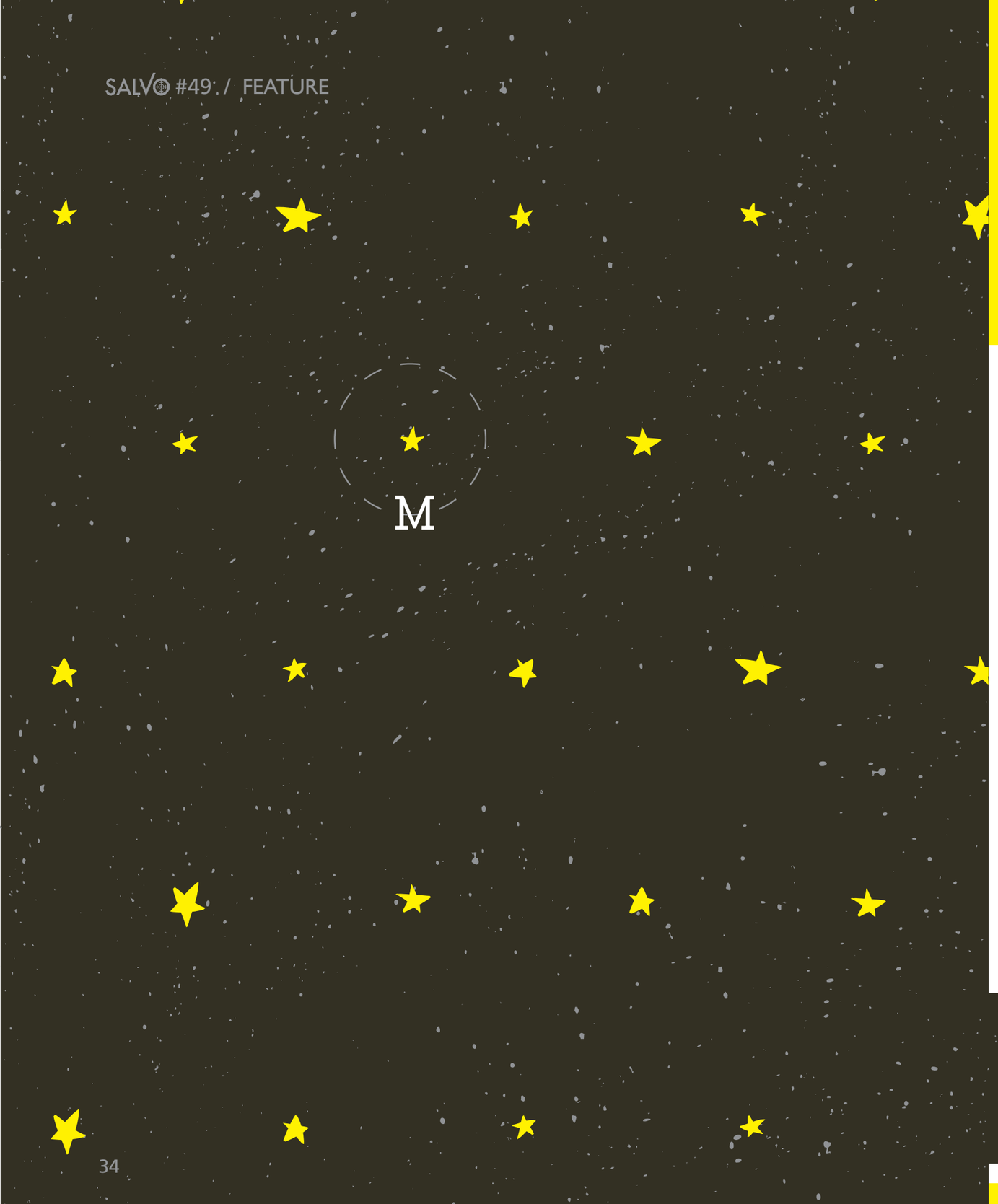


Adaptation of page from Kepler's *Epitome Astronomiae Copernicanae* (1617–1621) showing the Earth as belonging to just one of any number of similar stars. "M" stands for *Mundus*, Latin for "world."

Far & Away Above Average

The Demise of the Drake Equation = The Death of the Copernican Principle

by **John D. Martin**

It has almost become a ritual: when NASA or its European counterpart, the European Space Agency (ESA), releases new findings from the search for exoplanets, mainstream news outlets will announce confidently, "Earth's Twin Discovered!" or "Second Solar System Found!" or "New-Found Planet Looks Right for Aliens."[1] Type in any of these dramatic pronouncements on the search engine of your choice, and it will yield millions of results, citing newspaper and journal articles going back a decade or more. These articles will invariably feature some version of these imagination-firing headlines and will expand on the theme in the opening paragraph.

