Eavesdropping On ET

Is intelligent life out there? Avi Loeb looks for leaked transmissions from inhabited planets – not intentional beacons – which broadcast a cosmic announcement: "We are here."

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by STEVE NADIS

FQXi Awardee: Avi Loeb, Harvard University

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Harvard astronomers Avi Loeb and Matias Zaldarriaga have interests as wide as the universe itself. But high on their list is probing the period in the early universe before the first stars turned on, known as the "dark ages."

ET PHONE HOME Avi Loeb

The key to illuminating this murky epoch may lie in cosmic background emissions of primordial hydrogen, the most abundant element in the universe. It is widely believed that primordial hydrogen would assume a neutral form before being ionized by stars, galaxies, and quasars. So, a new generation of telescopes is now poised to search for the element's telltale signature, a red-shifted 21-cm emission line. Loeb and Zaldarriaga are on the science team for one of these efforts: the Mileura Wide-Field Array (MWA), which is being built in the radio-quiet desert of western Australia.

Turn That Noise Down

Such observations are technically demanding, in part because humans are extremely noisy in the meter-wave radio spectrum (corresponding to a wavelength of 21 cm after it has been stretched by cosmic expansion to a scale of meters): Our TVs, radios, military radars, cell phones, and even computers all pump radiation into that regime. Loeb and Zaldarriaga discussed this challenge on the way to lunch in 2005, when Loeb turned the problem on its head. The main difficulty, Loeb realized, is that the MWA will be sensitive--and indeed tuned--to the very frequencies that our civilization emits in. Might aliens transmit in the same frequencies? If so, maybe earth-based scientists could take advantage of the MWA's sensitivity in that range to detect them. Both astronomers chuckled over the idea and quickly moved on.

Until last spring. That's when Loeb heard about the FQXi Inaugural Request for Proposals and burst into Zaldarriaga's office with the news. To win an FQXi Award, Loeb needed a project that normal funding sources, like NASA or NSF, would never support: "Something that no one else was thinking about, and if they did think about it, they'd probably object."

DISTANT WORLD Artist's rendering of a distant world inhabited by intelligent aliens.
Image Credit: David A. Aguiler (CfA)

"It has to be something crazy," Zaldarriaga agreed. "What about that SETI idea you had last year?"

Un-SETI-ling

Loeb had not only forgotten about his 2005 whimsy, he was also surprised that Zaldarriaga remembered it, since he considered his younger colleague to be the more conservative of the two. "I'm the one who's always coming up with the wild ideas," Loeb says.

Wading into SETI waters would be a radical departure for both of them. As Zaldarriaga has often made clear: "I'm not a SETI person." Still, Zaldarriaga considered the idea worth pursuing as a "side project" piggybacking on MWA's main mission--mapping primordial hydrogen.

Loeb insists that even though SETI is not their usual focus, their idea could be approached scientifically as a hypothesis, however outlandish, tested against empirical fact. "The question of whether there's intelligent life out there remains one of the fundamental unknowns," he says. "The best way to attack it is to get some data."

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>
> *- Avi Loeb*

In Loeb's opinion, the project, eventually approved for FQXi funding in the amount of $47,370, has several things going for it. First, it would take SETI into brand new territory, the unexplored low-frequency radio band previously avoided because of terrestrial interfer-

ence. As Loeb and Zaldarriaga wrote in a 2007 paper for the Journal of Cosmology and Astroparticle Physics, "traditional SETI searches focused on high radio frequencies that do not match the frequency range over which our civilization is most luminous."

Second, SETI could now look for leaked transmissions--the kind of stuff, like *Seinfeld* reruns, that Earth sends out every day--rather than intentional beacons— a cosmic announcement that "We are here"—that astronomers have searched for in the past. Although it's a long shot, Loeb is confident that the idea could work if the source (presumably a planet) is close enough and the alien broadcasts are sufficiently powerful. Loeb and Zaldarriaga calculate that MWA could detect earth-like civilizations around the nearest thousand stars, if aliens used anything comparable to our current military radars. (The next-generation radio observatory, the Square Kilometer Array, is expected to have a far greater range, capable of eavesdropping on the 100 million nearest stars.)

