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Does Extraterrestrial Life Exist?

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Abstract

Evolutionary models and biblical creation models make very different predictions about the likelihood of life, and especially intelligent life, elsewhere in the universe. Evolutionary models generally predict that life, and probably intelligent life, is relatively common in the universe, while creation models generally predict that we are alone in the universe. Three lines of evidence—the Fermi paradox, SETI, and the search for extrasolar planets—provide evidence to reach a conclusion on the matter. The evidence thus far greatly favors the creationary prediction and contradicts the evolutionary prediction.

Introduction

Extraterrestrials (ETs) are life-forms that exist outside of the earth. While the term ET could apply to any living things elsewhere, in most contexts it refers to intelligent creatures, creatures capable of developing civilization, technology, and eventually space travel. Furthermore, it generally is understood that any ETs are physical beings, not spirit beings, such as angels or demons. In other words, ETs are beings that are in many respects like humans. It is in this context that I will discuss ETs in this paper. It is almost certain that life can exist only on planets, and that the clear majority of planets are not suitable for life. Hence, there has been much discussion as to what conditions a planet must have for it to sustain life.

It is easy to think that discussion of ETs in entirely modern, but that is not the case. Once the geocentric model was discarded in favor of the heliocentric model nearly four centuries ago, the debate of the plurality of worlds picked up. The plurality of worlds refers to the belief that there are other planets on which life might exist and hence would be like our world. Within the geocentric model, the plurality of worlds was not possible, because if the earth was at the center of the universe, there could be no other worlds truly like this one. But once people realized the earth was one of several planets that orbited the sun, those worlds held out at least the possibility that some planets could be like the earth and thus might harbor life. On the heels of acceptance of the heliocentric theory, most people came to realize that the sun is a star. If the sun is a star, then why could not other stars have orbiting planets as the sun does? And if many stars have orbiting planets, perhaps many of those orbiting planets are home to living things. Therefore, the concept of the plurality of worlds became quite a subject of debate.

One of the first people publicly to discuss plurality of worlds was Giordano Bruno in the late sixteenth century. Bruno was an early adherent of the heliocentric theory, and he understood the possible implications very quickly. Bruno opined that many of the planets of the solar system were inhabited, as well as many of the planets orbiting most stars. The Roman Catholic Church burned Bruno at the stake in 1600, and many people today mistakenly cite him as a martyr for science, supposedly because his cosmology and belief in the plurality of worlds ran afoul of religious authorities. However, it was Bruno's heretical *religious* beliefs that got him into trouble with the inquisition, not his cosmological musings (Bergmann, 2014).

In 1632, a few decades after Bruno's execution, Galileo published his *Dia-*

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logo Sopra i Due Massimi Sistemi del Mondo (*Dialogues Concerning the Two Chief World Systems*), in which he argued for the heliocentric theory. This book was called a dialogue, because it was written as a discussion between three participants over four days. Galileo focused on differences between the Ptolemaic (geocentric) model and the heliocentric model, and so he omitted any discussion of life on other worlds. Indeed, if Galileo had any opinions on the plurality of worlds, he kept them to himself. A few decades later, in 1686, Bernard Le Bovier de Fontenelle published *Entretiens sur la Pluralité des Mondes* (*Conversations on the Plurality of Worlds*). As with Galileo's book, this book was in the form of a series of conversations, but this time with two people, not three. Another difference with Galileo's *Dialogues* is that Fontenelle's book presented mostly a case for the heliocentric theory without arguments against the geocentric theory. Furthermore, it included explicit mention of the possibility of life on other planets.

Throughout the eighteenth century, interest in the plurality of worlds continued to increase. For instance, on April 25, 1756, future American president John Adams wrote in his diary about the plurality of worlds. He opined that if beings like us existed on other planets, then it would necessitate Jesus Christ having ministered, died, and risen again to atone for the sins of races on countless planets. By the early nineteenth century, the plurality of worlds was much discussed across society. This was the environment in which Joseph Smith grew up, so it is not surprising that the plurality of worlds is central to Mormon cosmology. Many of these discussions contained theological and philosophical arguments, but supposed scientific arguments began to be offered too. For instance, the famous astronomer William Herschel argued for life on other planets, and he believed that even the moon was inhabited. This reflected widespread belief in life on the moon at the time, which undoubtedly helped make the famous Great Moon Hoax of 1835 so believable.