What about articles pointing out that the probability of finding a "second Earth" or a world even remotely habitable by life of any kind is vanishingly small? They tend not to get much publicity because a realistic analysis of the data just doesn't make for good click-bait.

At least that is the case in the U.S. and British media. German media tend to be a bit more sober in their assessment of the likelihood of discovering new abodes of life in the cosmos. A case in point is an episode of the popular science program *Space-Time,* in which the host, German physicist and astronaut Walter Ulrich, and other physicists directly assail the exaggerated claims of such headlines and the excessive optimism of those who search for planets capable of supporting extra-terrestrial life.

The Drake Equation

In particular, Ulrich zeroes in on the idea that we can have a reasonable expectation of discovering extra-terrestrial civilizations, an idea often expressed using the famous Drake Equation, named for the astrophysicist and astronomer Frank Drake, who first proposed it in 1961. The equation is an outgrowth of Drake's work in Project Ozma, which entailed the first modern use of a radio telescope specifically to search for radio signals that would indicate the existence of alien civilizations. The equation reads like this:

$$N = R_* \times f_p \times n_e \times f_l \times f_i \times f_c \times L$$

- N = **the number of extraterrestrial civilizations with which we could communicate**
- R_* = the average rate of star formation
- f_p = the fraction of stars with planets
- n_e = the fraction of planets capable of supporting life
- f_l = the fraction of planets that actually develop life
- f_i = the fraction of planets that develop intelligent life capable of developing civilization
- f_c = the fraction of civilizations that develop the ability to communicate across interstellar distances (i.e., send and receive radio or laser signals that we could detect)
- L = the length of time over which such civilizations transmit signals that we could detect

The hope behind the equation is that when the terms to the right of the equal sign are multiplied, they will yield a number greater than 0, meaning that there was at least the possibility that we could detect and communicate (however inefficiently) with extraterrestrial civilizations.

Drake's Ozma Project predated John Kraus's "Big Ear" Project[2] by about three years, but both professors—Drake at Cornell, Kraus at Ohio State—were instrumental in establishing SETI (the Search for Extra-Terrestrial Intelligence) as a scientific endeavor.

Bad News

Returning to Dr. Ulrich: His point was that once we get beyond just the second term on the right side of the Drake Equation (f_p), the figures are made up of mere guesswork. Let's look at that second term, the fraction of stars with planets. To date, the total number of exoplanets of any kind that have been discovered—using the Kepler Space Telescope, the AAPS (Anglo-Australian Planet Search), the HARPS (High-Accuracy Radial velocity Planet Searcher), the CoRoT (Convection, Rotation and planetary Transits) space telescope, and other search projects—comes to around 3,700. These exoplanets orbit around relatively few stars—2,780 of them, according to the *Extrasolar Planets Encyclopedia*—with 615 stars having multi-planet systems.

That's it: after pointing their telescopes at numerous stars where they found nothing, eliminating as many false positives as they could, and confirming their results, the researchers found a mere 2,780 stars with planets, a miniscule fraction of the 100 billion (conservative estimate) to 400 billion (high-end estimate) stars in the Milky Way Galaxy. And, according to NASA at least, out of the 3,700 exoplanets discovered, the number that are in the habitable zones of those 2,780 stars is a staggeringly miniscule 30. This is bad news for anyone expecting or merely hoping that the *N* in the Drake Equation really will turn out to be higher than 0, since all the terms after f_p, that fraction of stars with planets, are factors of it.

The findings are also bad news for the Copernican Principle. This is a notion that, as popularly expressed, fundamentally misunderstands Copernicus's advancement of the heliocentric model of the solar system. The key misconception is that Earth is a completely average, entirely typical planet in an entirely unremarkable solar system. Thus misapprehended, the Copernican Principle implies that the rise of life, especially intelligent life, on Earth is nothing unusual. It's certainly nothing that requires an explanation in the form of a deliberate action by a vastly powerful intelligent agent, like, oh, God.

