Study reports dim odds for finding alien civilizations

August 12 2024, by David Appell

The Very Large Array (VLA) in New Mexico consists of consists of 27 individual radio telescopes that together make observations of distant objects. Credit: Creative Commons Attribution 3.0 Unported license from the National Radio Astronomy Observatory

Are there any advanced alien civilizations elsewhere in our galaxy? We don't know. All we do know is that there is at least one. Should we be

optimistic or pessimistic about finding others?

A new paper, appearing on the preprint server *arXiv*, argues that we are unlikely to detect other technological civilizations unless the ratio of the birth-to-death rate on other worlds, shaped by its carrying capacity, falls within a relatively narrow window. The authors refer to this as a "fine-tuning problem"—the ratio must be just right in order to detect other advanced civilizations. But a priori we have no idea what that ratio is.

"The population of advanced civilizations out there is a balance of the rate at which they emerge and die," said David Kipping, an astrophysicist at Columbia University. "This ratio is all that really matters, but we have essentially no constraints on these terms. The birth rate could be one emergence per world per millennia or one per trillion worlds per trillion years," and similarly for the death rate.

Together with Geraint Lewis of The University of Sydney in Australia, Kipping looked at the ratio of the birth rate to the death rate. This ratio could span orders of magnitude, below or above one. When the ratio is one, a species' population—whether it be humans, aliens or microbes—has reached a steady state and its population remains constant.

On Earth, this ratio has almost never been close to one. The planet is 4.6 billion years old and its only technologically advanced species has existed for only about 100 years.

At present the human birth-to-death ratio is slightly greater than one, but demographers believe it will tend to one by the end of this century. But the ratio is always subject to a drastic decrease, from catastrophes such as climate change, nuclear war, a serious pandemic or asteroid collision. So on Earth, the interval when the ratio is near one is very limited from a galactic perspective (the Milky Way galaxy being about 10 billion years

old).

Is the ratio's history the same for other advanced technological civilizations? Since we haven't found any others, we don't know, but based on Earth's history, the authors consider a ratio of one to be very unlikely.

In their paper, their analysis results in a "steady state Drake equation" involving the birth-to-death ratio; they then conclude that as SETI (Search for Extraterrestrial Intelligence) searches only investigate about a thousand to 10,000 star systems, without yet finding any ETIs, the birth-to-death ratio must be much greater than the reciprocal of this number, 0.001 to 0.0001.

That leaves a narrow window for a successful SETI search, with a ratio roughly 0.01 to 0.1, where ETIs exist that we could detect now. It is this small ratio range, or "valley," the authors say SETI optimists must hope for, which they call a "fine-tuning problem."

"We argue that someone hoping for success has somewhat of a fine tuning problem," said Kipping, "hoping that birth to death rate ratio is not too low, and acknowledging it can't be too high, but sat right in this uncanny valley of possibility."

Surveying more worlds increases the odds of success, but even increasing the survey to the entire galaxy, about 100 billion star systems, increases the relative probability of success by a factor of 10 million, but their calculation finds that the absolute probability of success is still "minuscule"—just once in 10 million trillion. Ultimately, this is because the birth-to-death ratio might well be much less than one, and in fact has no a priori lower limit.

The only way to overcome these odds, they write, is if their steady state

Drake equation is violated or the ratio of births-to-deaths out there is not near unity. As a demonstration of the consequences, they cite that on Earth the probability of spontaneously forming proteins from amino acids has been estimated by Douglas D. Axe to be on the order of 10^{-77}, an infinitesimally small number. And that is just the necessary first step to produce living creatures, let alone creatures with technological development.

"The requirement for such fine-tuning forms the basis of our concern," the authors write in their paper. We can't even put limits on the ratio by arguing there is at least one technologically advanced civilization in the observable universe, since our universe appears to be only a subset of a much larger universe beyond our observable piece of it, the so-called "Hubble volume," according to measurements by the Planck mission.

Still, the paper argues that SETI searches are still important and vital, as while the odds of success are small, one successful find would be the greatest discovery in the history of the world. And they note there are solutions to their finding that could drastically increase the odds, such as the "Grabby Aliens" hypothesis or Earth by chance being in a relatively quiet pocket of the galaxy. "There are several ways of salvaging hope in our formalism," they conclude.

The paper has been submitted to the *International Journal of Astrobiology*.

More information: David Kipping et al, Do SETI Optimists Have a Fine-Tuning Problem?, *arXiv* (2024). DOI: 10.48550/arxiv.2407.07097