Throughout the nineteenth century, several well-known scientists and theologians weighed in on the question of life elsewhere in the universe. Two worthy of mention are Thomas Chalmers, the man who invented the gap theory, and William Whewell of Cambridge, who is responsible for appropriating the word "science" as we understand it in the modern sense (what we call science today previously had been called natural philosophy). Chalmers was of the majority opinion, that there were many inhabited planets. On the other hand, Whewell took the minority position, that intelligent life was unique to earth. He published his thoughts in 1853 in *The Plurality of Worlds: An Essay*. Sir David Brewster, the famous physicist and critic of Darwin, in 1856 published a blistering response to Whewell's book in *More Worlds than One, the Creed of the Philosopher and the Hope of the Christian*. It is interesting that all three of these authors, among many, attempted to answer the question of the plurality of worlds from a biblical perspective.

By the end of the nineteenth century, as science rapidly became influenced by evolutionary thinking, the debate had taken a decidedly more secular turn. The French astronomer Camille Flammarion believed that Mars was inhabited by intelligent beings. Flammarion influenced the American astronomer and agnostic Percival Lowell, who saw a vast network of canals on the surface of Mars. To Lowell, these canals proved that a very advanced civilization existed on Mars. Lowell went on to write a series of popular-level books giving his reasons for belief in intelligent life on Mars. Lowell's work looms large, because it inspired the public, as well as many science fiction authors, such as H. G. Wells and Edgar Rice Burroughs. These collective contributions fueled widespread belief in life on Mars that lasted at least until a half century ago.

While it took the Mariner 4 taking close-up photographs of the Martian surface for the first time in 1965 to drive home the reality of the harshness of the Martian environment, much earlier there were good reasons to realize how hostile to life Mars was. In 1903 the famous evolutionist Alfred Russell Wallace published *Man's Place in the Universe: A Study of the Results of Scientific Research in Relation to the Unity or Plurality of Worlds*, in which he discussed the possibility of life elsewhere in the solar system. Wallace concluded that life could not exist anywhere else in the solar system, because conditions on other solar system bodies would not allow for the existence of liquid water, a necessary ingredient for life. In this book, he only briefly discussed the case for Mars.

In response to Lowell, in 1907 Wallace published *Is Mars Habitable? A Critical Examination of Professor Percival Lowell's Book Mars and Its Canals, with an Alternate Explanation*. The Christian astronomer E. Walter Maunder (who in 1908 published the book, *The Astronomy of the Bible: An Elementary Commentary on the Astronomical References in Holy Scripture*) reached a similar conclusion in his 1913 book, *Are the Planets Inhabited?* Maunder doubted that life existed on Venus, but he held out the slim possibility that it could.

While these writers of a century ago were pessimistic about life elsewhere in the solar system, all of them were optimistic about the existence of life on planets orbiting other stars. Their reasoning was based upon probabilities: even if planets favorable for life were relatively rare, the huge number of stars in the universe and the likelihood that many have orbiting planets implied that there may be many inhabitable planets.

Though usually not overtly admitted, nearly all modern discussion of ETs has been based upon the assumption of the naturalistic origin and evolution of life. If this is the correct explanation of life on earth, then what would an evolutionist expect about the prospects of life elsewhere in the universe? The overwhelming majority of evolutionists believe that life, even intelligent life, must be common in the universe. Otherwise, if life is unique to the earth, then that makes the earth exceedingly special, which in turn at least hints of creation. Therefore, most evolutionists believe in a form of the mediocrity principle, or as Hermann Bondi termed it, the Copernican principle (though the terms have slightly different contexts). Per this principle, there is nothing particularly favored about the earth—our place in the cosmos, the characteristics of the sun and the solar system, the characteristics of the earth, or the fact that life exists on earth. If the earth is in any way unusual among the planets in the universe, then it is merely a matter of statistics. Statistics being as they are, if there is one planet where life exists, then there likely are other planets where life exists. Given the huge number of planets that likely exist in our galaxy, let alone the universe, according to the mediocrity principle, it is almost certain that life must exist on many other planets.

