrestrial intelligent life. Islam never demotivated people for imagining neither the plurality of world nor extraterrestrial life. I believe this may be partly attributed to the absence of Christian doctrines which makes one believe in the uniqueness of humankind.

An example to present that Muslims came up with the ideas on extraterrestrial life is Ibn Abbas (619-687 C.E.). Ibn Abbas was a companion of Prophet Muhammad and his explanations of the Quran are well respected by Muslims. He also had a family relationship with the prophet. According to historical writings, Ibn Abbas stressed that there are other beings in different worlds who are intelligent. Furthermore, these extraterrestrial intelligent life forms were not void of prophets. They have prophets just like we had, according to Ibn Abbas (Determann 2021, 13; Mahmood [1987] 2010, 174).

In the same era, there is another important Muslim commentator who had an idea of the many worlds and extraterrestrial intelligent beings. Respectable Imam Muhammad al-Baqir (676-733 C. E.) is another example to show that there have been brainstorm on extraterrestrial life since the first years of Islam. Similar to Ibn Abbas, Imam Muhammad al-Baqir contemplated on the plurality of worlds and extraterrestrial intelligent life forms: "Maybe you see that God created only this single world and that God did not create Homo sapiens besides you. Well, I swear by God that God created

thousands and thousands of worlds and thousands and thousands of humankind” (Quoted in Weintraub 2014, 165).

There are these kinds of ideas among 12<sup>th</sup> century theologians as well. For example, kalam scholar Imam Ghazali (1058-1111 C. E.) held a similar position. He asserted that the heavenly worlds harbor beings on them and he even went further to claim that the beings were able to contact one another (Cited in Mahmood [1987] 2010, 175).

Also, Fakhr Al-Din Razi (1149-1210 C. E.) contemplated on the mediocrity of the world. He worked on many issues including the science of his day but especially kalam. The respectable kalam scholar evaluated the claims that put our world in a unique position and concluded that they are unjustifiable. He underlined that God could create many worlds (Weintraub 2014, 165).

Likewise, Turkish Muslim astronomer Ulugh Beg (1394-1449 C. E.) expressed ideas on many worlds. Ulugh Beg is famous for his contributions to astronomy and known as a prominent scientist. He also spoke of extraterrestrial life forms based on his understanding of the Quran (Cited in Wilkinston 2013, 16).

Unfortunately, there is no elaborative research on the history of Islamic opinions on the extraterrestrial life debates. Because there are scarce quotations from Muslim scholars, there are time gaps between the scholars I mentioned. There may be other opinions among different Muslim scholars in history. This field needs further research by historians.

Contemplations on extraterrestrial life also occurred in the not-too-distant future. Ömer Nasuhi Bilmen (1882-1971), a Muslim Turkish scholar, is an example. He believed that current science was suggesting the existence of extraterrestrial life forms in heavenly bodies. He also spoke of the possibility of crusades between these extraterrestrial life forms and the inhabitants of Earth. Like Ulugh Beg, he thought that the Quran was implying the existence of extraterrestrial life (Bulğen 2015).

The Quran motivated many religious scholars for contemplating extraterrestrial life. Many Quran translators, despite their not being scientists, proposed the existence of extraterrestrials because of some Quran verses, as I will delve into in the next section. For example, Yusuf Ali (1872-1953), Sayyid Abul A’la Mawdudi (1903-1979), and

Mirza Tahir Ahmad (1928-2003) believed that some verses in the Quran can be understood as they are implying extraterrestrial life forms.

I believe the existence of comments on extraterrestrial life among prominent Muslim scholars suggests that Islam motivated people's imagination. While it is proposed that religion hampered the imagination in Europe (see Traphagan 2015, 22), this is not the case for Islam. Because even a contemporary of Prophet Muhammad was able to suggest the existence of extraterrestrial intelligent beings, as I mentioned before. In the next section, I will review the verses in the Quran which make the way for extraterrestrial life.

### **3.4. The Perspective of Quran on Extraterrestrial Life**

Any questioning on Islam should start with the Quran. Because as I mentioned above, the Quran is the source of Islam and despite some differences in religious applications, the Quran is accepted by all schools of Islam.

