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## Our Galaxy Should Be Teeming With Civilizations, But Where Are They?

by [Seth Shostak](#)

Is there obvious proof that we could be alone in the Galaxy? Enrico Fermi thought so -- and he was a pretty smart guy. Might he have been right?

It's been a hundred years since Fermi, an icon of physics, was born (and nearly a half-century since he died). He's best remembered for building a working atomic reactor in a squash court. But in 1950, Fermi made a seemingly innocuous lunchtime remark that has caught and held the attention of every SETI researcher since. (How many luncheon quips have you made with similar consequence?)

The remark came while Fermi was discussing with his mealtime mates the possibility that many sophisticated societies populate the Galaxy. They thought it reasonable to assume that we have a lot of cosmic company. But somewhere between one sentence and the next, Fermi's supple brain realized that if this was true, it implied something profound. If there are really a lot of alien societies, then some of them might have spread out.

Fermi realized that any civilization with a modest amount of rocket technology and an immodest amount of imperial incentive could rapidly colonize the entire Galaxy. Within ten million years, every star system could be brought under the wing of empire. Ten million years may sound long, but in fact it's quite short compared with the age of the Galaxy, which is roughly ten thousand million years. Colonization of the Milky Way should be a quick exercise.

So what Fermi immediately realized was that the aliens have had more than enough time to pepper the Galaxy with their presence. But looking around, he didn't see any clear indication that they're out and about. This prompted Fermi to ask what was (to him) an obvious question: "where is everybody?" This sounds a bit silly at first. The fact that aliens don't seem to be walking our planet apparently implies that there are no extraterrestrials anywhere among the vast tracts of the Galaxy. Many researchers consider this to be a radical conclusion to draw from such a simple observation. Surely there is a straightforward explanation for what has become known as the Fermi Paradox. There must be some way to account for our apparent loneliness in a galaxy that we assume is filled with other clever beings. A lot of folks have given this thought. The first thing they note is that the Fermi Paradox is a remarkably strong argument. You can quibble about the speed of alien spacecraft, and whether they can move at 1 percent of the speed of light or 10 percent of the speed of light. It doesn't matter. You can argue about how long it would take for a new star colony to spawn colonies of its own. It still doesn't matter. Any halfway reasonable assumption about how fast colonization could take place still ends up with time scales that are profoundly shorter than the age of the Galaxy. It's like having a heated discussion about whether Spanish ships of the 16th century could heave along at two knots or twenty. Either way they could speedily colonize the Americas. Consequently, scientists in and out of the SETI community have conjured up other arguments to deal with the conflict between the idea that aliens should be everywhere and our failure (so far) to find them. In the 1980s, dozens of papers were published to address the Fermi Paradox. They considered technical and sociological arguments for why the aliens weren't hanging out nearby. Some even insisted that there was no paradox at all: the reason

we don't see evidence of extraterrestrials is because there aren't any. Could galactic empires exist? In a previous article, we noted that there has been plenty of time for aliens keen on colonizing the Milky Way to pull it off. However, we see no signs of galactic federation ("Star Trek" aside). Why does the cosmos look so untouched and unconquered? What is keeping advanced extraterrestrials from claiming every star system in sight? This puzzle, known as the Fermi Paradox, has burned up a lot of cerebrum cycles when scientists tried to reconcile the lack of company with the expectation that there are many advanced alien societies.

One possible explanation is that interstellar travel is just too costly. Consider how expensive it would be for us to populate another star system. Imagine sending a small rocket to Alpha Centauri, one that's the size of the Mayflower (180 tons, with 102 pilgrims on board). Your intention is to get this modest interstellar ark to our nearest stellar neighbor in 50 years, which requires about 150 billion billion joules of energy. No one's sure what aliens pay for energy, but here on Earth the going rate is about ten cents a kilowatt-hour. So the transportation bill per pilgrim would be \$40 billion. That's a lot of moolah, a lot more than it takes to buy each emigrant a few thousand six-bedroom palaces and set him up for life. The fact that the trip is costly, in whatever currency, is reason enough to deter any alien society from trying to settle distant real estate. With far less expenditure, the extraterrestrials could pursue the good life at home.