EAVESDROP Single antenna tile from the Mileura Wide-Field Array. Image Credit: Frank Briggs (Mt. Stromlo Observatory)

Third, the whole endeavor would cost practically nothing, since no new hardware would be needed. All that would be required is some software to filter through the flood of data pouring into MWA's supercomputer and pick out a so-called "bump in the night"--an odd signal of unnaturally narrow bandwidth, which stands out from the smooth hydrogen background but does not correspond to any known atomic or molecular emission lines.

For this reason, the Loeb-Zaldarriaga experiment wouldn't interfere with MWA's main goal, notes Miguel Morales of MIT, one of the telescope's designers and builders. "People always write programs after the fact to search for specific objects, and that's exactly the reason to build an instrument like this. When you open up a new window to observation, you hope people will come up with new ways of using the data, and that's exactly what Avi and Matias have proposed."

Jill Tarter, research director of the SETI Institute, also applauds Loeb and Zaldarriaga's planned entry to the world of SETI. "The more people we have in the game, the better because we have a large haystack to search," Tarter says. "And if they have some new equipment to bring to this effort, and make some different assumptions about where to search, so much the better."

Don't Call Us, We'll Call You

Loeb, too, is eager to join the hunt for intelligent life in the universe. But he offers a few caveats. "If you look at transmissions from earth, most of the power comes from military radars," he says. "So if we detect extraterrestrial signals, we should be cautious before indicating our presence."

In addition, he points out that our civilization has been broadcasting into the cosmos for about 50 years, which means our emissions have traveled some 50 light-years into space. (That, coincidentally, matches the distance out to which the MWA could detect such broadcasts). Consequently, aliens in this neighborhood could eavesdrop on us using the same technology. "We better hope that no hostile civilization is picking up our signals now," warns Loeb.

Loeb's wife voiced some concerns of her own, telling him: "If the aliens land in our backyard, make sure they don't ruin my lawn. And if you go back there to talk with them, please leave the car keys with me."

Lofar Tunes In

The UK recently became part of the Low Frequency Array (LOFAR), the European counterpart to the MWA. In England, three banks of radio arrays, each consisting of 96 antennas, are slated to link up with an even bigger radio telescope network in Europe.

A member of the UK LOFAR team, University of Portsmouth cosmologist Robert Nichol, has an avid interest in developing algorithms for "detecting the unknown." Nichol was therefore delighted to happen upon a paper posted online last November by Loeb and Zaldarriaga entitled "Eavesdropping on Radio Broadcasts from Galactic Civilizations..." Nichol downloaded the paper, and began what he calls his own "personal exploration."

The search for extraterrestrial intelligence (or SETI), Nichol says, "is quite a different area of research for me, as it is for Loeb and Zaldarriaga. Another reason I took this idea seriously is that I know the reputations of these two gentlemen in cosmology. If they're writing a paper on SETI, it has to be well thought-out."

If MWA could do some SETI on the side, Nichol surmised, so could LOFAR. Further, having two such telescopes could be helpful in the event that one detects a signal appearing to be of artificial origin: the second would be available for corroboration. Nichol is now figuring out how to write a computer program to sift through LOFAR's enormous data pipeline and find "that one spike sticking its head above the noise"--a transient blip on the screen that cosmologists interested in neutral hydrogen would normally ignore.

If an interesting signal is spotted, Nichol jokes, "we'll first have to make sure it's not due to pigeon droppings on the inside of the antenna," referring to an infamous incident during the discovery of cosmic microwave background radiation. "But if it's real, it could be aliens or a spinning neutron star. Either way, we have the chance to find something interesting so long as we keep our minds open."