As it may seem from the previous examples on the ideas of extraterrestrial life, contemplations on extraterrestrial life follow the speculations that suggest our world is mediocre. The mediocrity of the world implies that there is nothing about our place in the universe that makes it the most special. Whatever happens here, can happen in another world too. Whereas this idea seems easy to grip in the present day, it would require a colossal change of perspective in a community which held the geocentric view of the universe. For example, for people in Europe who were under the influence of the geocentric views of Aristotle, the perspective change couldn't be done until the Enlightenment (Traphagan 2015, 22).

However, for Muslims who were looking from the Quranic perspective, there was not any need for change in the view of the universe to embrace the views of the mediocrity of the world. I believe, the Quran prepared the minds of Muslims to contemplate the mediocrity of the world, even extraterrestrial life. Although there are Muslim philosophers who held the Aristotelian cosmology, it doesn't mean that their geocentric views are motivated by the Quran. Vice versa, their understanding of putting the world, therefore humankind, in a special place was in trouble with the discourses of the Quran, as I will mention below.

In the previous section, it has been seen that Muslims had ideas on extraterrestrial life since the first years of Islam. What makes these people suggest that? What cultivated the imagination of Muslims? I believe the answer lies in the Quran. The Quran has implications that paved the way for both the mediocrity of the world and extraterrestrial life. For example, the first sura of the Quran speaks of plural “worlds (‘aalameen)” instead of the singular world:

"Praise be to God, The Cherisher and Sustainer of the worlds." (Quran 1:2)<sup>6</sup>

As it may seem, one can comment on this verse as it implies the plurality of universes. Although this verse is open to be commented as it is implying the existence of metaphysical beings, the contrary is also compatible with the verse. Therefore, this verse makes a Muslim at least think of the possibility of other life forms. The meaning of “worlds (‘aalameen)” can be the “solar system” or “universe” too, instead of the metaphysical meaning. In that case, this verse will be implying mediocrity of the world. Therefore, this verse is a reason why Muslims should be open to the ideas on the plurality of worlds. Muslim Kalam scholar Fakhr Al-Din Razi (1149-1210 C. E.) held this position and emphasized God’s capacity to create many worlds:

It is established by evidence that there exists beyond the world a void without a terminal limit (khala' la nihayata laha), and it is established as well by evidence that God Most High has power over all contingent beings (al-mumkinat ). Therefore He the Most High has the power (qadir ) to create millions of worlds (alfa alfi 'awalim) beyond this world such that each one of those worlds be bigger and more massive than this world as well as having the like of what this world has of the throne (al-arsh), the chair (al-kursiyy), the heavens (al-samawat ) and the Earth (al-ard ), and the Sun (al-shams) and the moon (al-qamar ). The arguments of the philosophers (dala'il al-falasifah) for establishing that the world is one are weak, flimsy arguments founded upon feeble premises (Quoted in Setia, 2004).

Along with the statements as “Lord of the worlds” in the Quran (41:9), there are other verses signifying the heavens (samaawaatinw).<sup>7</sup> Some verses in the Quran signifies the existence of many heavens:

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<sup>6</sup> All Quran verses in the thesis are taken from Yusuf Ali’s translation.

<sup>7</sup> The word “heaven” used here is the translation of the term “samaawaatinw” which alludes to firmament and sky; it shouldn’t be confused with the term “jannah” which alludes to the afterlife. While both of the terms are translated as heavens in English, the word heaven I am using herein alludes to firmaments exclusively.

“Allah is He Who created seven firmaments and of the Earth a similar number...” (Quran 65:12).

“The seven heavens and the Earth, and all beings therein, declare His glory...” (Quran 17:44).

As it can be seen, this verse underlines the multiplicity of the heavens. The word “seven (sab’a)” in Arabic stands for the meaning of “many”, as Muhammad Asad explains in his Quran translation (Asad [1980] 1993, 8). Therefore, this verse signifies the plurality of the heavens. Even if we were taking the term “seven” as it alludes to the number of seven, it would still be signifying the multiplicity. Therefore, this verse clearly underlines the plurality in the heavens. Asad holds the word “heaven (samaawaatinw)” as it can mean “cosmic systems” (Asad [1980] 1993, 8). This comment paves the way for an understanding of the Quran as it may imply the heavenly bodies being many.

