

## SESSION 1

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# Astrobiology

What is the current state of astrobiology? How likely is it according to experts that there is extraterrestrial life and how soon might we discover it, if it exists? If life has started in multiple places, how does it reshape our understanding of Earth and our self-understanding of our place in the universe?

## ASTROBIOLOGY - I

### Initial Reflections

— JONATHAN LUNINE —  
PROFESSOR OF ASTRONOMY, CORNELL UNIVERSITY

THERE IS A tremendous difference between the implications of finding microbes and finding self-aware intelligent life (ETI). The former is all we will find in our solar system and requires sampling of material from moons and planets that might hold life. The latter requires scanning the galaxy for active or inadvertent signals. The radio search for ETI, pioneered at Cornell in 1959, has been met with no success. A third approach, to search for the effects of a biosphere on the atmosphere or surface of planets around other stars, requires very high resolution spectroscopy that will require a new generation of space telescopes beyond JWST. JWST might be able to tell us whether an exoplanet (a planet around another star) is *habitable*, but not whether it *is* inhabited.

The search for microbial life in the solar system is challenging but feasible. Conceptually, it is not an easy project to explain because the cultural prejudices about where life might be are at odds with what has been discovered by planetary exploration. Before the space age (seventy years ago), Mars was thought to be vegetated and Venus habitable (if rather humid). By the mid-1970s it was clear that neither the surface of Mars nor the surface of Venus can support life, each for different reasons. (The idea of microbial life in the clouds of Venus remains a speculative distraction). By the 1990s, Mars exploration from orbit discovered that the early environment of the Red Planet was much more Earth-like and could have supported life. Then, the era of roving surface exploration began, and at present, two sites where conditions suitable for life long ago are being examined by sophisticated rovers, one of which (Perseverance) is encapsulating samples for eventual return to Earth in the 2030's. It is

not expected that living microbes will be brought back—at best, the rovers will return with fossils, but very careful precautions are being developed to prevent contamination if they should find living microbes.

Beyond the asteroid belt, in what is called the outer solar system, a moon of Jupiter (Europa) and two of Saturn (Titan, Enceladus) have been found to host liquid water oceans beneath icy surfaces. There are varying levels of certainty that other moons may also host oceans. Europa's water ocean is salty, and twice the volume of Earth's surface ocean. We know little else about it, including whether there are carbon-bearing molecules in the ocean. Europa's surface is bombarded with a sterilizing radiation field, but the ocean is protected by kilometers of ice. The practical search for life will depend on the finding of places where fresh ocean material is expressed to the surface along fractures as Europa is flexed by Jupiter's powerful gravity field. A mission called Europa Clipper will launch to Jupiter in 2024 to learn more about the ocean and find places where fresh ocean material may be present, for eventual sampling by a lander. That lander would carry instruments designed to detect microbes.

More is known about Enceladus than the others, thanks to direct sampling of a plume of gas, dust, and ice shooting out of the south pole of this small Saturnian moon, done by instruments aboard the Cassini Saturn Orbiter, which explored the Saturn system from 2004–2017. Water ice with salt, carbon-bearing molecules, and mineral grains have been found. The source of the plume is a subsurface ocean, about the volume of Lake Superior, which was detected in several ways by Cassini. The results of this mission show that the ocean of Enceladus, which lies five to thirty kilometers under an ice cap that protects it from the vacuum of space, is capable of supporting microbial life as we know it. Future missions are being proposed to try to detect the signs of life in molecules and grains in the plume or to directly collect and sample living cells from either the plume itself or deposits on the surface. Such missions will not arrive at Enceladus until around 2040 or later.

Saturn's giant moon, Titan, which is larger than the planet Mercury, has a deep subsurface water ocean detected by Cassini. However, more interesting is Cassini's finding that Titan is a moon with a dense nitrogen atmosphere and a surface climate driven not by water but by methane. Dotted the north polar icy landscape are lakes and seas made of liquid methane—perfectly stable in the cold conditions that result from Titan's great distance from the Sun. There are beaches of organic sands, waves, methane rain, and islands of

water ice in the methane seas. Could a form of life evolve and exist in liquid methane seas? This is an intriguing question which, should the answer be yes, says that the occurrence of life requires not narrow conditions, but simply conditions suited to the raw materials at hand. The answer to this question, though, awaits future missions.

