

AstroTalk: Behind the news headlines of July 2015

Richard de Grijs (何锐思)

(Kavli Institute for Astronomy and Astrophysics, Peking University)

The search for life beyond Earth is heating up!

The search for extraterrestrial intelligence elsewhere in the Universe has leapt to prominence once again, with the announcement of the *Breakthrough Listen* initiative, an ambitious bid to combine modern, vast computing capacity with the world's most powerful telescopes. Announced this past July and funded to the tune of US\$ 100 million by Russian billionaire Yuri Milner, it will be a high-risk, high-reward programme, searching for signals from intelligent aliens – definitive proof that we are not alone.

Milner, who made a fortune through investments in companies like Facebook, said the power of Silicon Valley technology and innovation would be used.

“The scope of our search will be unprecedented: a million nearby stars, the Galactic Centre, the entire plane of the Milky Way and 100 nearby galaxies,” Milner told a packed press conference at the Royal Society in London.

Organizers say the *Breakthrough Initiatives* project, supported by the *Breakthrough Prize Foundation* and endorsed by prominent scientists, is the biggest ever scientific search for alien life. It includes a ‘listening’ programme—the effort to analyse vast amounts of radio signals in search of signs of life—and a ‘messaging’ component that will include US\$ 1 million in prizes for digital messages that best represent the planet Earth. The messages will not be sent, however, in part because some scientists—including the eminent theoretical physicist Stephen Hawking of Cambridge University—fear messages sent into space could possibly spur aggressive actions by alien races.

The idea that we might not be alone in the Universe is not new. It has passed in and out of fashion for at least the last few centuries, with past astronomers speculating on advanced life on our neighbouring planets. Astronomers eventually revealed that these planets are far from the oases they might have been. Rather than a verdant tropical planet, Venus turned out to be a hellish, pressure-cooker world with a surface hot enough to melt lead. And Mars is a cold, arid, husk of a world, poorly suited to complex life.

So if we want to find life as we know it on Earth – someone alien to talk to – we have to cast our net more widely. And this is where the *Search for Extraterrestrial Intelligence (SETI)* comes into play. The idea is that once a species becomes sufficiently technologically advanced, it will advertise its presence to the cosmos in some way that could be detected by astronomers on other worlds. As a species, we humans have already passed that point. Some argue that the human-induced modification of our environment was the threshold. Indeed, they argue that agriculture and the controlled use of fire would have made us detectable by advanced alien astronomers thousands of

years ago.

SETI, however, is more interested in the technological broadcast of life's existence. The radio and television broadcasts of the last century will provide definitive evidence of our existence to any alien observers, at least if they know where to look. The first transatlantic radio broadcast, by Guglielmo Marconi, occurred in 1901. Of very low power, the radio waves emitted in that broadcast that escaped Earth will now have travelled for 114 years, out towards the stars that were above the horizon for the broadcaster.

Over the years, our broadcasts have become louder and spread across the electromagnetic spectrum. As a result, a vast and ever-expanding bubble of space centred on Earth is full of our noise. If they knew which frequencies to study, aliens at the right distance would be able to tune in to coverage of the 1936 Olympics, the coronation of Queen Elizabeth II or even watch episodes of our popular television shows. If we are broadcasting to the Universe, then perhaps others are too? If so, *SETI* aims to uncover their signals – the evidence that there is not only life, but life like us, somewhere out in space.

That search has proceeded intermittently for years, with different groups of scientists using ever more advanced tools to search for a needle in a haystack. The *Breakthrough Listen* initiative is simply the latest. Just as our early thoughts on life beyond Earth were focused at our own solar system, so was our search for alien life. An astonishing example was the National Radio Silence Day, held in the USA during a particularly close approach between the Earth and Mars in August 1924. For a period of 36 hours around the time of closest approach, the American government asked civilians to maintain radio silence for the first five minutes of every hour. During the periods of silence, radio receivers listened to the sky, searching for signs of a signal from the Martians.

None arrived.

As technology continued to improve, so did our efforts to detect the signs of extraterrestrial technology. In 1960 the first true modern *SETI* programme began with *Project Ozma*. Led by renowned radio astronomer and astrobiologist Frank Drake – who created the Drake Equation, which estimates the number of potential civilizations in our galaxy – *Project Ozma* used a large radio telescope to listen to two single, nearby, Sun-like stars – τ Ceti and ϵ Eridani.