Muhammad Asad is not the only scholar on this thought. Also, respected Muslim Quran translator Abul A’la Mawdudi (1903-1979) stated a similar position on verse 65:12. He stressed the multiplicity of worlds and even spoke of extraterrestrial life: “God has made the earth to serve as a bed and a cradle for the creatures living on it. In like manner, God has also made the other earths in the Universe to serve the same purpose – to provide a bed and a cradle to the creatures living on them” (Mawdudi n.d.).

The verses I mentioned above, indirectly paves the way for extraterrestrial life. Because, the plurality of worlds implies the plurality of events that made us. The same processes could have happened in another heavenly body as well. However, the Quran also states other beings in the heavens explicitly. Therefore, besides not having a geocentric view, the Quran also motivates the reader to think of other beings in the heavens:

“And among His signs is the creation of the heavens and the earth, and the living creatures that He has scattered through them: and He has power to gather them together when He wills” (Quran 42:29)

“And to Allah doth obeisance, all that is in heavens and on Earth, whether moving (living) creatures or the angels: for none are arrogant (before their Lord).” (Quran 16:49)

In these verses, the word that is translated here as “living creatures” is “dabbah”. Besides the previously mentioned verses that underline the multiplicity of heavens which can be understood as heavenly bodies, this verse suggests that heavens are occupied by “dabbah”. Herein, the meaning of “dabbah” is crucial for whether it implies extraterrestrial life. If the meaning of “dabbah” encompasses spiritual meanings, the motivation for suggesting that the Quran signifies extraterrestrial beings will be less and my claim will remain as just a possibility. However, many scholars agree that the term “dabbah” mentions biological organisms exclusively. There is an agreement among many theologians that “dabbah” cannot allude to spiritual beings. For example, Muslim scholar Yusuf Ali assess that the term “dabbah” points to biological beings: “beasts, living, crawling creatures of all kinds...the word is used for living creatures of all kinds, life generally, whose material basis is the mysterious thing which science calls protoplasm” (Ali [1989] 1997, 1254). Likewise, Muhammad Asad states that dabbah cannot be spiritual beings: “The term dabbah denotes any sentient, corporeal being capable of spontaneous movement, and is contrasted here with non-corporeal, spiritual beings designated as angels” (Asad [1980] 1993, 401). Additionally, Mirza Tahir Ahmad (1928-2003) holds a similar position and states that only corporeal creatures can be a form of “dabbah” (Ahmad 1998, 330).

Therefore, if one claims that the term “dabbah” in these verses stands for angels, we have linguistic reasons to oppose. Also, since there is a conjunction between “angels” and “dabbah” in the verse 16:49, we might claim that they seem to be different beings. After examining the language used in this verse, Mirza Tahir Ahmad concluded that verse 42:29 speaks of the existence of other beings but not just the possibility of their existence (Ahmad 1998, 330). Furthermore, the Quran mentions other beings in the heavens without referring to the term “dabbah”:

“Say: None in the heavens or on Earth except Allah, knows what is hidden...” (Quran 27:65).

Hence, considering all the comments of Muslim scholars on the verses, the last three verses I quoted seem to imply the existence of living beings in the heavenly bodies. This means that a Muslim should be in the expectancy of extraterrestrial life forms on the heavenly bodies. Moreover, another verse may suggest that the creatures may be more intelligent than we are:

"We have honoured the sons of Adams; provided them with transport on land and sea; given them for sustenance things good and pure; and conferred on them special favours, above a great part of our creation" (Quran 17:70).

In this verse, the Quran speaks of the aboveness of humankind and refers to the blessings we are bestowed. However, this verse also clearly states that we are not the greatest being. Because the verse states that humankind is "above a great part" but not all. This means that the Quran implies other creations that are above our kind. If they are above our kind, this can make us think that they are more intelligent than us. But who are they? Again, one may ask whether these creations are angels. However, I believe this is not the case because of another verse that implies the superiority of human over angels:

"Behold! We said to angels: "Bow down unto Adam": They bowed down except Iblis: He said, "Shall I bow down to one whom thou didst create from clay?" (Quran 17:61).

