SETI reborn—the new search for intelligent life

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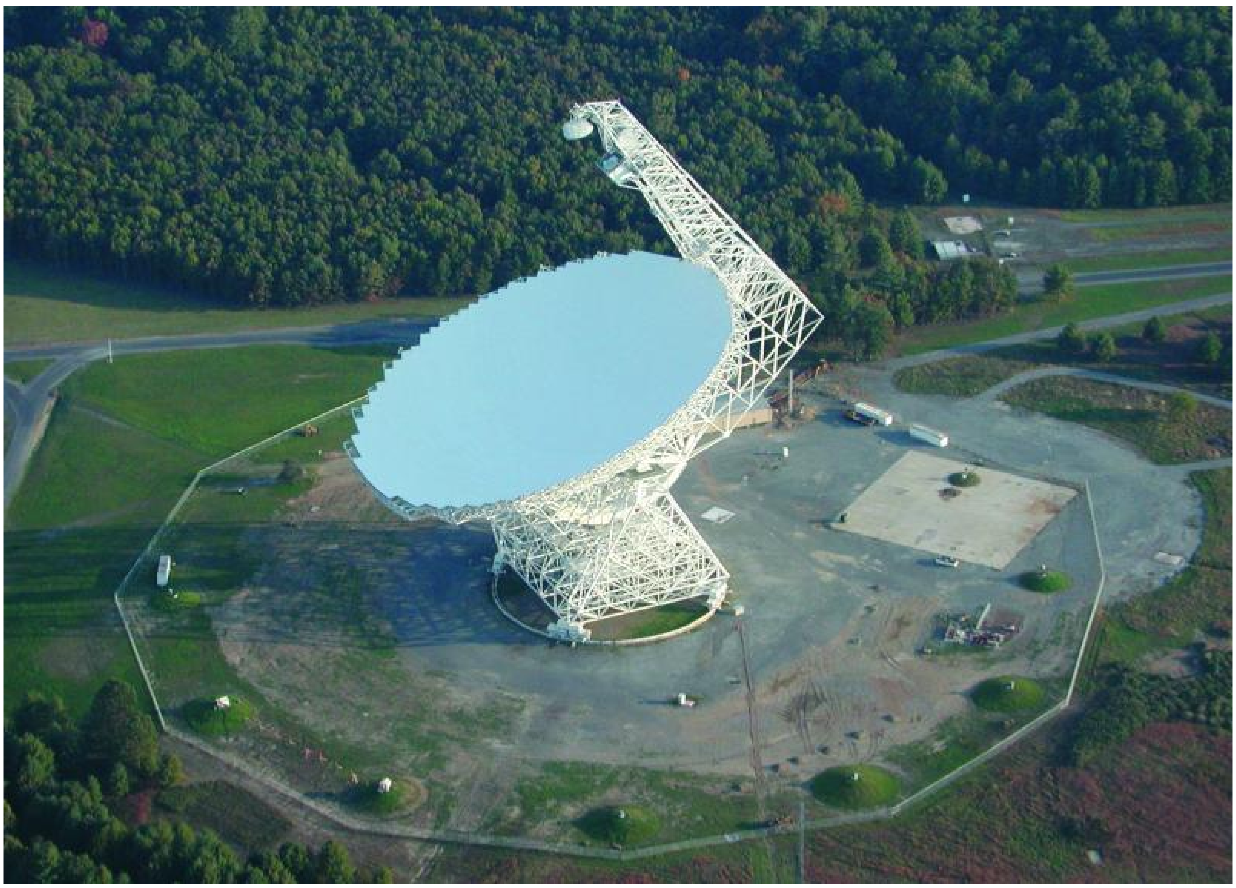

The Robert C Byrd telescope at the Green Bank Radio Observatory, which is the ancestral home of SETI, will play a key role in the Breakthrough Listen project. Credit: NRAO/AUI/NSF

A new influx of money has saved the Search for Extraterrestrial Intelligence (SETI) from collapse, but what does the future hold for our quest to discover intelligent life in the Universe?

In July 2015 Russian billionaire philanthropist Yuri Milner announced that his Breakthrough Prize Foundation would donate $100 million over the course of 10 years to fund the biggest SETI project ever attempted. Prior to this, the field of SETI had effectively been the pauper of the astronomical sciences, shorn of government funding and limping along thanks only to the generosity of public and private donations. At best, its global annual funding was $1.5 million. With Milner's millions, everything has changed.

"This is the biggest infusion of money for SETI since the NASA SETI program, which was terminated by Congress in 1993," says Seth Shostak, the senior astronomer and director of the research division at the SETI Institute, one of the world's most prominent centers for SETI research, nestled in California's Silicon Valley. "So, of course this is a major boost to the search."

The Breakthrough Listen project, as it is known, intends to direct some of the largest radio telescopes in the world on a decade-long mission to find evidence of intelligent life. Already, the 64-meter Parkes radio telescope in Australia and the 100-meter Robert C. Byrd Green Bank Telescope in West Virginia have been enlisted in the project to search the nearest million stars, which is three orders of magnitude more stars than before, as well as listen along the galactic plane of the Milky Way and to a hundred nearby galaxies for radio signals from another world.

This is in stark contrast to where SETI had been headed. With no money, the opportunity to fund telescope time and manpower to conduct and analyze searches was growing increasingly limited and two of SETI's chief observatories, Green Bank and the Arecibo Observatory in Puerto

Rico, were on the National Science Foundation's chopping block to cut costs. Yuri Milner's money will go a long way toward helping Green Bank win a reprieve, although the future of Arecibo remains in more serious doubt.

