How we could snoop on extraterrestrial communications networks

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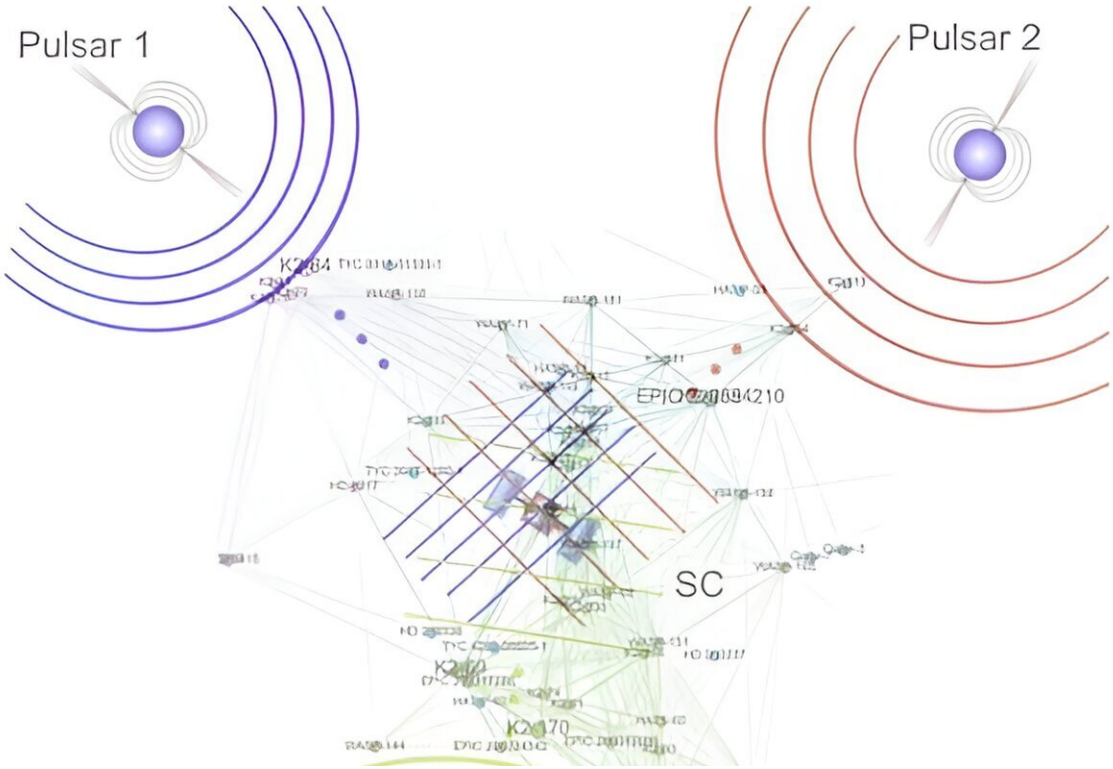

A 3-pulsar navigation system for an ET civilization. Credit: Ross Davis (2022)

The conditions for life throughout the universe are so plentiful that it seems reasonable to presume there must be extra-terrestrial civilizations in the galaxy. But if that's true, where are they? The Search for Extra-

terrestrial Intelligence (SETI) program and others have long sought to find signals from these civilizations, but so far there has been nothing conclusive.

Part of the challenge is that we don't know what the nature of an alien signal might be. It's a bit like finding a needle in a haystack when you don't know what the needle looks like. Fortunately, any alien civilization would still be bound by the same physical laws we are, and we can use that to consider what might be possible. One way to better our odds of finding something would be to focus not on a direct signal from a single world, but the broader echoes of an interstellar network of signals.

As noted in a 2022 paper posted to the *arXiv* preprint server, one physical constraint is that there is a great deal of dust and interstellar gas in the Milky Way. Since radio light penetrates gas and dust better than visible light, the signals sent between stars are likely to be microwave radio signals. Another fact is that if you are traveling between the stars you need to know where you are and where you are going. One way to do this is to use pulsars as navigational beacons. In the paper, the author argues that these can be combined as a broadband radio signal from the hub of the alien civilization that contains X-ray pulsar navigation metadata (XNAV).

One of the biggest challenges of detecting stray alien signals is that they would likely be difficult to distinguish from random noise. Even simple signals such as television broadcasts rely upon a known protocol. Without that protocol, we can't decipher the message. This is similar to the challenge of breaking the Enigma code during World War II. One of the breakthroughs came when it was realized that most messages contained a weather report, so the message likely contained the German word for weather. Metadata in an alien signal could serve a similar role. If we know radio signals should contain XNAV metadata, then we can use this as a starting point. In game theory this is known as a Shelling

Point.

The author outlines nine steps for how an interstellar civilization might construct a pulsar navigation system, and what the pattern of that network might be. By creating multiple scenarios, we might be able to recognize certain patterns as technosignatures. As the author notes, one limitation of this approach is that any metadata scenario we imagine is still based on how homo sapiens think, which might not be how an alien intelligence sees things.

All of this is speculative, but it's worth considering. We will only recognize an alien signal if we better understand the forms they might take, and perhaps a few wild ideas like this one are exactly what we need.

More information: Ross Davis, Finding the ET Signal from the Cosmic Noise, *arXiv* (2022). DOI: 10.48550/arxiv.2204.04405

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