I should point out that there is a minority viewpoint among evolutionists today that life is exceedingly rare in the universe. Major proponents of this position have been the late Sir Fred Hoyle and Chandra Wickramasinghe. They have argued that the biochemistry of life is so incredibly complex that it is extremely improbable that life would ever have arisen in a universe that is merely 13.8 billion years old. If, on the other hand, as Hoyle and Wickramasinghe thought, the universe is eternal, then it is possible, even very probable, that life would have arisen at least once in the universe. Does that mean the earth is perhaps the one place in the universe where life arose spontaneously? Not necessarily. If life is unique to the earth, that would seem to violate the Copernican principle (Bondi, like Hoyle, supported the steady state theory of the universe, in which the universe is eternal). Therefore, Hoyle and Wickramasinghe propagated the concept of undirected panspermia, that life arose once in the universe and has spread from planet to planet via impacts. The ardor that Hoyle had in arguing for the impossibility of life arising spontaneously may have had more to do with his commitment to an eternal universe than anything else. At any rate, Hoyle's view on the rarity of life in the universe is itself rare among evolutionists today, and hence I will not consider this possibility further.

There is one other minority opinion among evolutionists that suggests that life may be unique to the earth or at least very rare in the cosmos. Ward and Brownlee (2000) defined the rare earth hypothesis, that the earth is quite rare, and hence life in the universe is exceedingly rare. This remains the minority viewpoint, because it violates the mediocrity principle. Rather than suggesting any theistic trapping, the extremely rare conditions present on earth are attributed to an incredibly improbable series of events. Given that the rare earth hypothesis remains a minority position among evolutionists, I will not consider this possibility any further either. I note, however, that if the points raised in this paper ever are acknowledged by the evolutionary mainstream, then many evolutionists likely will adopt the rare earth hypothesis.

Biblical creationists agree with Hoyle about the improbability of life in the universe but obviously for very different reasons. Biblical creationists believe God made all things in six normal days and that God had great purpose and exhibited extraordinary design in all that He made. This contrasts sharply with the belief that life arose solely through natural means. The fact that it is extremely improbable that even a single useful protein could arise spontaneously, let alone the many other necessary parts for even a so-called "simple organism," is a powerful argument in favor of special creation. If creation is the correct explanation of life on earth, then the question of whether God created life elsewhere is a theological one, not a scientific one.

Early in the modern creation movement there was some discussion of the possibility of ETs (Cousins, 1970; Armstrong, 1970; Erpenstein, 1972), but there has been little discussion in the technical creation literature since. Of necessity, I must repeat some of the theological arguments of Armstrong. Erpenstein concentrated on planets of the solar system; and it is abundantly clear now that ETs almost certainly are not present on other planets of the solar system. Both Armstrong and Cousins examined the data as it then existed nearly five decades ago to determine the likelihood of extrasolar planets. The first extrasolar planet was discovered a little more than two decades ago, and there has been a sharp increase in the number of extrasolar planets discovered since. Therefore, the time is right for a new appraisal of the question of ETs.

Did God Create ETs?

There is no biblical passage that directly addresses whether God created ETs. In the absence of a clear positive teaching, some Christians suggest it would be a waste if God did not create intelligent life elsewhere. There are at least 10^{22} stars in the universe. That is a staggering number. Data now suggest that a significant fraction of stars have planets, so it is possible that the number of planets is comparable to the number of stars. If that is the case, then one must wonder what the purpose(s) of all those planets must be. Considering the many wonderful sights in so many places in our own world, how many other remarkable vistas must exist on alien worlds? Surely, it is reasoned, God must have made creatures somewhat like us to enjoy these glorious things. This was the essence of the theological argument put forth in the early and mid-nineteenth century by some Christians, such as Brewster. This amounts to an argument of economy. However, who are we to question God's notion of economy? Humanity occupies only a thin sliver on the surface of the earth. Mankind never will directly explore the overwhelming majority of the earth's volume. What delights exist there that no man will ever contemplate? Caverns do not plumb very deeply into the earth's interior, and many of them hold immense beauty and wonder. Yet man has discovered, and likely will discover, only a tiny fraction of all caves in the earth. By the argument of economy, one must posit that the earth's interior must be populated by intelligent beings. Note that the argument of economy has no biblical passages in its support but merely relies upon the belief of well-intentioned people on how they think the world ought to be.