If angels are asked to bow down to a human being, how can we claim that angels are superior to humankind? This verse renders it hard to believe that spiritual beings are referred to in the verse 17:70. There, I believe, this verse should make a Muslim expect the existence of more intelligent extraterrestrial life forms. Although one could claim that only Adam was superior to angels but not all humankind, this claim needs support from the Quran where I think there is none.

All these verses I mentioned above, cumulatively suggest that the Quran doesn't have a problem with the mediocrity of humankind. Therefore, any claim that "religions have a problem with either the Copernican revolution which made Earth ordinary, or

extraterrestrial life which will put humankind into an ordinary position” will be highly problematic, if the word “religions” encompasses Islam in the critique. The Quran puts humankind into a very ordinary position:

“Assuredly, the creation of the heavens and Earth is a greater (matter) than the creation of men: yet most men understand not” (Quran 40:57).

Therefore, a Muslim who has a human-centric view will have difficulties reconciling his religion and human-centric view. Although humans have some privilege in this world (Quran 43:12, 22:65), there is no reason to suppose that humans are privileged in the whole universe. From the Quranic perspective, both Earth and humankind seem to be mediocre.

I think the motivation the Quran gives by these verses is probably the main reason why many Muslim scholars contemplated both mediocrity of the world and extraterrestrial intelligence. For instance, Yusuf Ali noted in his commentary on verse 42:29: "Life is not confined to our one little planet. ... it is reasonable to suppose that life in some form or another is scattered through some of the millions of heavenly bodies scattered through space" (Ali [1989] 1997, 1254). Likewise, Ömer Nasuhi Bilmen expressed a similar opinion on the same verse and thought that the Quran implies extraterrestrial beings (Bulğen 2015).

Up to now, I have mentioned the difference between Islam and Christianity on the claims about the uniqueness of humankind. I stressed that Islam ought to be examined independent from Christianity. There are two reasons for the need for independent evaluation. Firstly, Islam is void of some Christian doctrines such as incarnation and redemption that are hard to reconcile with extraterrestrial life. Secondly, Islam has a motivation for belief in extraterrestrial life forms, even intelligent life forms.

However, there are also common opinions in Islam and Christianity. I believe, both of them have some common motivation, at least to some extent, for the plurality of worlds and therefore extraterrestrial life. Considerations on the theistic plenitude of worlds may be a reason to expect the existence of extraterrestrial life for followers of all

Abrahamic religions. This opinion may be the main reason why there are Christian believers of the mediocrity of the world in history, as I mentioned in the first chapter.

Both religions refer to God as the “most perfect Creator”. This attribution of God suggests that God may create many worlds. Because, if God is more creator by creating many worlds, why would God withhold his capacity and create just one world harboring living beings on it? If God will be a better creator by creating more of the living beings, God would create them. Therefore, I believe all theists have motivation because of the “Creator” attribution of God. If a theist insists that our world is unique, this will cause difficulty for her to reconcile the nature of God and her belief in the uniqueness. This explanation, known as the theistic principle of plenitude, is used for the defense of the multiverse in theological studies (see Vainio 2018, 59-84). Together with the multiverse, we may claim that also extraterrestrial beings could possibly be thought as a consequence of God’s Creator attribution. In line with this perspective, respected Muslim scholar Ibn Taymiyya believed God’s perpetual creative activity. He made reference to a verse to support his position: “Is then He Who creates like one that creates not?” (Hoover 2004, 294).

I should note that although I defend that there are some verses that make a Muslim expect extraterrestrial life, I am not defending that my understanding of these verses is conclusively true and a Muslim has to believe in extraterrestrial life. I think these verses make a way to the expectation of the possibility of extraterrestrial life. Thus, although I am open to understanding these verses differently (if possible), I stress that the Quran motivates a Muslim to contemplate the existence of extraterrestrial life. Considering these verses, it seems more probable to me that there are extraterrestrial intelligent life forms than the nonexistence of them, according to the Quran. But again, there is no conclusive statement from the Quran.