Should microbial life be found on bodies distant enough from Earth that they are not the result of cross-fertilization, it would suggest that the origin of life is not a divine act separate from cosmic evolution itself, but a part of that evolution. This says nothing one way or the other about the existence of God—the Thomistic view of the God who creates everything *ex nihilo* in an ontological sense and can certainly design reality so that ever more organized structures evolve in a temporal sequence in that creation. St. Thomas himself wrote that the diversity of things is a sign of the divine ordering of things, and extraterrestrial life would be part of that diversity.

And ETI's? Marie George has more to say than I. Suffice to consider the likelihood that, were ETI's to exist, we wouldn't understand them or even know they were there. My dog and I have a very limited range of interaction despite our co-evolution: I can't ask him to cook dinner or pay the bills, and he can't explain what it's like to smell things with such acuity. Now imagine two self-aware beings separated by billions of years of evolution, with one of them ten million or a hundred million years "ahead" of the other. We might as well imagine we can understand angels (when they don't care to have us do so).

## ASTROBIOLOGY - II

### Initial Reflections

— MARIE GEORGE —  
PROFESSOR OF PHILOSOPHY, ST. JOHN'S UNIVERSITY

**M**Y THESIS IS: if we take as our starting point that the Second Person of the Trinity became incarnate as a human being and saved us by His cross and Resurrection, this does not exclude the possibility that intelligent extraterrestrials exist, but it does render such an existence unlikely.

I am not talking about physicist Paul Davies's claim that ETI existence is incompatible with "the doctrine that man is God's supreme and special creation."<sup>1</sup> This claim is incorrect for several reasons. First, we are God's supreme creation on earth. Secondly, we are special insofar as we, unlike non-rational animals, are called to an eternal destiny. Lastly, the Word became incarnate as one of us, which is not the case for all rational creatures, e.g., the angels.

My arguments are as follows: if ETIs exist, they are either fallen or unfallen. If they are fallen, surely God, in His great mercy, would redeem them. However, Scripture indicates that all who are redeemed are redeemed through Christ:

He is the head of the body, the church; he is the beginning, the firstborn from the dead, so that he might come to have first place in everything. For him all the fullness of God was pleased to dwell, and through him God was pleased to reconcile to himself all things, whether on earth or in heaven, by making peace through the blood of his cross.<sup>2</sup>

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1 Paul Davies, "Biological Determinism, Information Theory, and the Origin of Life," in *Many Worlds*, ed. Steven J. Dick (Philadelphia: Templeton Foundation Press, 2000), 15.

2 Col. 1:18-20 NRSVCE

While it is possible for God to decide to save fallen ETIs through Christ's sacrifice, there are reasons to think this did not occur. So many of the details of Christ's story are so carefully fitted to the human beneficiaries of his salvific act that it is hard to see how another material rational could fit in this story. For example, Christ is not the new ETI, but the new Adam. Christ does not provide ETIs with the most suitable role model and subject of devotion. And the ETI version of St. Anselm's "divine dilemma" would lack the same neat resolution which holds in our case, for it would not be an ETI who made reparation for the ETI fall.

Hebrews 2:14-16 is especially telling with respect to whether Christ's sacrifice was intended to redeem ETIs:

Since, therefore, the children share flesh and blood, he himself likewise shared the same things, so that through his death he might destroy the one who has the power of death, that is, the devil, and free those who all their lives had been held in slavery by the fear of death. For it is clear that he did not come to help angels, but the descendants of Abraham.<sup>3</sup>

It is apparent from this that Christ wanted to share the same flesh and blood as those he saved.

As for unfallen ETIs, it is questionable whether God would create a rational species in which no individual sinned. Granted, we only know of our case and that of the angels. Still, in both cases, some individuals sinned. This highlights the reality of free will and grace in a way that would not be the case if no individual sinned. In addition, it is hard to see how unfallen ETIs could play a pertinent role in a universe that centers on Christ. Some suggest that the Word could become incarnate in their nature. This is indeed possible. The Word is hardly exhausted by taking on human nature. However, many Scripture passages speak of the Word's incarnation, death, and resurrection as the central event in the universe's history. The "Cosmic Christ" passages are the basis for the Catechism of the Catholic Church's affirmation:

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<sup>3</sup> Hebrews 2:14-16