While the Bible does not tell us whether God made ETs, one may draw inferences from Scripture that offer guidance. It appears from the totality of Scripture that God's attention is principally focused upon mankind. It is not necessary that man be at the physical center of the universe, but God's attention certainly is centered on man. God is infinite, so He certainly could concentrate on more than one race of intelligent beings, but there are other theological considerations. If God created ETs similar to humans (i.e., as moral creatures) on any other planets, then are these ETs sinful? Is there a gulf separating them from communion with God? Do they have eternal destinies either with their Creator or separated from the Creator? If not, then ETs are nothing like humans. But if so, what is the origin of their sinful nature? And did God provide a way of salvation? As for their sinful nature, there are two possibilities. One possibility is that ETs have sinful natures because of Adam's transgression (1 Corinthians 15:20–22). But this same chapter contrasts Adam with Jesus Christ, the last Adam, and His saving work (I Corinthians 15:45). Therefore, if ETs are sinful because of Adam's transgression, then the atoning work of Jesus Christ on Calvary for Adam's race is required to satisfy the demand of God. But to ETs, Adam is the alien. And the atonement provided by Jesus Christ was on an alien world. This clearly does not suffice.

The other possibility is that ETs are sinful, because on each of their worlds there was a primordial being, an alien Adam as it were, who transgressed and caused sin to enter their worlds. If that is the case, then the only way of salvation would be that on each of those worlds Jesus Christ was born, lived a perfect life, sacrificially died, and rose again from the dead. Once His ministry was finished on earth, did Jesus go to another planet to provide a way of salvation for ETs there? Hardly. When Jesus left this world, He went to heaven, to sit at the right hand of His Father (Luke 22:69; Acts 2:33; 7:55; Romans 8:34; Ephesian 1:20; Colossians 3:1; Hebrews 1:3; 8:1; 10:12; 1 Peter 3:22). It appears that Jesus, quite literally, died "once for all" (cf. 1 Peter 3:18).

There is one other possibility, that God created ETs, but they remained sinless creatures. The problem with this is that Romans 8:18–25 indicates that the taint of Adam's sin has affected all of creation. This is the reason the entire creation will be redeemed via destruction and reconstruction of a new heavens and a new earth (Isaiah 65:17; 66:22; 2 Peter 3:10–13; Revelation 21:1). If ETs are sinless, they are living in a world that is contaminated with sin through no fault of their own. If ETs are like mankind in every fundamental respect that makes man human, then ETs must also be morally responsible agents, as man is. But they would be sinless beings living in a sin-tainted world. This is a most difficult situation theologically. Therefore, it does not appear that sinless ETs exist.

Having exhausted all the possibilities, we may conclude biblically there are no ETs. This is in stark contrast with the general evolutionary expectation that ETs likely are to be common in the universe. Therefore, we can view these expectations as predictions: the evolutionary model predicts that ETs exist and are even common in the universe, while the creationary model predicts that ETs do not exist. For a long time, there were no data by to which evaluate these two predictions. However, technological advances in recent decades have produced a wealth of data—data that continues to accumulate. What do these data reveal? I will evaluate three lines of evidence that have bearing on the issue.

The Fermi-Hart Paradox

The Fermi paradox, as this is usually known, resulted from an informal discussion over lunch, probably in 1950 (Jones, 1985). The conversation involved Nobel laureate physicist Enrico Fermi, Emil Konopinski, Edward Teller, and Herbert York. Part of the discussion concerned the existence of ETs, which probably was sparked by the tremendous interest in numerous recent UFO sightings at the time. Fermi noted that if intelligent life is common in the universe, then one might expect that many civilizations are far more advanced than ours, and so they likely have already conquered space. Therefore, one would expect that ETs already would have visited the earth, which they have not done (clearly, Fermi rejected the numerous UFO sightings of the time as evidence of alien visitation). This prompted Fermi to ask the question, "Where is everybody?" Twenty-five years later, Michael Hart (1975) more formally addressed the topic.

There has been much discussion of the Fermi paradox (e.g., Webb, 2015). Most discussions have been attempts to explain the paradox, even though life probably is common in the universe. One explanation is that the great distances involved in interstellar travel would require a very long time and that ETs would find such long journeys difficult for various reasons. However, this objection overlooks the possibility of breakthroughs in interstellar travel and the use of small robotic probes. It is not necessary that ETs make their existence known by directly visiting the earth, which instead could be done via robotic proxies. Even now, the private Initiative for Interstellar Studies has proposed Project Dragonfly—the use of solar sails to send small, unmanned spacecraft to nearby stars. There also has been discussion of the possibility of von Neumann probes, self-replicating spacecraft that explore space.