Of course, if energy costs can be brought way down, for example with fusion or matter-antimatter technology, or by capturing more of the radiation spewed into space by the home star, this explanation might not hold water. But even if the aliens can afford colonization, maybe they haven't got the stamina to see it through. Subduing the Galaxy takes more than sending a ship full of restless nomads to the next star. The nomads have to settle that star, and then spawn pilgrims of their own. And those émigrés have to produce yet more settlers. And so on. If each and every colony eventually founds two daughter settlements (a pretty decent accomplishment), then 38 generations of colonists are required to bring the entire Galaxy under control. Even the Polynesians, who swept across the western Pacific domesticating one island after another, didn't manage this. Maybe the aliens can't do it either. On the other hand, if a few of them remain committed to expansion, their project might still succeed – just more slowly. Some researchers suggest that the Galaxy is colonized, but we just don't notice. Arthur C. Clarke pointed out that truly advanced engineering projects would be indistinguishable from magic. Perhaps the evidence of alien presence is so beyond us that we simply don't recognize it (somewhat like mice in The Louvre checking out the Mona Lisa). Another thought is that the aliens find Earth an interesting nature park, and have arranged matters so that, while they can observe us, we can't observe them. The idea that we may be some aliens' high-tech ecological exhibit is called the "zoo hypothesis." These explanations, and a bushel-basket more, have been proffered to deal with the Fermi Paradox. Any of them might be true. Nonetheless, some scientists find them too contrived, too unlikely to work in every case. Will all the aliens find colonization too costly? Will they all run out of empirical steam? Are we so special that someone has really gone to the trouble to put us behind invisible bars?

Or is there a much simpler explanation?

Next time, we'll consider some of the more obvious – if more disquieting – resolutions of the Fermi Paradox. We seem to have the Galaxy to ourselves. At least, that's the obvious conclusion from the apparent lack of aliens in the neighborhood.

But this conclusion might be a bit too obvious, and possibly wrong. In [previous articles](#), we've considered why extraterrestrial intelligence – even if common – would have restrained itself from spreading to every half-decent star system in the Galaxy. It's possible that the aliens have done cost-benefit analyses that show interstellar travel to be too costly or too dangerous to warrant ambitious colonization efforts. An alternative suggestion that would explain our apparent solitude is that the Galaxy is urbanized, and we're in a dullsville suburb.

Yet another resolution for the so-called Fermi Paradox is that we've been singled out for special treatment: we are an exhibit for alien tourists or sociologists. Our world may be known to the extraterrestrials, but they observe us through a sophisticated type of one-way mirror. While there's no evidence to give credibility to this last idea (known as the "Zoo Hypothesis"), many would argue that evidence does exist for another possibility – namely, that the Paradox is just a red herring because the aliens are in the neighborhood. In fact, they're in our back yards, or just above them. Many thousands of sightings of unidentified flying objects (UFOs) are reported each year, and polls show that one-third to one-half of the population believes that at least some of these aerial apparitions are alien spacecraft. The presence of aliens on Earth would neatly resolve the Fermi Paradox.

But while this is a prevalent idea among the public, the evidence for alien visitation has failed to sway most scientists. To convince researchers, who are inherently skeptical, unambiguous and repeated detection of flying objects by satellites or ground-based radar would be required. Better yet would be some indisputable physical evidence, such as the landing lights from an alien craft. In other words, something better than witness testimony is necessary, since such testimony isn't good enough, no matter how credible the witness.

Consider the fact that lots of people claim to have seen ghosts, and will be pleased to tell you what they saw. But the case for the existence of these shrouded spirits isn't what you would call convincing. You don't read a lot about the parameters of ghosts in scholarly journals.

Until and unless better evidence is collected, few scientists are inclined to accept the premise that the Fermi Paradox can be resolved by the claim that aliens are either soaring through the stratosphere, or are stashed away in meat lockers at Area 51.

Of course, there's no doubt that aliens in the neighborhood would be dramatic news, and that's part of the appeal of such claims. But the opposite circumstance would be similarly startling. What if we have failed to spy the extraterrestrials simply because there aren't any? After all, the evolution of intelligence may be a rare occurrence, even if biology is common. Could it be that in the enormous reaches of the Milky Way, ours is the only planet with thinking beings? That would neatly solve the puzzle posed by Fermi. And no matter how discouraging (or otherwise) the thought of being unique may be, we still haven't the proof that it isn't true.

While possible resolutions of Fermi's Paradox are as plentiful as gas stations, we still have no idea which, if any, is correct. Perhaps the universe is teeming with societies so subtle we can't prove their presence. Or haven't yet. On the other hand, maybe we're alone.

It's all a bit perplexing, but in fact there's hope. SETI experiments offer the promise of relegating the Fermi Paradox to the dustbin of historical curiosities by proving that other intelligence is out there. So while it's interesting and instructive to consider the pros and cons of galactic colonization, we should also make sure that we do some careful observing. In science, speculation is desirable, but experiment is definitive.

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