The observations continued for six hours a day for a period of several months. The astronomers involved concentrated their efforts on radio waves at a wavelength of 21 centimetres, an astronomical hailing frequency at which radiation floods the Universe from cold hydrogen gas between the stars. The 21 centimetre wavelength is one that has often been used as a target for *SETI*, the idea behind this being that it would be an obvious frequency for alien civilizations to choose for communication with newly fledged technologies.

Again, we heard nothing.

But still, the searches continue. The odds of finding something are very low, but the potential reward so great that it is definitely worth trying. Prior to the latest announcement, the *SETI* project that most captured the public imagination was *SETI@home*. That project used the downtime of computers around the world to search for signals from beyond the Earth through a screensaver people could install on their home computers. At its peak, the project involved 9 million users, all participating in the search for life elsewhere.

And again, nothing has been heard.

Which brings us to our current headline maker, *Breakthrough Listen*, launched by eminent and world renowned astronomers, including Frank Drake – now chairman emeritus of the SETI Institute – the theoretical physicist Stephen Hawking and Matthew Bailes from Swinburne University of Technology in Australia. Hawking, who speaks using a computer-generated voice due to the effects of motor neuron disease, explained the reason for the US\$ 100 million project:

“We are alive. We are intelligent. We must know.”

The project will be supported by the 100-metre diameter Robert C. Byrd Green Bank Telescope in West Virginia (USA) and the 64-metre Parkes Radio Telescope in Australia. In addition, the Lick Observatory in California (USA) will conduct a deeper-than-ever search for optical laser transmissions. The new programme dwarfs all previous searches. It will cover ten times the area on the sky, scan a swathe of the radio spectrum five times broader, and do all that one hundred times faster than any survey before.

Breakthrough Listen will be allocated a quarter of the science time available on the Parkes Radio Telescope from October 2016 for a period five years. Australia has the only capability for radio astronomy in the southern hemisphere that can deliver the scientific goals for the new initiative. The Parkes Radio Telescope is essential for the scientific integrity of *SETI*. It is ideally situated for a search such as this. The most interesting and richest parts of our own Milky Way pass directly overhead in Australia (or anywhere else in the southern hemisphere). If we are going to detect intelligent life elsewhere, it is most likely going to be found towards the centre of the Milky Way.

The Parkes Radio Telescope is also one of the world's premier big dishes and has an outstanding ability to detect weak signals that a search like this requires. It has always been at the forefront of discovery, from receiving video footage of the first Moon walk on 20 July 1969, to tracking NASA's *Curiosity* rover during its descent onto Mars in 2012, to now once again searching for intelligent life. The Parkes Radio Telescope has also played a leading role in the detection and study of pulsars, small dense stars that can spin hundreds of times a second, the recent discovery of enigmatic (but unexcitingly named) 'fast radio bursts,' and in the search for 'gravitational waves.'

Parkes also played a leading role in previous *SETI* searches. In 1995 the

California-based SETI Institute used the telescope for six months for its *Project Phoenix* search. The Parkes Radio Telescope provided the critical capability to search the southern sky that could not be accessed using telescopes in the northern hemisphere.

The researchers involved in the *Breakthrough Listen* initiative say the focused computing power and the use of some of the world's most powerful telescopes will allow them to collect in one day the same amount of data that would have taken one year to collect before the programme began. Milner plans to back the programme financially for at least 10 years, although scientists agree it may take longer to find proof that alien life exists. Hawking said the new programme should succeed, because it has ample resources: access to time on major telescopes, a huge data capacity, and a long-term financial commitment that will not be withdrawn.

"If a search of this sophistication finds no proof, that is an interesting result," he said. "It will not prove that we are alone but it will narrow the possibilities and it is likely to produce data that is fascinating in its own right."

Based on new information about the number of other worlds where life could have taken hold, it is 'quite likely' humans are not alone, he said.

"There is no bigger question," Hawking said. "It is time to commit to finding the answer to search for life beyond Earth."

