New Scientist

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65TH ANNIVERSARY SPECIAL

do we exist?
do we grieve?
are we irrational?
is there a cosmic speed limit?
does evolution happen?
are we conscious?
does time only move forward?
is there something rather than nothing?
is the universe intelligible?
haven't we heard from aliens?
is quantum theory so strange?
are we good and evil?
is the universe just right?

13 of the most profound questions about the cosmos (and us)

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Why haven't we heard from aliens?

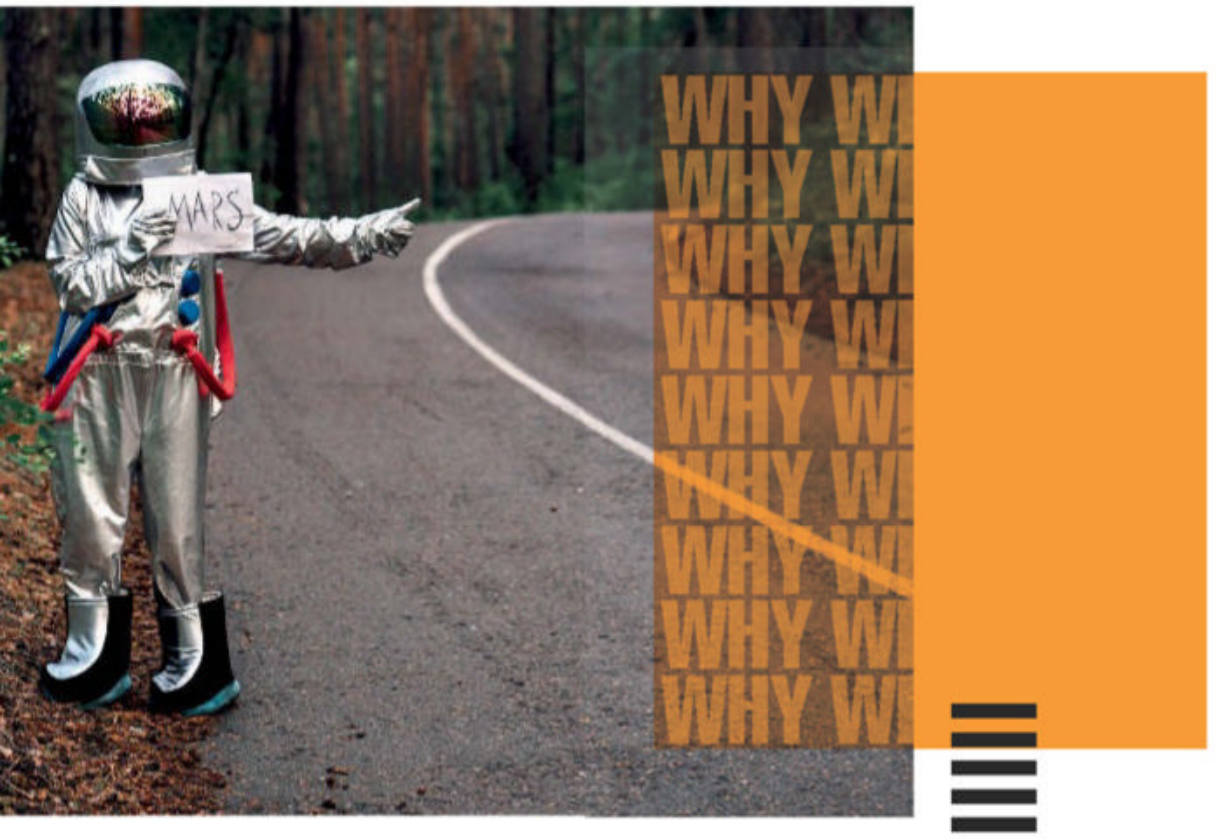
IN 1960, astronomer Frank Drake began an experiment. With a radio telescope, he studied two nearby sun-like stars, hoping to find signals that could only have been generated by life on planets orbiting these stars. He came up blank. In the six decades since Drake started the search for extra-terrestrial intelligence (SETI), astronomers have kept listening, carefully and systematically. Still, we have heard nothing.

One possibility is that there simply are no aliens out there – that we truly are alone. But this seems unlikely, given the vastness of the cosmos, with hundreds of billions of galaxies containing hundreds of billions of stars, most of which have at least one planet orbiting them, at least according to our burgeoning knowledge of exoplanetary systems in our own galactic neighbourhood.

Jill Tarter, co-founder of the SETI Institute in California, says we haven't listened for long enough or looked hard enough to make any such sweeping statements yet. Astronomers have studied all kinds of electromagnetic radiation – light, radio waves, gamma rays – looking for signals. Such a search has to cover all directions and distances in space, plus the different ways a signal might manifest itself, such as shifts in polarisation, frequency, modulation and intensity. Tarter sees these parameters as a multi-dimensional ocean. "When SETI turned 50, we had explored one glass of water from that ocean. By the time it turned 60 it was more like a small hot tub," she says. "It's getting better and faster all the time, but there's a lot more to explore."

According to Beth Biller, an astronomer at the University of Edinburgh, UK, searching through time is the biggest challenge. Humans have only lived on Earth for the blink of an eye compared with the age of the universe, and we have only been broadcasting our presence with things like radio waves for just over a century.

Alien life hasn't made its presence obvious so far



"The civilisation that you want to contact has to exist at the same time as your own civilisation," says Biller, which given light's finite speed of travel, could be thousands, millions or billions of years in the past once their signals reach us, depending on how far away from Earth you are looking. "When you're talking about finding aliens, you just have to get a lot of timings correct," she says. Electromagnetic waves from other worlds will radiate in all directions, so the further away we are, the fainter any signal will be. Even the closest neighbouring star system to Earth, Proxima Centauri, is more than 4 light years away, putting a big delay on any conversation.

Even if a transmitting alien civilisation were close enough, we might not see it. Around 70 per cent of exoplanets have been found using the transit method, which involves observing the light from stars periodically dimming when planets pass in front of them. A study published in June 2021 by Lisa Kaltenegger, an astronomer at Cornell University in New York, and her colleagues turned this logic around to ask how likely aliens would be to see us using this method.

They identified just over 2000 systems within about 300 light years of Earth that might see our planet in this way at some point between 5000 years ago and 5000 years from now. Within the list, there are seven stars with planets in the habitable "Goldilocks zone", where it is the right temperature for liquid water on the surface, of which four are close enough to have already received radio waves. Most of them lie in a heavily populated area of space so far unexplored by exoplanet surveys, at least until NASA's Transiting Exoplanet Survey Satellite (TESS) started operating in April 2021. "And yes, I gave them the star list to search for planets," says Kaltenegger.

Even a continued no-show might not tell us much. If alien life forms exist, it might be that intelligence or technology are rare. Perhaps technological civilisations are simply too combustible, liable to destroy themselves before they can make their presence unambiguously known. Perhaps they do know about us – but have decided to leave us alone.

Or perhaps we are simply looking for the wrong thing, our focus on electromagnetic signals reflecting the state of our current technology. Why not gravitational signals, say – or something else entirely? "We may have to discover new physics before we get it right," says Tarter. **Abigail Beall**