

## Signs of life

*Is it time for a new approach to finding extraterrestrials?*

IN THE Cascade mountains of California, north of Lassen Peak, astronomers are looking for aliens. The Allen Telescope Array (mostly paid for by Paul Allen, co-founder of Microsoft) consists of 42 dish antennas, each six metres across, scattered across the countryside. When the array is complete, it will have 350 dishes that, by acting in concert, will have the power of a single instrument 700 metres across.

The Allen telescope is looking for aliens the traditional way: by searching for radio signals that have either been sent out deliberately, or leaked into space accidentally, as human radio signals are. The search for extraterrestrial intelligence, or SETI, is a 50-year-old idea. Much progress has been made in locating Earthlike planets (see article) but about 1,000 star systems have also been subject to serious radio scrutiny. The Allen array will increase the number to 1m within a decade.

That is an impressive number but some think this is the wrong approach. Paul Davies, a physicist at Arizona State University, points out that widespread radio communications may prove a short-lived historical phenomenon on Earth. Humans are, after all, increasingly using fibre optics to talk to each other. Moreover, many modern radio devices (such as mobile phones) rely on a technique called "spread spectrum" encoding. It uses signals that look like background noise, except to a receiver equipped with the right unscrambling code. Humans figured this out within a century of inventing radio technology, so aliens might have done the same. Radio signals that are clearly artificial in origin may, then, be only a transient sign of civilisation. So it might make sense to widen the search by looking for other telltales.

The truth is out there

Dick Carrigan, a retired particle physicist, has enumerated several suggestions for such signs in a paper posted recently on arXiv, an online repository of scientific papers. His first idea is to look for pollution in the atmospheres of promising planets. This is an extension of the idea of looking for signs of life in atmospheres. It would be obvious to anyone who turned a spectroscope on Earth, for example, that something odd was going on. Air that is 21% oxygen, one of the most reactive elements in the periodic table, suggests the gas is being freshly minted—as it is, by photosynthesis.

In February this year Mark Swain of the Jet Propulsion Laboratory in California and his colleagues reported that they had developed a new technique for calibrating data arriving at ordinary ground-based telescopes, allowing them to identify the components of an extrasolar atmosphere. They used it to detect methane in the atmosphere of a planet nearly 63 light-years away. In the past only space-based telescopes could manage this trick—and they are ludicrously expensive.

Dr Carrigan says that besides looking for oxygen, astronomers should seek molecules such as chlorofluorocarbons (CFCs) which would be unequivocal signs of technology, since no natural process on Earth creates them. (Although if CFCs were as damaging as they are on Earth, they too might be transient technologies.)

Instead of looking for the earliest signs of industrialisation, then, perhaps the thing to do is to let the imagination run riot and ask what technology might do to a solar system if it had tens or hundreds of thousands of years to work its magic. This is the realm of science fiction, of course. But the best sci-fi is grounded in reality.

One famous work of science fiction is "Ringworld", by Larry Niven. This book, which describes the descendants of a civilisation that has converted the material in its planets into a giant ringlike structure around its sun, was inspired by Freeman Dyson's idea that a truly technologically advanced species would endeavour to capture as much light as possible by building a spherical shell around its central star. Such so-called Dyson spheres would, if they exist, reradiate captured energy (after some of it had been put to good use) as heat—infra-red radiation.

This radiation can be detected although Dyson spheres remain difficult to distinguish from natural astronomical objects that give off similar signatures. The birth and death phases of stars, for example, are associated with heavy dust clouds that give off an infra-red signal which might resemble the swarm of artificial satellites constituting a Dyson sphere.

So far, few astronomers have conducted searches for Dyson spheres—and none has been successful. But Dr Carrigan still thinks it is worth trying. He has been cataloguing possible candidates from the Infrared Astronomical Satellite, a collaboration between America, Britain and the Netherlands that conducted the first space-based survey of the entire sky at infra-red wavelengths and located hundreds of thousands of sources. On his website he offers tips for amateur cosmic archaeologists who wish to hunt for Dyson spheres. An investigation of SETI signals from the 13 "least implausible Dyson sphere candidates" is planned for the Allen telescope.

Any civilisation that has built a Dyson sphere will have to have been around for a long time, of course—and in the very long run its star will start to change in unpleasant ways, ballooning to form a red giant. Another signature of advanced technology would be an attempt to slow this process down. Red giants are created when a star exhausts its supply of hydrogen at its core, with the result that the inner layer contracts and the outer layers expand, forming a redder and much larger star. If the star's outer layers could be mixed into the core, that would slow the process of inflation down. And, presumably, a sufficiently advanced civilisation would try to do that if it could.

Such a star would look odd, though. It would be bluer than it should be and would be of a type known to astronomers as a "blue straggler". Although, again, there are perfectly natural reasons these might form. The universe, though, is an ancient place, so many civilisations could be very old indeed. Perhaps, then, it will be a sign like this—of a technological civilisation millions of years old—that is seen, rather than some upstart that has not even got its radio waves under control.

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