SETI's Prospec

Thousands of communicating civilizations could populate our galaxy. And there are plenty of reasons why none of them have visited Earth.

by Seth Shostak

Is there intelligence elsewhere in the Galaxy? Are there other beings who not only can see the stars, but who can also understand where they are and how they work? That's the question today's SETI experiments try to address. A single signal from the cosmos — a sudden burst of photons or a soft radio squeal — would immediately provide an answer.

It is now four decades since the first modern SETI experiment, and we still have not detected and confirmed such a signal. This is reason for some astronomers, including my distinguished opponent Ben Zuckerman, to question the premises of SETI, or simply the likelihood that it will ever succeed. To my mind, this is as if the crew aboard *The Resolution*, Captain James Cook's ship — having sailed for months in search of Terra Australis Incognita — opted to set up debating clubs to argue the possibility that they would ever stumble across the postulated southern continent. In fact, debate would have been far less useful than continuing to sail. Cook's repeated probes into uncharted southern latitudes both constrained the search space and indirectly told his successors where to look next. In 1820, nearly a half century after Cook's forays, Thaddeus von Bellinghausen finally sighted Antarctica. In other words, experiment is better than debate, and that's why SETI researchers continue to deploy their telescopes.

Frankly, it's possible that tomorrow, next week, or next year, SETI will receive a signal that renders all argument about the likelihood of success obsolete and quaint. I personally believe that the telescopes and techniques currently being developed — instruments that will increase by three orders of magnitude the number of star systems scrutinized for cosmic company — are likely to result in the detection of someone else's technology. But that's my opinion. Meanwhile, and in the spirit of interesting pugilistic polemics, I will take issue with some of the rationale Ben Zuckerman has offered in support of his assertion that SETI will fail. After all, he's not only telling us it will fail, he's telling us why.

Planet-Sniffing Telescopes

Ben's fundamental insight is that all advanced civilizations will build telescopes able to detect small planets, and possibly even indications of biological activity, at distances out to a few hundred light-years. To Ben, this fact is obvious, given that we will soon have this capability ourselves. Indeed, having made this point, Ben then advises the SETI community to skip over nearby star systems and direct its scrutiny to more distant arenas. After all, he argues, why waste time investigating local stars until we know if they have Earth-size planets? Even better, he notes that in a decade or two, telescopes such as NASA's Terrestrial Planet Finder (TPF) will be able to sort out the best of these Earth-size worlds by spectroscopically

Since intelligent life has evolved on one planet, it could have sprouted on some of the billions of other planets that populate our galaxy. Yet these planets are separated by enormous distances, making it exceedingly difficult for civilizations to travel between them. Courtesy of NASA/GSFC.

ts Are Bright

analyzing their atmospheres for gases (e.g., oxygen and methane) that would betray the presence of life.

In other words, if you're going to look for extraterrestrials, it helps to know the territory, and by waiting a few decades, SETI researchers will have a list of all the Earth-like worlds around nearby stars. Stars without such planets can be skipped.

But this advice, although apparently reasonable, is not terribly helpful and will soon be irrelevant. While it's true that learning that, for example, a planet around the relatively nearby star 55 Cancri has oxygen in its atmosphere would surely improve its attractiveness for SETI, it hardly stamps it as a gold-plated SETI target. Earth's atmosphere has had an oxygen signature for 2 billion years, and nearly all that time our planet was devoid of sophisticated life. Even if advanced societies survive for tens of millions of years, only 1 in 100 life-bearing planets is likely to sport intelligent aliens right now. This already argues for extending the search beyond the nearest star systems, and in fact, this is being done. New detectors suitable for conducting SETI at optical wavelengths, as well as the extraordinary capabilities of the Allen Telescope Array (see "SETI All the Time," page 29) and its likely successor, the Square Kilometer Array, will shortly swell the list of SETI targets to hundreds of thousands of star systems, and, within a few decades, millions. The overwhelming majority will lie far beyond the "nearby stars" that Ben says waste SETI's time.