Hence, a Muslim has motivations to expect the existence of extraterrestrial beings. Considering this, the nature of extraterrestrials and how likely extraterrestrial life may occur needs to be discussed from the Islamic perspective. In the next section, I will delve into the implications of different opinions on the likelihood of the emergence of life from the Islamic perspective.

### **3.5. Implications of Likelihood of Emergence of Life**

As I spoke of in chapter 2, there are many unknowns about the definition and origin of life. Although there are many attempts to understand how life emerged, all information we gained increases the number of unknowns about the nature of life. We are currently trying to create model environments to see whether life can be generated in the simulation environments. If we manage to create life, this will be a great contribution to our understanding of life. However, in the present day, we are in dark. And there is no certainty when we talk about life.

As I mentioned in chapter 2, scientists can be grouped into two different parts about the likelihood of life. While some think that life necessarily emerges under conditions similar to Earth's, others believe that the likelihood of the emergence of life is very low. Let me call the former view "high probability view" and the second as "low probability view" hereupon.

These two opposite opinions may have some theological implications. Each opinion can be defended by both theists and nontheists to strengthen their claim. For example, if the high probability view is held, one may claim that this is not what we expect if theism is true: "...they claim that a Christian has more reason to believe in the possibility of a miraculous supplementation to cosmic development on God's part where such supplementation seems to be needed, as it does where the origin of life is concerned" (McMullin 2000, 158).

If one has the expectancy of miraculous intervention, finding out that life emerges necessarily under a chemical process would cripple one's religious belief. However, the high probability view can also be seen as it strengthens the position of theists: "If it turns out that life does emerge as an automatic and natural part of an ingeniously biofriendly universe, then atheism would seem less compelling and something like design more plausible" (Davies 2000, 27).

Likewise, the low probability view can be held by both theists and nontheists. By holding the low probability view, one can believe that life is a product of chance and accident or believe that God intervened with the origination of life. For example,

Jacques Monod thinks that life had emerged by chance: "...man knows at last that he is alone in the universe's unfeeling immensity, out of which he emerged only by chance. His destiny is nowhere spelled out, nor is his duty" (Monod 1972, 180). However, we also see some religious defenses using arguments that use the low probability of emergence of life as a premise, such as supporters of some creationism and intelligent design proponents (see Thaxton et. al. [1984] 1992, 196-7).

It turns out, according to her previous beliefs, one can hold both views to either attack or defend religion. C. S. Lewis speaks of this issue:

If we discovered no objects in this infinite space except those which are of use to man (our own sun and moon), then this vast emptiness would certainly be used as a strong argument against the existence of God. If we discover other bodies, they must be habitable or uninhabitable: and the odd thing is that both these hypotheses are used as grounds for rejecting Christianity. If the universe is teeming with life, this, we are told, reduces to absurdity the Christian claim—or what is thought to be the Christian claim—that man is unique ... If, on the other hand, the earth is really unique, then that proves that life is only an accidental by-product in the universe, and so again disproves our religion (Quoted in Goetz 2018, 73).

It is evident from the previous verses I referred to that any claim that the high probability view will harm religion doesn't apply to Islam. Although, the uniqueness of life is important for some Christian doctrines, this is not the case for Islam. And about the critique of the low probability view, I believe this is again not a problem for Islam. It turns out that neither of the views is going to prove or disprove religious claims. About my subject, Islam, both of these views can be understood as they are compatible with Islam.

Because there are Quran verses that seem to imply the existence of extraterrestrial life, I think the most plausible scenario for a Muslim is to hold the high probability view. If we are expecting extraterrestrial life to exist there is no reason to suppose that life is a low probability event. On the contrary, a miracle scenario is not what we should expect from an Islamic perspective. Because miracles are associated with prophets in the Quran. Since there is no prophet in the emergence of life, a miracle scenario is not how the Quran motivates Muslims. However, even if we hold the low probability view, we can still reconcile the Quran and our view.

