

The Fermi paradox: 'Where is everybody?'

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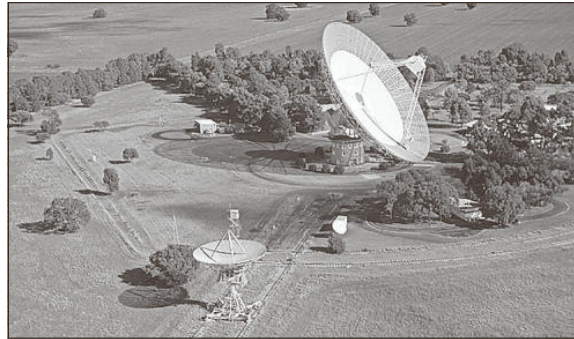
Enrico Fermi was an Italian-American physicist who was a pioneer in nuclear physics. He headed the team that designed and built the first power-producing nuclear reactor in 1942. He was also a key member of the Manhattan Project that created the atomic bomb.

After the war, Fermi continued to work at Los Alamos National Laboratory in New Mexico. In 1950, he was having lunch with some colleagues, including Edward Teller, the father of the hydrogen bomb. The group was discussing a New Yorker cartoon showing aliens emerging from a spaceship. Fermi had done some rough calculations on the probability of intelligent life in the universe. He concluded that intelligent beings were indeed probable and should have spread throughout the universe by this time. But "Where is everybody?" he exclaimed to his friends.

What Fermi was saying is that, aliens, if they existed, have had billions of years to colonize the universe and should have left visible signs of their presence everywhere. But all observations of the cosmos indicate a "dead" universe. This has come to be known as the Fermi Paradox and has been a key point of discussion in astrobiology ever since.

Now, 68 years after Fermi made his statement, we have learned a great deal more about the possibilities. Thanks to our observations from space-based instruments, like NASA's Kepler spacecraft, we know with more certainty that, in our Milky Way galaxy alone, there are estimated to be more than 100 billion planets. Many of which would be like Earth.

According to some analyses of the possibilities, using something called the Drake Equation, millions of these planets should have also produced intelligent life. Many of these civilizations would have been formed millions, or even billions, of years before us. It is easy to imagine that these beings would have created the



Photograph by John Sarkissian, CSIRO Parkes Observatory

The Parkes radio telescope near Alectown, Australia.

means to travel to other stars. After all, it only took us 66 years to go from the Wright brothers at Kittyhawk to Neil Armstrong stepping on the moon. Imagine how much space travel will improve over the next million years, a cosmologically short time!

If we look back at human history, expansion and colonization is a prime directive for our species. It is highly probable that if an advanced civilization like ours developed light-speed, space travel capability, their civilization would have exploded into the galaxy.

Yet, again, there is no sign of them.

Over the years, many scientists have proposed explanations for Fermi's Paradox. Professor John Ball of the Harvard-Smithsonian Center for Astrophysics suggested a possible answer in 1973. The aliens are out there, he said, and they know about us, and other civilizations like us. But, they have chosen to keep us in a type of preserve and let us mature and evolve naturally. They will watch until they think we are ready to join the extraterrestrial community. And then they will make contact with us.

Another scientist with an explanation for the Fermi Paradox was Carl Sagan. In 1985, he commented on the lack of results from the projects engaged in the Search for Extraterrestrial Intelligence (SETI). Since 1961, the date of the first SETI experiment, most of these projects have been using radio telescopes to try to detect signals from an alien civilization. And they have yet to hear the first whisper. Sagan said that we may not be listening for the aliens

in the way they are broadcasting. Their technologies are so advanced, that their communication systems are unknown to us.

One of the key academic centers for considering the answer to the Fermi Paradox is the Future of Humanity Institute at Oxford University in England. Professor Robin Hansen, a member of the Institute, proposed the "Great Filter" theory in 1998 to explain the lack of evidence for alien civilizations. Many other scientists have picked up on his ideas and expanded them.

Essentially, Hansen said that there are several steps of development that aliens on another planet must go through to reach the point where their civilization could colonize the universe. At any one of these steps there could be a Great Filter that stopped thousands of possible civilizations in our galaxy. So, they never were able to colonize the stars and that is why we don't see evidence of them.

The big question: Is that Great Filter behind us here on Earth or ahead of us? If it is behind us, that is good news. Earth has won the lottery. Everything necessary for intelligent life to develop and evolve came into place, even though all the probabilities were against it. Now, we will be the first to develop interstellar space travel and, over the next billion years, spread throughout the cosmos.

On the other hand, if the Great Filter is ahead of us, then there were probably thousands or even millions of civilizations before us, all of which hit the Great Filter and were destroyed before they could reach other stars.

How will we know which alternative is correct? If the planned NASA mission to Mars in the 2030s finds nothing, then the question is still unanswered. If, on the other hand, the mission discovers the remnants of an ancient civilization, that would be bad news indeed. It would confirm that the Great Filter is ahead of us, and as Robin Hansen says, "We're next!"

Beside Fermi, other scientists have tried to develop a quantitative estimate of the number of intelligent civilizations in the universe. The most famous is astronomer Frank Drake. In 1961, he developed an equation with seven variables. The variables include the rate at which new stars form, the fraction of stars with planets, the number of planets per star where conditions are suitable for life, the fraction of planets where life actually emerges, etc. When estimates for each of the seven variables were put into the equation, the result was that the galaxy should be teeming with life.

Recently, however, Anders Sandberg, a colleague of Robin Hansen at Oxford's Future of Humanity Institute, took another look at Drake's equation and updated it with more recent knowledge of biology, chemistry and cosmology. Because there is still considerable uncertainty with the estimates, they used a range of values for each variable. Their calculations had a surprising conclusion. The chance that humanity is alone in the Milky Way galaxy has a median probability of about 77 percent. In other words, there is a very good chance that E.T. doesn't even exist.

So, they say, we shouldn't be surprised that we don't see evidence of aliens. And, therefore, there is no paradox. We are just the lucky ones.

But, most scientists agree, including Anders Sandberg himself, we still don't have enough information to make a strong conclusion. There is at least a 23 percent chance that E.T. is out there. So, the SETI scientists and the astrobiologists should continue their work.

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