If Aliens Are There, They'd Be Here

Having warned against using precious telescope time to investigate nearby stars now, Ben then takes the stance that all star systems out to a distance of a few hundred light-years are guaranteed to be alien-free. His reasoning is as follows: Any advanced extraterrestrials around these stars, wielding planet-sniffing telescopes, will discover Earth and its telltale, biogenic atmosphere. They will fire up their SETI telescopes but will fail to detect a signal because *Homo sapiens* has yet to arrive on the scene. At this point, they will face a quandary of curiosity: The relative motion of stars in the Galaxy ensures that the Sun and its planetary retinue will move out of their local neighborhood within a few million years. Rather than let an intriguing world slip their grasp, these aliens will come to visit. They'll do this in person, as exploration by robots is ultimately unsatisfying. The aliens will want to study our "redwood trees, dinosaurs, and whales" (although it's more likely they will only find our bacteria). Once these visitors arrive on the terrestrial scene, they will not return to whence they came, but lodge permanently on Earth. Because we don't see these alien squatters today, this means they didn't visit in the past, and consequently they're not within manageable traveling range — a distance Ben estimates to be hundreds of light-years.

This line of reasoning is merely a modification of an argument well known in SETI circles: the Fermi Paradox. If aliens can manage interstellar travel (and, after all, such travel does not violate the laws of physics), then at least some of them should have colonized the Galaxy by now. The fact that we don't see any evidence of these supercivilizations is taken by skeptics as proof that no extraterrestrials exist. Ben's logic is simply a truncated version of Fermi's Paradox. He assumes

The Sun's closest stellar neighbor, Proxima Centauri, is the red star in the middle. With new radio telescopes, SETI will be able to leapfrog nearby stars that are within the range of TPF. Courtesy of David Malin, UK Schmidt Telescope, DSS, and AAO.

that technological societies will build their own TPFs and then visit those interesting places (including Earth) that they discover situated within a few hundred light-years.

Even if you buy into this, it still fails to rule out the possibility of finding an ET signal. Suppose that Ben is right: advanced aliens will colonize all biologically interesting worlds within, say, 500 light-years of their home, carving out a "sphere of influence" that's 1,000 light-years across. If 30,000 civilizations are randomly sprinkled throughout the Milky Way's voluminous star fields, then our galaxy will be fully stuffed with such spheres of influence. But if there are fewer than 30,000, there will be areas of the Galaxy that are untouched by the aliens. Frank Drake has frequently suggested that the number of contemporary alien societies in the Galaxy (the N in his famous equation) is about 10,000. If so, and if expansion reaches out hundreds of light-years as Ben has postulated, then the majority of the Milky Way's stars fall in the cracks — in the empty spaces between these inhabited zones — and would be free of curious, colonizing aliens. In this case, there's no reason to assume that, simply because extraterrestrials aren't walking the streets of your neighborhood, they're also absent from star systems that lie more than several hundred light-years away.

Going All the Way

But let's do something Ben has not done, and extend his argument to more than a first generation of interstellar expansion. Suppose the first civilization to build atmosphere-analyzing telescopes spawns colonists that quickly reach out a few hundred light-years. Let's also assume that their descendants do the same. First, they build planet-sniffing hardware of their own and then they venture out a few hundred light-years beyond their colonized homes. Repeat this scenario a few hundred times. Within a few tens

Spiral galaxies like the Milky Way and M83 (shown in this image from the Very Large Telescope) contain hundreds of billions of stars. Given these numbers, many people conclude that intelligent life is common. Courtesy of European Southern Observatory.

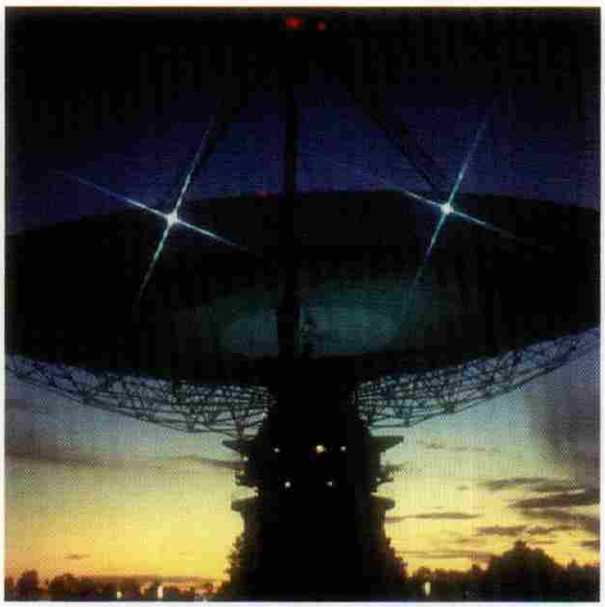
of millions of years, the colonizers will be ensconced on every attractive world in the Galaxy.

If this scenario were realistic, SETI supporters really would have a problem. The aliens or their mechanical proxies should be everywhere. This is, of course, the usual form of the Fermi Paradox, and it has been addressed in a substantial body of literature by folks who have been remarkably inventive in formulating scenarios that explain why such saturation colonization wouldn't take place. It would be both tedious and redundant to many readers to list all of these scenarios here, but they generally fall into three categories: (1) technical, (2) sociological, and (3) radical.