In the previous section, I suggested that the Quran seems to imply the existence of extraterrestrial life. Thus, one may suppose that the low probability view contradicts with Quranic motivation to expect extraterrestrial life. However, I believe that the low probability view can be understood as it is not in contrast with the Quran. I propose three explanations for this.

First, if the universe is infinite, regardless of how low the possibility of the emergence of life, there may be extraterrestrial life forms. We know that our universe is unimaginably big and the vast size increases the possibility of the emergence of life despite its low probability. Furthermore, if the universe is infinite, which may be the case according to physics, there will be some extraterrestrial life forms. In that case, the Quran's implication of the existence of other life forms will not be debunked.

A second explanation may be God's intervention within the undetermined quantum gaps. If God arranges some conditions for the emergence of life, again the low probability view holds. For example, God may determine the indeterminacies in the quantum world (Jung 2018). Hence, we may still expect low probable life to emerge elsewhere in the universe. Likewise, God may arrange some conditions at the beginning for the emergence of life. If this is the case, we can reconcile the low probability view with the Quranic motivation for extraterrestrial life. Moreover, this claim doesn't have to be counted as a miracle. Muslims among the Ashari school believe that God intervenes in every event in the whole universe. If this claim is to be held, we may assert that low probable events may occur.

These two claims solve the apparent contrast between the low probability view and the Quran's implication for extraterrestrial life. However, we can go further and imagine that the low probability view is true and also there is no life in the universe. Suppose that we know for sure that life doesn't exist in the whole universe. Even in that case, we can modify our understanding of the Quran and assume that these beings are inaccessible to us. For example, if these beings are in a parallel universe, we will never find them even if we look for the whole universe. They will be in another universe. Thus, the low probability view is far from debunking Islam.

Besides the probability of the emergence of life, also the structure of life and its similarity to our biology and the odds of intelligent life has implications for religion. In the next section, I will discuss different views on the complexity of extraterrestrial life and its implications for Islam.

### **3.6. Emergence of Complex Life is Under Question**

In the previous section, I delved into the implications of different views on the probability of the emergence of life. However, what happens after the emergence of life has also some implications for religions. Will they remain as primitive life forms, or will they become intelligent species like humans?

I mentioned different opinions on the complexity of extraterrestrial life in the previous chapter. Recall, defenders of the convergent evolution claim that life will evolve into human-like beings if the evolution occurs again. The scientists defend the convergent evolution and believe that the natural selection process doesn't allow the survival of structures that are completely different from us. Thus, according to the convergent evolution view, life would be similar to us from many aspects and intelligence would evolve in the end. On the contrary, the contingent evolution could be more likely to produce primitive structures in unicellular or multicellular form without generating intelligence.

These contrasting opinions have some implications. For example, convergent evolution may be understood teleologically. Therefore, an atheist may tend to believe in contingent evolution. However, I believe that both of these opinions can be reconciled with Islam. If contingent evolution is right, the odds of coming up with a human-like structure are very low, although it is possible. Therefore, we may stumble upon primitive life forms as extraterrestrial life forms.

Since verse 17:70 can be understood as it implies intelligent life beyond Earth as I mentioned above, convergent evolution seems more likely to be the case for the Quran. However, even if contingent evolution is true and primitive life forms are more likely to occur than humanlike intelligent life, still this view can be held. Now, I will delve into two potential theological problems if the life forms we will find will be primitive,

and contingent evolution is true. The first problem is that one may ask why would God create primitive life forms that flourish on their planet? And the second problem is the implication of the Quran that there is intelligent life other than us. I believe both of the claims can be answered from the perspective of Islamic theism. Let's propose some answers to the first problem.

Why would God create primitive life forms? The first possible reason may be that life may have an intrinsic value for God. We don't know what God values to create. Since we know God created us as intelligent beings and other beings are in interaction with us, we can reason that intelligence is valuable. However, it is also possible that life itself has an intrinsic value regardless of intelligence. After all, the diversification in the creation of God would sign his Creative power. If He is able to create many forms of life including the primitive ones, why wouldn't He do it?