Other attempted resolutions to the Fermi paradox posit that humans are among the most advanced civilizations in existence. However, that would violate the heart of the mediocrity principle. Still others suggest that ETs purposefully have avoided the earth.

Some evolutionists have opined that planets like the earth are very rare, and hence ETs also are rare. As previously mentioned, this is out of the mainstream of evolutionary thinking. This amounts to modifying the evolutionary hypothesis in the face of data that contradicts the predictions of that hypothesis. Within the evolutionary mainstream, belief in the uniqueness, or at least the extreme rarity, of humanity is not widely accepted, hence the need to explain the Fermi paradox. Of course, the creationary prediction is that there are no ETs, so in the creationary paradigm, there is no paradox. Rather, the null result known as the Fermi paradox is confirmation of the prediction of the creation model.

SETI

Frank Drake conducted the first Search for Extra-Terrestrial Intelligence (SETI) experiment in 1960. Drake reasoned that by 1960, humans had been broadcasting radio for about four decades. He realized that many of these radio signals inadvertently had been escaping the earth, and thus could be detected by alien civilizations within forty light years of the earth. He further reasoned that we could reverse the process and eavesdrop on alien transmissions. Drake used a radio telescope to search for intelligent signals from two stars, Tau Ceti and Epsilon Eridani. His results were negative. From this modest beginning, SETI has grown significantly. At least two current projects are worthy of note. The Allen Telescope Array (ATA, and named for the prime benefactor, Microsoft cofounder Paul Allen) is a privately funded SETI project at the Hat Creek Radio Observatory in northern California. The ATA consists of forty-two 6.1-meter diameter radio dishes (the original plan called for 350 dishes). With the use of very sophisticated electronics, the signals of all dishes are combined, and the system has the capability of scanning a huge number of frequencies in relatively large parts of the sky. The system has operated for nearly a decade, and during that time, it has followed up and classified more than 200 million signals. None of them appear to be from extraterrestrial intelligent sources. Besides the SETI work, the ATA also does conventional radio astronomy work.

The Search for Extraterrestrial Radio Emissions from Nearby Developed Intelligent Populations (SERENDIP), which started in 1979, takes the opposite approach of ATA. SERENDIP piggybacks on existing conventional astronomy programs operating on radio telescopes. The sophisticated equipment observes at many frequencies while other research programs unrelated to SETI operate. This allows search for faint intelligent signals from various sources in the sky. Over the years, a few interesting signals have been identified, but none have been confirmed as coming from an extraterrestrial intelligent source. SERENDIP continually operates on several large radio telescopes.

Since 1999, SETI@home has allowed home computer users to participate in SETI. Volunteers load the software on their computers and then allow that software to run in the background of their computers, sifting for intelligent signals in the huge volume of data generated by SETI. As with other SETI programs, SETI@home has produced a few interesting signals, but none have been confirmed as arising from alien civilizations. Again, all SETI programs to date have produced negative results, despite the incredibly large amount of data collected thus far. This is consistent with the prediction of the creation model, but it contradicts the prediction of the evolution model.

Extrasolar Planets

Extrasolar planets are planets orbiting other stars. As previously discussed, when most people believed the geocentric theory, the possibility of extrasolar planets was inconceivable. The widespread adoption of the heliocentric model during the seventeenth century changed this. However, until two decades ago, extrasolar planets were hypothetical, for there was yet no data to show that they existed. In the interim, there was much speculation about (and belief in) the existence of many inhabitable worlds. At one time, many people opined that all the planets of the solar system were inhabited, as well as the moon. However, during the twentieth century, many of these speculations were put to rest as we learned just how hostile to life the moon and other planets in the solar system are.

The discovery of extrasolar planets became a reality a little more than two decades ago as technological advancement permitted for the first time detection of planets orbiting other stars. The primary means of detection have been via subtle Doppler motions induced on stars by their orbiting planets (following Newton's third law of motion) and dimming of stars as their orbiting planets transit them. Spencer (2010) has briefly described these techniques. The transit technique received a major boon with the launch of the Kepler spacecraft in 2009. At the time of this writing, the number of known extrasolar planets is approaching 4,000, and that number is certain to continue to grow.