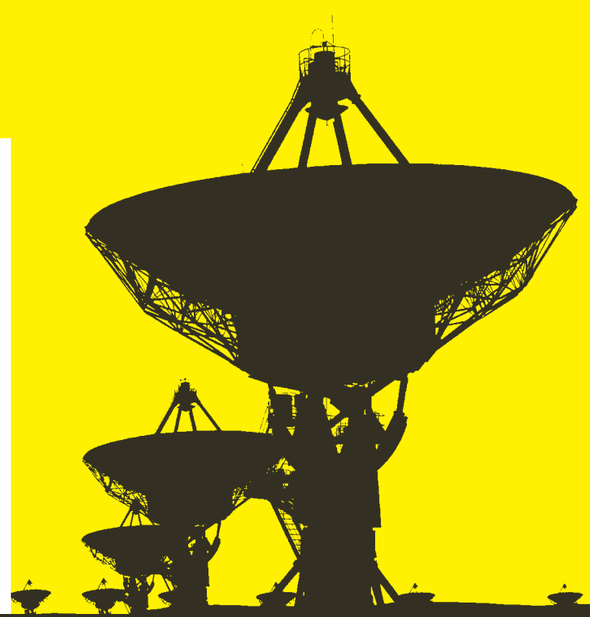
But the data don't support the notion that Earth is in any way "average." Instead, with each new exoplanet discovery, we see more evidence that Earth is not only unusual but staggeringly unusual by cosmic standards. Certainly, there are planets around other stars, but not the sort of planets we should expect to be habitats for life. The "average" planet found so far is either a "Hot Jupiter" or a tidally locked rock with an orbit so tight on its parent star that it has been blasted sterile by the solar winds of that far-away sun.

This is the limiting factor on the possibility of life on other worlds that was addressed by recent research at Princeton University. Using Proxima Centauri b as a model, researchers concluded that the solar wind would ionize gases in the atmospheres of planets in the habitable zones of their parent stars if the planets did not have a magnetic field like that of the Earth to deflect the star's constant stream of ionizing radiation. To quote physicist Chuanfei Dong, who works at the Department of Energy's Princeton Plasma Physics Laboratory:

> The evolution of life takes billions of years. . . . Our results indicate that PCb [Proxima Centauri b] and similar exoplanets are generally *not* capable of supporting an atmosphere over sufficiently long timescales when the stellar wind pressure is high.[3]

This is just one of several limiting factors on planetary habitability. At a meeting of exoplanet hunters held in November 2017 in Laramie, Wyoming,[4] attendees acknowledged that the presence of water was not the only factor that had to be taken into account (indeed, a "water world" could be inimical to life); others included the amount of exposed (i.e., not water-covered) land, the chemical composition of the planet's rocky elements, and whether or not the planet had a molten core enabling it to be tectonically active. The consensus was that it was unlikely that a planet truly capable of supporting life would be found before 2040.

The attendees' estimate of the factors involved in making a planet habitable had, in 2017, finally caught up with that of astronomer Guillermo Gonzalez circa 2004. Gonzalez's "Privileged Planet Hypothesis," along with the "Rare Earth Hypothesis" advanced by Peter Ward and Donald Brownlee at the University of Washington, is finding ever-increasing corroboration in the observed evidence from astronomy. The Copernican Principle is dead, precipitously reducing the likelihood that the third term of the Drake Equation (n_e) will have any value other than "0."



Straining Against Reality

But this scientific reality is not yet reflected in the scientific and popular imaginations. On the same *Science Daily* website where one can find Chuanfei Dong's comments about solar winds scouring atmospheres away from rocky planets, one can also find a story asserting, "Ancient fossil microorganisms indicate that life in the universe is common,"[5] in spite of the Olympus-sized mountain of evidence contradicting that thesis. There's a lot of tension, at least in the Anglo-American sphere, in what people think—or are expected to think—about the likelihood and importance of discovering extra-terrestrial life. *National Review*'s Michael Brendan Dougherty articulated this tension when responding to a story about Navy aviators allegedly encountering a UFO in December 2017:

> I can't quite get a read on what the hive mind of culture wants us to think and feel about the possibility of intelligent life on other planets. The smart and safe attitude seems to say on the one hand that the universe is far too large and our place in it far too obscure and remote, for us to arrogantly believe that we are the only intelligent life out here, *much less that we are at the center of some great cosmic drama*. On the other hand, a smart and intelligent person in our culture is expected to treat as a rube anyone who believes *that the aliens that must exist somewhere* have visited us.[6] (Emphasis added.)

After pointing their telescopes at numerous stars where they found nothing, eliminating as many false positives as they could, and confirming their results, the researchers found a mere 2,780 stars with planets, a miniscule fraction of the 100 billion to 400 billion stars in the Milky Way Galaxy.