In the Symbol of the faith the Church confesses the mystery of the Holy Trinity and of the plan of God’s “good pleasure” for all creation: the Father accomplishes the “mystery of his will” by giving his beloved Son and the Holy Spirit for the salvation of the world and for the glory of his name. Such is the mystery of Christ, revealed and fulfilled in history according to the wisely ordered plan that St. Paul calls the “plan of the mystery” and the patristic tradition will call the “economy of the Word incarnate” or the “economy of salvation.”<sup>4</sup>

Elucidating the cosmological meaning of Christ’s Resurrection, the Catechism says:

The eighth day. But for us a new day has dawned: the day of Christ’s Resurrection. The seventh day completes the first creation. The eighth day begins the new creation. Thus, the work of creation culminates in the greater work of redemption. The first creation finds its meaning and its summit in the new creation in Christ, the splendor of which surpasses that of the first creation.<sup>5</sup>

If the Word (or other Divine Person) were to become incarnate in an ETI nature, it would be difficult to see Christ’s incarnation as human to be the universe’s central event. And if no Divine Person became incarnate as ETI, it is hard to see what role unfallen ETIs play in a universe that centers upon Christ.

On the assumption that the Word incarnate as ETI had a mother, a question would arise as to who would be Queen of Heaven. Note that the theological arguments by fittingness that I have been presenting are predicated upon what we know God has done in the universe. If ETI were to exist, there would have to be some way of fitting them in the story, as awkward as this appears.

A general objection against the existence of ETIs emerges from the notion that, in order for the universe to be well ordered, there must be interconnection between its principal parts. As Aquinas, commenting on Aristotle, puts it when

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4 *Catechism of the Catholic Church*, 2nd ed. (Vatican City: Vatican City Press, 1997), 1066, <http://www.scborromeo.org/cccp2.htm#1066>.

5 *Catechism of the Catholic Church*, 349.

arguing against a multiplicity of worlds: “But plurality of realms is not good: Just as it would not be good for diverse families which did not communicate with each other to be in one house.”<sup>6</sup> ETI existence would derogate from God’s wisdom, for the universe would be deficient as to the interactivity of its citizens, assuming that the current pessimistic prognosis for future communication between earth and other habitable parts of the universe is accurate. I would be interested in hearing the thoughts of an astronomer on SETI, and also on the Fermi Paradox, according to which if ETIs existed, they would already be here.

Another question I have concerns the Drake equation. One of the unknowns is the probability of life arising and complexifying. The presence of this unknown impacts the ability to estimate another variable in the Drake equation, namely, the number of habitable planets. As Michael Crowe points out, a planet may be similar to Earth without being similar to it in those ways that are crucial for life to begin and complexify. Until we know what these factors are, a planet that is Earth-like in some ways may turn out to lack something needed for life to originate and complexify. A certain number of scientists favor the Rare Earth hypothesis, which proposes that features that make the Earth habitable are unlikely to be found on another planet. I would be interested in hearing what Jonathan Lunine has to say here, given he is the author of *Earth: Evolution of a Habitable World*.

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6 Thomas Aquinas, *In Duodecim Libros Metaphysicorum Aristotelis Expositio*, ed. Raymond M. Spiazzi, OP (Rome: Marietti, 1950), Bk. 12, lect. 12, no.2661-63. Translation is my own.



## POST-CONFERENCE REFLECTIONS

### FROM JONATHAN LUNINE AND MARIE GEORGE

#### JONATHAN LUNINE

I want to thank the organizers for the opportunity to have a stimulating dialog with Marie George, and also to express my regrets that my planned in-person participation fell victim to “the great billion-year war between ribosome- and capsid-encoding organisms.”<sup>7</sup>

We hold firmly that God is the author of all Creation. What shall we make, then, of the messiness of evolution, whereby the number and variety of life forms on Earth has been much greater over geologic time than that which exists today? And what should we make—assuming we discover such—of the presence of alien microbes in the oceans of Jupiter’s moon Europa and Saturn’s Enceladus, or of exotic biology in the methane seas of Saturn’s moon Titan?

Aquinas’s answer comes in Part One, Chapter 102 of his *Compendium Theologiae*. Following from his previous chapter’s discussion of why all things were made—that they might be made like the divine goodness—St. Thomas goes on to consider why there is multiplicity and distinction among organisms.