How many of these extrasolar planets have conditions that are conducive for life? Liquid water is thought to be essential for life. Hence, life is possible only on a planet on which liquid water exists. Astronomers define the habitable zone as the region around a star where an orbiting planet with an appropriate atmosphere could support liquid water on its surface. The habitable zone is a thin shell: if a planet orbits interior to this shell, the surface temperature of the planet would be too high for liquid water to exist, and if the planet orbits outside of the habitable zone, the surface temperature would be too cold for liquid water to exist. The size of the habitable zone depends upon the temperature and luminosity of the star. For a cooler and fainter star, the habitable zone is very close to the star, while for a hotter and/or brighter star, the habitable zone is much farther from the star. As we shall see, this factor is very important in evaluating the possibility of life on some extrasolar planets.

Any planets that fall well outside of a star's habitable zone certainly are eliminated for consideration as possible harbors for living things. However, a planet simply orbiting in a star's habitable zone is not sufficient to establish that it may be habitable. Very small planets lack sufficient mass for their gravity to sustain an atmosphere favorable for life. For instance, the moon is well within the sun's habitable zone, but it lacks any appreciable atmosphere, so it cannot sustain life[1]. On the other hand, planets that have very large mass have the opposite problem—their gravity is so strong that they hold onto many gases that are not conducive to life. Many of the extrasolar planets found so far are very massive—often comparable to Neptune or Jupiter; and many others, termed "super Jupiters," are far more massive. These planets likely lack solid surfaces and are not considered habitable, even if they are in the habitable zones of their stars.

Evaluating whether a more modest extrasolar planet (closer in size to the earth) orbiting in the habitable zone of a star is indeed habitable requires knowing the planet's diameter and its mass. We know the masses of the planets discovered via Doppler motion, but we generally do not know their diameters. On the other hand, we know the diameters, but not the masses, of extrasolar planets discovered with the transit method. Knowing either the mass or diameter, one can infer the other by assuming some average density. More typical, one may consider a range of densities and hence infer a range in the unknown quantity. Claims of the discovery of Earth-like extrasolar planets depend upon the assumption of density, so there is tremendous uncertainty in these claims.

Astronomers recognize that the overwhelming majority of extrasolar planets are not hospitable to life. From time-to-time, one hears of the discovery of an earth-like planet orbiting in a star's habitable zone, where life might possibly exist. The first such announcement came in 2007 with the discovery of Gliese 581 d, the first extrasolar planet with a size similar to Earth's known to exist within a star's habitable zone. Gliese 581 d is nearly seven times the mass of the earth (it is dubbed a "super earth"). Since we do not know its diameter, its composition could be more like that of the Jovian (Jupiter-like) planets, which would be problematic for life. But there are additional difficulties. The habitable zone around Gliese 581 (the star that Gliese 581 d orbits) is so close to the star that it is almost certain that the star's tidal effect has synchronized the planet's rotation and revolution so that one side of the planet perpetually faces the star (Spencer, 2010). This would be very bad for supporting life, because one side of the planet would be very hot all the time, while the other side would be very cold all the time, assuming the planet is even Earth-like to begin with. Faulkner (2010) has identified another major problem: the star Gliese 581 is a BY Draconis-type variable star (its variable star designation is HO Librae). Observations of Gliese 581 over a few decades have revealed that the star varies by about 2%. However, the brightness of BY Draconis-variable stars *can* change by 50%. Because we have observed Gliese 581 for only a few decades, we do not know what its long-term behavior is. A variation in brightness by 2% is bad enough, but if it varies by far more, then the prospects for life on Gliese 581 d are very dim. Of more consequence is the mechanism by which BY Draconis-type variables vary in brightness: large sunspots combined with the rotation of the stars. Large sunspots are accompanied by much chromospheric activity that results in the release of many charged particles. Orbiting so closely to Gliese 581, Gliese 581 d likely is bathed in a tremendous flux of charged particles. This would be very hostile to life directly, but the flux of charged particles also would strip any planet of its atmosphere, again rendering the planet lifeless. Hence, there is no realistic expectation that Gliese 581 d could harbor life. If this were not bad

[1] While technically not a planet because it orbits the earth rather than the sun, the moon is large enough so that if it orbited the sun on its own, it could be classified as a planet.

enough, Gliese 581 d may not even exist (Robertson et al, 2014)!