It seems to me that the drive to preserve the Copernican Principle—itself born out of a misunderstanding of medieval cosmology—and to continue to treat the Drake Equation as anything other than an entertaining conversation starter is based in a certain philosophical attitude. Aliens must exist somewhere—in order to prove that we are not the center of some great cosmic drama. Life must have evolved by sheer, blind chance somewhere else—in order to prove that life here on Earth arose by sheer, blind chance, with neither direction nor purpose, rather than through a divine decision to bring it into existence. Earth has to be typical; otherwise, the "it just happened" hypothesis that lies at the base of the materialist's philosophy is under serious threat. Why? Because if Earth is *not* typical, then it's a-typicality requires an explanation—and the greater the degree of a-typicality, the more acute the need for an explanation.

The evidence—if we are honest about the physics and the chemistry involved, and about the actual observations from nearly sixty years of SETI—stacks up overwhelmingly in favor of Earth being cosmically unique, and thus points *against* the proposition that our world is merely a commonplace cosmic happenstance. Hence the need to prop up these twin ideas.

The Chimerical "Shadow Biosphere"

An indication of the seriousness of the threat posed by the paucity of evidence supporting the materialist's creation myth and the preponderance of evidence against it was perhaps best made clear in a 2016 *Scientific American* article by physicist Paul Davies. In that piece, Davies, who is one of the few voices in the science press giving a realistic assessment of the SETI data, made this statement:

> Affirmations that life is widespread are founded on a tacit assumption that biology is *not* the upshot of random chemical reactions but the product of some kind of directional self-organization that favors the living state over others—a sort of life principle at work in nature. There may be such a principle, but if so we have found no evidence for it yet.[7]

In the closing paragraph of his article, Davies posits that evidence for such a "life principle" (which, by the way, would itself be inexplicable in materialist terms) might be found through the discovery of a "shadow biosphere," that is, the discovery of life forms based on other sorts of chemistry than our familiar organic chemistry existing alongside us here on Earth. Such a discovery would neatly rescue the materialist theory by showing that life had originated multiple times right here on our own planet, through the spontaneous action of sheer, brute physical forces.

The problem with this idea is that it long ago ran afoul of the facts. Well before Davies mentioned the hypothesis in 2016, research scientists in the field of primitive life had dismissed the best-known results from researchers purporting to have "found" the "shadow biosphere."[8] For example, the claim that an arsenic-based life form had been discovered on Earth was debunked in the journal *Science* in 2012.[9] All the evidence produced thus far indicates that life on Earth had *one* origin event, and that the pathways to that event confound the explanatory power of strict materialist accounts of the origin of life.

The Work of an Artist

Finally, as much a threat as the confirmed rarity of life on Earth is to materialist thought, the converse, that confirmation of extra-terrestrial life would undermine any non-materialist accounts, is not true. It is particularly untrue when applied to a Judeo-Christian view of creation. God called the creation of life "good" and the creation of intelligent life (us) "very good."

Indeed, if the materialist takes the observed data seriously, he's got much less reason to expect extra-terrestrial life to exist than the Bible believer has. Throwing a box of paints against the wall and getting *The School of Athens*—well, that can happen once—actually no; it can't happen ever, not in an eternity of infinite possibilities. Now, an artist taking that same box of paints and painting *The School of Athens*, or *Water Lilies,* or any number of other works of breathtaking beauty—that *can* happen. And God is an artist. ⊕

Notes

1. See, e.g., nytimes.com/2014/04/18/science/space/scientists-find-an-earth-twin-or-maybe-a-cousin.html; theguardian.com/science/2015/jul/23/nasa-closest-twin-to-earth-kepler-452b; telegraph.co.uk/science/2017/02/22/nasa-announcement-live; newsweek.com/planet-habitable-alien-life-lhs-1140b-586266.
2. For a history of the Big Ear radio telescope, see setileague.org/articles/bigear.htm.
3. princeton.edu/news/2017/11/30/scientists-reduce-chances-life-exoplanets-so-called-habitable-zones-around-red.
4. nature.com/news/exoplanet-hunters-rethink-search-for-alien-life-1.23023.
5. sciencedaily.com/releases/2017/12/171218154925.htm.
6. nationalreview.com/2017/12/new-york-times-ufo-story-i-want-believe.
7. scientificamerican.com/article/the-cosmos-might-be-mostly-devoid-of-life.
8. https://phys.org/news/2012-07-dispel-shadow-biosphere-earth.html.
9. philly.com/philly/blogs/evolution/Annoying-Arsenic-Claim-Debunked-for-Good---We-Hope-.html.