A second answer to this question may be that the existence of some primitive life forms we find would be there for us to find and examine them. If we find a planet that is occupied by only primitive life forms, their existence may be for the sake of our scientific improvement. We know that Quran motivates us to investigate the history of life (Quran 29:20). If we find extraterrestrial primitive life, we can learn a lot about this different form of biology and understand what life is better. So, why wouldn't their existence be for us to learn from them? However, this explanation may be understood as human-centric, which is contrary to what I defended in this chapter of the thesis. Nevertheless, I believe this claim doesn't have to be human-centric. Because, in this assertion, I am not suggesting that there is only one intelligent being which is us and all primitive life forms are for us to find. There may be other intelligent life forms and there may be other primitive life forms for them to examine. In that case, humans are superior to some beings but not to all beings.

The third answer could be about evolution. If we find extraterrestrial primitive life, it can be in its evolutionary beginning phase. We don't know whether this primitive life form will produce intelligence in the consequent evolution. Thus, even if we claim that intelligence is what God values but not only life itself is valued, the existence of primitive life forms is still open to be understood as it is compatible with Islam. We can presume that the organisms will be intelligent in the future. This can be more likely

the case if convergent evolution is true, however, it is also possible if the contingent evolution is true.

As a fourth answer, the possible consciousness of all living beings ought to be evaluated. If we presume that what God values to create is consciousness, creating primitive life forms will be compatible with some Sufi claims attributing consciousness to all living beings. The assumption that all living beings have consciousness can be supported by some Quran verses. Quran speaks of the communications of some animals. For example, in the verse 27:18, we see an ant is warning others that prophet Solomon is arriving. Likewise, Prophet Solomon has the ability to communicate with animals (Quran 27:16, 22-28). Furthermore, Quran states that all animals are a community as we are (Quran 6:38) and also mentions the glorification of birds for God (Quran 24:41). Also, the bee's revelation by God is mentioned in the Quran (16:68). Because of these motivations from the Quran, one may claim that all living beings are endowed with consciousness and this is the reason God created primitive life forms.

Therefore, these answers show that it is not incompatible with Islam if we come across primitive life forms that are flourishing on their planet, without there being a human-like intelligent organism. Now, I will discuss the second problem. Recall, the second problem is that I claimed that God may have mentioned extraterrestrial beings that are more intelligent than we are. If contingent evolution is true, intelligent life has a low probability to evolve. Thus, the contingent evolution may seem problematic for my comment on this verse. However, I don't think so. Now, I will propose some explanations similar to what I used when I discussed the low probability view of life.

The first explanation may be that our universe is practically, even maybe in reality, infinite in size. In the vast universe, if there are numerous emergences of life, some of them will be intelligent in the end. There is no reason for the contingent evolution to contradict the emergence of intelligence, therefore, with my understanding of verse 17:70.

A second explanation may be that even if the probability of the emergence of intelligence is very low, we can still claim that God may do it on some occasions. He

can interact with quantum gaps or determine some initial conditions for the emergence of intelligence. If God does this just one time, my understanding of verse 17:70 will be satisfied.

Thirdly, I can also claim that the intelligent life forms are in parallel universes. If they are not in our universe but in a parallel universe, the contingent evolution idea will be applicable to my understanding of verse 17:70.

Thus, possible problems for holding the contingent evolution view from the Islamic perspective can be solved by these explanations. We see that none of the opposing scientific opinions we evaluated so far are in contrast with the Quran. Thus far, I stressed that the problems of a possible finding of extraterrestrial life are solvable. However, also the possible religion of extraterrestrial life may have an implication for Islam. In the next section, I will delve into the implications of whether extraterrestrials have a religion or not.

### **3.7. Religion of the Extraterrestrial Intelligence**

If we find extraterrestrial intelligent life, their religion can have implications for us. What would their religion or absence of religion mean for us? Are we ought to preach Islam to them? These questions are significant for our way of understanding religion. I will start with the latter.