Among the technical explanations, an oft-cited suggestion is that interstellar travel is not as easy as Ben assumes. Aside from the enormous energy costs required to send a single craft to another star at 1% the velocity of light (3,000 kilometers per second), there's also the danger of interstellar material slamming into the nose of the spaceship at this blistering speed. In addition, one should be aware of the magnitude of the effort if large numbers of stars have habitable worlds. Within 500 light-years of us we can find about a million star systems! Ben might argue that only a small percentage of these will have decent planets, but if the number is small, then the probability of worlds with intelligent beings is smaller still. In this case, his whole argument falls apart because the chances that any potential colonizers have sprouted up within a few hundred light-years of us is negligible, even in the past 2 billion years when Earth has had an oxygenated atmosphere. In other words, if this is the case, then the reason we haven't yet detected extraterrestrials has nothing to do with their lack of presence on Earth, but is simply due to the fact that such societies are sparse. That could be the case. Indeed, it's the obvious rationale for increasing SETI's range of reconnaissance.

Among the sociological scenarios for the Paradox we can cite is the historical fact that colonization efforts on Earth have been much more limited than one would expect based on travel times or interest in distant lands. What stopped the Romans (or the Polynesians, etc.) from colonizing every temperate continent? Not travel time, and not a lack of appealing

The 305-meter Arecibo radio telescope in Puerto Rico is the world's largest and most sensitive antenna for detecting radio signals from another civilization. Courtesy of Seth Shostak.



The 64-meter radio telescope in Parkes, Australia, allows Project Phoenix to search for E.T. signals emanating from Southern Hemisphere stars. Courtesy of Seth Shostak.

destinations. Competition, overextensions, or simply a decline in motivation brought a halt to all such efforts. It's also possible that long-lived extraterrestrial civilizations are passive. On Earth, the development of rocketry occurred in roughly the same epoch as the invention of nuclear weapons. Aggressive societies may self-destruct before colonization begins, suggesting that only the less adventurous societies survive. According to this line of reasoning, the oldest alien cultures have managed to rid themselves of aggression and are disinterested in colonization.

It's also worth noting that humans are not uniformly distributed over Earth, but are concentrated in relatively small cities and suburbs. Perhaps the aliens, too, are urbanized, clustered around objects where matter and energy are highly abundant. Our solar system may be an uninteresting desert, relatively speaking, in the vast landscape of the Galaxy.

It is difficult to evaluate the validity of these efforts to explain how the Galaxy could be semi-packed with aliens while still allowing for a bit of empty space (which we inhabit). Ben has apparently given thumbs up to option (3) and chosen one of the two radical explanations for Fermi's Paradox: We are alone. (The other radical explanation, that the aliens are here on Earth, is popular with much of the public, but not with many scientists.) Ben insists that because they're not here, they're not there. This is like deciding that the world doesn't host large animals because (1) despite the fact that big animals could roam the world in short order, (2) you still don't see any in your backyard.

The Debate Continues On-Line

To read Ben Zuckerman's response to this article, and then Seth Shostak's rejoinder, visit www.astrosociety.org/pubs/mercury/31_05/response.html.

Bottom Line

My opponent has presented SETI scientists with two caveats. First, he argues that there's little point in observing nearby star systems now, because we will soon be able to learn which of these stellar habitats have Earth-like worlds. Second, the fact that Earth has not been settled by aliens indicates that none of the stars out to a distance of hundreds of light-years sports advanced societies.

The first point is moot, as SETI researchers are already extending their reconnaissance to greater distances. The second point is merely a special edition of the Fermi Paradox, in which it's assumed that only one generation of colonization will take place. But this argument also becomes less interesting as new telescopes push the radius of SETI searches farther into space. My opponent's arguments could be extended to the more general Fermi Paradox, which envisions a spread of civilization to every galactic nook and cranny. But there are many possible impediments to a thorough colonization of the Milky Way, and to summarily decide that our world has been left alone because there's no one anywhere else in the Galaxy is not logic, but merely conviction.

In short, while it is interesting and edifying to debate the likelihood that we will uncover evidence of thinking beings elsewhere, it is hubris to think that we can decide this issue based on the activities of our own society or the situation of our immediate neighborhood. Cook's sailors might just as well have concluded that Antarctica couldn't exist because there was ice-free water around their ship. It makes more sense to sail on.

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