[T]he multiplicity and distinction existing among things were devised by the divine intellect and established in things so that the divine goodness might be represented by created things in various ways, and that different things might participate in the divine goodness in varying degree. All this was so that a certain beauty might shine forth from the very order existing among diverse things, a beauty which

7 Patrick Forterre and David Prangishvili, “The great billion-year war between ribosome- and capsid-encoding organisms (cells and viruses) as the major source of evolutionary novelties,” *Annals of the New York Academy of Sciences* 1178, no. 1 (Oct. 2009): 65-77.

would direct the mind to the divine wisdom.<sup>8</sup>

What is novel about alien microbes is that they would add a different kind of multiplicity and distinction to what evolution has produced for life on Earth. If, as would be likely given the vast distances from our own planet, microbes of the outer solar system would have come to be and evolved separately from life on Earth, then they would represent a novel kind of diverse thing. Of course, Aquinas didn't know about evolution, but given that both the origin and evolution of organisms are secondary causes through which God, the Uncaused First Cause, works, I think that what Aquinas has to say about the beauty shining forth from the "very order existing among diverse things" applies just as well to the putative existence of extraterrestrial life as to the diversity of life on Earth.

The theological problems associated with rational and ensouled extraterrestrial life (ETIs) have been carefully laid out by Marie George and I have nothing useful to add. But I don't expect that we will ever face these problems: either ETIs do not exist, or the contingent nature of evolution and the vast timescales of cosmic evolution put them out of our reach or recognition.

Some may despair at such a view. I would have, in my youth. But now, meeting intelligent extraterrestrials means far less to me than meeting the author of all things, as Paul promises us in 1 Corinthians 13:12, "then I shall know fully, as I am fully known."

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8 Thomas Aquinas, *Compendium Theologiae*, trans. Cyril Vollert, S.J., (St. Louis: B. Herder Book Co., 1947), Part 1, Ch. 102.

## MARIE GEORGE

I agree with Jonathan Lunine that it is unrealistic to think that we could have a meaningful conversation with ETI via radio signals, given the time lapse between receiving and sending messages, not to mention the time required for one of us to decode the other's language. I do think that if ETIs arrived on earth, they would figure out our language. Rational beings eventually arrive at the general concept of language, that is, that sensible signs can be used to express thoughts. Helen Keller, despite being unable to see and hear, had that *aha* moment via signs presented to her sense of touch. Now, while one would expect ETI senses to differ from ours, nevertheless, it seems impossible that they could get the idea of traveling to a distant planet, if they could not see. Also, as Aristotle points out, it is difficult or even impossible for any organism to stay alive without a sense of touch to warn it of imminent threats to its bodily integrity, such as excessive heat. The question then becomes: would we have anything to talk about or would our lives be so different that we would have nothing to say to each other? We could certainly talk about space travel! They must have the concept of escape velocity if they made it off their planet—and similarly for other scientific concepts related to space travel. Another thing we would hold in common is the need to nourish ourselves. Their way of doing so may be very different from ours, but we've already figured out how organisms as different as sulfur-oxidizing bacteria, *E. coli*, and green plants do so, so there's no reason to think that we could not eventually talk to them about their mode of nutrition. In addition, rational beings—by the very fact of being rational—are created in the image of God. So ETIs hearts, like ours, would be restless until they rest in God. Consequently, they would naturally ask whether God exists, and this could be a topic of conversation.

Jonathan Lunine's talk focused on microbial life, so I didn't get a chance to ask him what he thinks of the "Rare Earth" hypothesis, which holds that the earth has a unique set of features unlikely to occur on another planet. I got the impression from his book, *Earth: Evolution of a Habitable World*, that he might agree. For example, he discusses whether plate tectonics and the carbon cycle explain how the Earth's climate stabilized over time, and he observes that plate tectonics do not seem to be found on other

planets in our solar system. He notes that the earth has a relatively stable axis, apparently due to the Earth's moon, which is unusually large. The absence of such features may not preclude existence of microbial life, given the oceans of Europa and Enceladus may harbor life, but I suspect these features are needed for rational beings to evolve. I am interested in the Rare Earth hypothesis, since I maintain that Christian belief renders ETI existence improbable (not impossible), and this thesis would gain credibility if scientific data supported it.