If we are assuming that we should preach Islam to extraterrestrials, we should presume that extraterrestrial intelligent life forms are responsible for Islam. However, there is no religious motivation to have the supposition. In fact, the Quran states that it is sent for humans (Quran 14:52; 33:72); instead of all sentient beings. Furthermore, even if we try to preach Islam to the extraterrestrials and teach them Islamic jurisdiction (fiqh) from the Quran, this cannot end up with success. Many Islamic rules will not be applicable to them. For example, the direction for prayers will be a problem if they are living on distant planets (Weintraub 2014, 163), or hajj will be very difficult. Likewise, if their metabolism is different, they may not do fasting. Therefore, the Quran may not be applicable for extraterrestrials.

These difficulties imply that the extraterrestrials may need their own religion from God, with the same message as Quran. For example, the jurisdictions may be completely different, but we expect God to send them a religion that speaks of the unity, creativity, and omnipotence of God. My claim that they may have their own religion is not a big leap from the Islamic perspective. Muslims already believe that some jurisdictions changed over time and there are differences between the jurisdictions of different prophets. For example, the direction of prayer changed within the time of Prophet Muhammad (Quran 2:144). However, the essence of religion was always the same (Quran 42:13). For example, the Quran refers to believers before itself as Muslims (Quran 3:67). Why wouldn't we expect Muslim extraterrestrials, even if they don't have the revelation of the Quran but have a revelation of a message with the same essence of the Quran? Thus, I believe that the extraterrestrials would have their own revelation. And finding an Islam-like religion of extraterrestrials would be a confirmation for the Quran.

However, let's think of what are the implications if we find an intelligent extraterrestrial civilization that doesn't have a revelation. Or they have a religion but different from Islam. Would it disprove Islam? I think no. Before discussing this point I should clarify one thing. Since according to the Islamic perspective there is only one religion, which is Islam, the existence of a very different religion which doesn't attribute the same features to God like Islam, corresponds to lack of religion. Therefore, the explanations in the next paragraphs encompass both situations. I will call both of them the lack of religion.

A first explanation for the lack of religion in extraterrestrials may be that they may not be spiritually developed enough for the endowment of revelation. This may be the case even if they are technologically more developed than we are. Because we know from the usage of technology to kill people that spiritual advancement doesn't follow technological advancement. They may get the revelation in the future, or, if they never become spiritually advanced enough, they may never get a revelation. If they don't have moral instincts or don't have free will, they will not be satisfying all the necessary conditions for the endowment of revelation. Thus, we may not see the religion of the extraterrestrial intelligent civilizations.

A second explanation may be that they may have religion but not as a revealed religion. If they are spiritually more advanced than we are, they may have their own religion which has the same message of Islam just by using their intellect. If they find out the essence of the religion without revelation, this may be another reason that we may not be seeing revealed religion among the extraterrestrials.



## **CHAPTER V**

### **CONCLUSION**

Herein, I discussed whether Islam is compatible with any possible finding of extraterrestrial life. In Chapter 1, I presented some historical examples of the discussions on extraterrestrials and also debates on their compatibility with religion. In this chapter, it is presented that thoughts on extraterrestrial life go as far back as antique times. In Chapter 2, I talked about modern science on extraterrestrial life; the candidate places to harbor life, search techniques for extraterrestrial life, and possible signs of extraterrestrial life. Although we haven't found any conclusive evidence for neither unicellular nor intelligent life, it is probable that we can find them with the help of our technology, if they exist. In the third chapter, I delved into the Islamic perspective on extraterrestrials in detail. I stressed that Islam is different from Christianity on the uniqueness of humankind, therefore, any critique of religion must evaluate them independently. Also, I presented some Quran verses that are open to being understood as they are implying the existence of extraterrestrial life forms. After emphasizing the expectancy of extraterrestrial life from the Islamic perspective, I discussed the likelihood of the emergence of life. I suggested that it is compatible with Islam in both of the opposite outcomes: life is low probable or high probable. Furthermore, I discussed the possible outcomes of the emergence of life through evolution and claimed that both contingent evolution and convergent evolution, two opposite views, are congruent to Islam. In the last section, I advocated that there is no reason for us to preach Islam to extraterrestrials. Moreover, both the extraterrestrials having revealed religion or not are also possible outcomes and consistent with Islam.

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