"Frankly we're getting incredible value in terms of telescope time; the Green Bank telescope is a $125 million telescope," says astrophysicist Andrew Siemion of the University of California, Berkeley, who is one of the directors of the Breakthrough Listen project. "It's a world-class radio telescope in every sense of the word and we're getting it for pennies on the dollar."

Siemion hints that more announcements in the Breakthrough project are still to come, but at the SETI Institute, Shostak and his colleagues are running their own project on their own radio observatory, the Allen Telescope Array (ATA). This is a network of 42 radio dishes dedicated to searching the skies for radio signals from extraterrestrial civilizations, but which is also used for regular astronomy too.

"We have the ATA here in California that we use exclusively," says Shostak.

At one time it looked as though the ATA was also under threat. The original premise was to build a large array of 350 six-meter radio dishes at Hat Creek, 290 miles northeast of San Francisco, and an initial endowment from Microsoft's cofounder Paul Allen paid for the first 42, but the money dried up and all fundraising today goes toward sustaining operating costs.

One of the 42 dishes belonging to the Allen Telescope Array, listening to the stars. Credit: Seth Shostak/SETI Institute

In 2011, budget shortages forced UC Berkeley to drop out of the ATA project and it entered a temporary shutdown before being revived thanks to the non-profit research institute, SRI International (formerly the Stanford Research Institute). Now that it is up and running again, it has its own niche to carve out.

"There are some SETI experiments that are actually much faster using an array such as the ATA," says Shostak.

For example, an array can be faster and more sensitive to imaging surveys, and it's able to observe many stars at once with each of its radio dishes or work in unison to focus on one target.

"Though if we knew precisely the best strategy to use in the search, we would of course put all our effort into that," adds Shostak. "We don't, and we can't."

Being able to diversify has been crucial to SETI's survival as a viable scientific field of study. This century is increasingly one of optical SETI—small telescopes and carefully calibrated photometers looking for pulses of laser light that may last mere fractions of a second. To this end, the University of California's Lick Observatory on Mount Hamilton is lending its Automated Planet Finder, a 2.4-meter robotically-controlled optical telescope, to the Breakthrough Listen project to look for the flashes of powerful lasers that could be beamed our way. Laser signals do not disperse as quickly as radio waves and have a higher bit rate, meaning they can carry more information even in a short pulse. Furthermore, there is less inherent noise in the system because lasers shine at a single specific wavelength, with none of the background hiss present in radio.The downside is that optical lasers can be attenuated by dust and gas in the interstellar medium, which results in the dimming of the light.

"By the time you get to a thousand light years, an optical laser would lose about 90 percent of all its light," says Shelley Wright, an astrophysicist at the University of California, San Diego. "The interstellar gas and dust would absorb it."

Ordinarily that means optical SETI searches are limited to looking at stars within a few hundred light years, but the solution that Wright has come up with is to search for infrared lasers instead. Because the interstellar medium is mostly transparent to infrared light (and radio waves), infrared lasers could be beamed across much greater distances without losing their intensity.

The NIROSETI team, led by Shelley Wright (third from right) and Dan Werthimer of the University of California, Berkeley (second from left). NIROSETI is an infrared SETI experiment on the one-meter Nickel Telescope at Lick Observatory

Wright's infrared experiment, called NIROSETI (Near InfraRed Optical SETI), is on the 1-meter Nickel Telescope at Lick Observatory and has begun its first survey this summer with student involvement. Funded by a private donation, NIROSETI also employs a unique way of saving the data that it collects, allowing Wright and her team to sift through it retrospectively and search for signals of any specified duration, be it 20 seconds or 20 nanoseconds. This could be vital to the success of the experiment because scientists can only guess at how long a signal may appear.

"We'll hopefully have a summary paper out in the fall and we're planning to make all the data public to allow others to play with it in ways we haven't thought of," says Wright.

A million stars is but a small fraction of the 250 billion or more stars in our galaxy, and 10 years is a cosmologically short time, meaning the odds will still be against finding ET within the next decade. Fortunately, SETI will likely not end with the Breakthrough Listen project.

In the next decade the Square Kilometer Array (SKA), an upcoming powerhouse in the world of radio astronomy that is under construction in South Africa and neighboring countries, as well as Australia, becomes operational. Once it is turned to the stars, the SKA will collect petabytes (many thousands of billions of bits) of data every day, all of which will be publicly accessible to scientists around the world, and there may be the opportunity to equip the SKA with SETI-dedicated instruments.

SETI is now in a position to take advantage of the many exoplanet discoveries that are now taking place. Credit: ESO/M Kornmesser/Nick Risinger (skysurvey.org)

"We've been trying really hard to get a SETI capability on the Square Kilometer Array, so I'm hopeful that the Breakthrough Listen project will help that along," says Siemion. "The SKA will be an exquisite instrument, eventually becoming capable of conducting sensitive sky surveys that SETI can piggyback on."

Meanwhile, a telescope called MeerKAT (Karoo Array Telescope), which is a prototype of the SKA, also has tremendous potential as a SETI telescope when it comes partially online by the beginning of 2016. Then there's the giant 500-meter Aperture Spherical Telescope being built in China that is also potentially an impressive SETI instrument. With the new money, the hope is that SETI will make itself attractive enough to other investors to continue the search with some of these next generation telescopes if the Breakthrough Listen project does not detect a signal in the next 10 years.

"SETI is a long term project," concludes Siemion. "We're going to do the 10-year, $100 million dollar initiative. It's a dream come true and we're going to do a great project with it, but the most likely outcome is that we won't detect anything. But then maybe people will start to think that we're the only intelligent life in the Universe and I think that would be an incredibly profound realization. If the Breakthrough Listen project succeeded in communicating that fragility and rareness to the public, I think it would have been a success."

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