A recently promoted Earth-like planet is Proxima Centauri b, discovered in the summer of 2016. Proxima Centuari b is the first planet discovered orbiting Proxima Centauri, the closest star to the solar system. Proxima Centauri b was discovered by the Doppler motion method. We do not know the inclination of its orbit, so the mass of Proxima Centauri b is not exactly known. Its minimum mass is 1.27 Earth masses. If the actual mass is close to the minimum mass, then Proxima Centauri's mass is a good fit to Earth. We do not know the diameter of Proxima Centauri b. Assuming a composition and density like that of Earth, the minimum size of Proxima Centauri is 10% larger than Earth's diameter. Of course, Proxima Centauri b could be appreciably larger than the minimum size or mass. Furthermore, we do not know the composition of Proxima Centauri b. It is merely an *assumption* that the composition is similar to Earth's. There is an excellent chance that the composition of Alpha Centauri b is significantly different from that of Earth.

Of much greater concern is the star that this planet orbits. Being a red dwarf, Proxima Centauri is very similar to Gliese 581 in its overall properties, such as size, mass, surface temperature, and luminosity. Like Gliese 581, Alpha Centauri is a variable star, albeit of a different type. Proxima Centauri (also known as V645 Centauri) is a flare star. Flare stars are subject to eruptions on their surfaces similar to solar flares but usually more energetic. The X-ray emissions from Proxima Centauri are believed to be like that of the sun (Wood et al., 2001). As with Gliese 581, Proxima Centauri's habitable zone is very close to the star. Proxima Centauri b orbits its star at 1/20 the distance that Earth orbits the sun. As with Gliese 581 b, Proxima Centauri b probably has synchronous rotation. Assuming X-ray emission comparable to the sun, Proxima Centauri b is bathed in an X-ray flux 400 times greater than Earth is. Furthermore, the flux of charged particles from Proxima Centauri experienced by this planet probably is far greater than on Earth. The charged particle flux (stellar wind) could strip Proxima Centauri b of its atmosphere. These factors do not bode well for life on Proxima Centauri b.

The two examples of supposedly Earth-like extrasolar planets briefly described here are among the best candidates. However, both suffer from considerable problems that seriously undermine their status as Earth-like. Only the rosiest of scenarios could qualify these planets as Earth-like. The stark reality is that out of nearly 4,000 known extrasolar planets, *none* is Earth-like. That is, the data from extrasolar planets thus far strongly suggest that the earth is unique.

Conclusion

I have discussed three lines of evidence that suggest that intelligent life is unique to earth: the Fermi paradox, the null results of various SETI programs, and the lack of Earth-like planets among extrasolar planets. Therefore, proper application of the scientific method leads to the conclusion that intelligent life is unique to the earth. Of the three lines of evidence, the Fermi paradox is the least convincing. This is because there are many explanations of why ETs have not yet visited the earth, or at the very least have not left any evidence of their visitation. Not the least among these explanations is the difficulties of interstellar travel. More convincing is the lack of positive results from SETI programs. Advancements in technology in recent decades have enabled us potentially to detect radio emissions from many possible advanced civilizations. Despite the incredible volume of data collected, not one unambiguous alien transmission has been detected.

Probably the most significant data are those resulting from discovery of extrasolar planets. Out of nearly 4,000 detected planets orbiting other stars, not one planet has been clearly identified where life could exist.

Is it not time that we make the conclusion that life is unique to the earth? One objection to reaching this conclusion almost certainly will be that not all the data are in yet. This is true, but when are the all the data ever available? One always can collect more data, yet this normally does not inhibit us from reaching at least preliminary conclusions. After all, it is the nature of science to change conclusions as new data arrives that contradicts earlier conclusions. Why is there such paralysis in making this justified conclusion now?

The reason for the reluctance to reach this conclusion is that the conclusion is contrary to the worldview of many scientists. Many scientists are so committed to life elsewhere that they cannot accept the data that show otherwise. In their estimation, we must refrain from reaching a conclusion on the matter of extraterrestrial life until data that conforms to their foregone conclusion arrives. The only thing that inhibits reaching such an obvious conclusion is the interference of dogma. It is ironic that creationists frequently are accused of letting our dogma cloud our judgment, yet here is a very good example of how evolutionary dogma prevents most scientists from reaching the proper conclusion.

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