Milner said that the data taken by *Breakthrough Listen* will be open so anyone can access it; it will rely on open-source software so findings can be shared throughout the world.

"Our approach to data will be open and taking advantage of the problem-solving power of social networks," he said.

The programme will nicely complement the existing scientific uses of the Parkes Radio Telescope. Although it will take up a quarter of the available science time, it will benefit the research undertaken during the other three-quarters of the time the telescope is in operation. It will enable even greater scientific capability to be provided to a wide range of astronomy research through both the financial support and through the provision of new data processing and analysis systems and techniques. The dramatic increase in data processing capability also means that astronomers can analyse telescope data in new ways, searching for many different types of artificial signals.

The overall project will be tied in with *SETI@home*, meaning that anyone with a home computer will be able to help in the search through the data. The probability of detecting intelligent life is small but it is much greater today than ever before. To be the first to discover intelligent life would be a phenomenal achievement not only for the scientific community but for all humankind. If we find incontrovertible evidence of intelligent life beyond Earth, it would probably

be the single most breathtaking discovery in history. Then, the real work would start. Are they close enough to contact back? Could they already have heard us? That all plays into the second new *Breakthrough Initiative* project – *Breakthrough Message*. But that’s a story for another article.



Figure 1: Renowned physicist Stephen Hawking sits in front of a presentation image during a press conference in London, Monday, 20 July 2015. Stephen Hawking and Russian tech entrepreneur Yuri Milner are pushing the search for extraterrestrial life into higher gear. The pair said that the US\$ 100 million *Breakthrough Initiatives* programme funded by Milner will harness computer power as never before in a search of the heavens. (AP Photo/Matt Dunham)

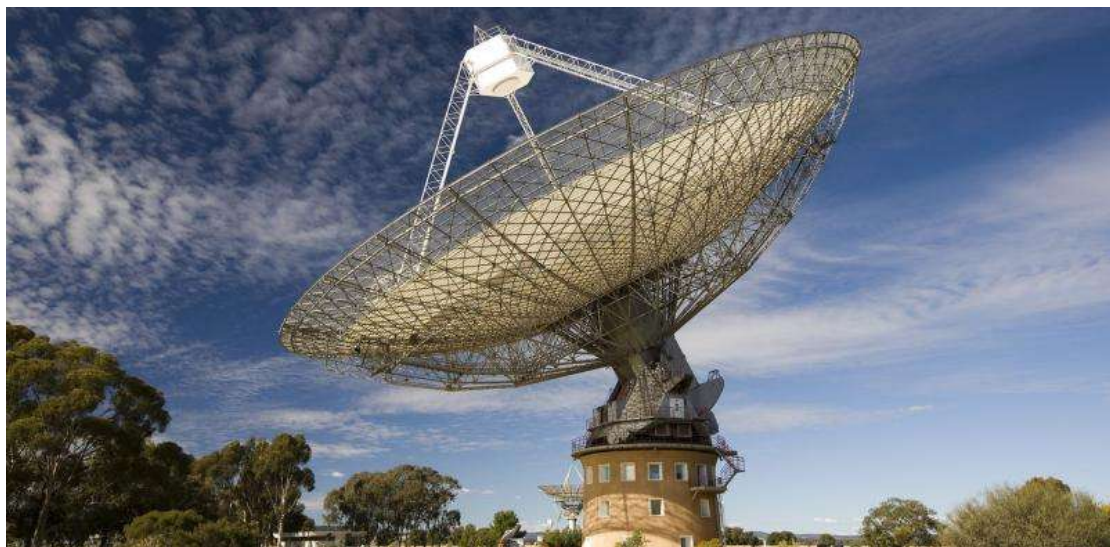


Figure 2: The 64-metre Parkes Radio Telescope will be instrumental in the search for extraterrestrial intelligence. (Credit: CSIRO/David McClenaghan, CC BY)



Figure 3: The Milky Way as seen from the southern hemisphere in the winter in a 180 degree view. The bulge towards the centre of our galaxy is directly above the head of the observer.
(Credit: Flickr/Luis Argerich, CC BY-NC)



Figure 4: The Green Bank Telescope is one of the observatories that will eavesdrop on aliens.
(Credit: NRAO/AUI, CC BY-SA)



CC-BY



CC-BY