

# BREAKTHROUGH LISTEN

The *Breakthrough Listen* Initiative is a search for signatures of technology as a proxy for intelligence, representing humanity's most significant effort to date to quantify the distribution of advanced life in the Universe.

- Headquartered at the University of Oxford, research centers at partner institutions including the University of Manchester, UC Berkeley and the SETI Institute, to name a few
- Launched in 2015, funded by the Breakthrough Initiatives, established by entrepreneur Yuri Milner and renowned physicist Stephen Hawking
- Survey of one million nearby stars, the Milky Way galactic plane, and 100 nearby galaxies in search of potential signs of advanced life
- Employs advanced signal processing algorithms, computational techniques, and cutting-edge machine learning to analyze petascale radio and optical datasets collected from telescopes, searching for anomalies in astronomical data
- Operates with a philosophy of openness and transparency, making data publicly available, enabling contributions from scientists worldwide
- Utilizes the world's most powerful observing facilities:
  - 100-meter Green Bank Telescope in West Virginia, USA - the largest steerable radio telescope in the world
  - 64-meter Parkes Telescope in Australia - covering the southern hemisphere sky
  - MeerKAT array in South Africa - surveying one million stars in a commensal (piggyback) search
  - Jodrell Bank Observatory in the UK - home to the 76-meter Lovell Telescope
  - FAST Telescope in China - the world's largest single dish radio telescope
  - Murchison Widefield Array - located in an extremely radio-quiet zone in Western Australia
  - LOFAR - Low Frequency Array with stations in Ireland and Sweden
  - VERITAS Cherenkov Telescope Array in Arizona, USA - for pulsed optical SETI
  - 64-meter Sardinia Radio Telescope at Cagliari Observatory, Italy
- Other observatory partners include:
  - Allen Telescope Array (ATA) in California, USA - fully dedicated facility for SETI research
  - Very Large Array (VLA) in New Mexico, USA - used for a commensal SETI program called COSMIC
  - Transiting Exoplanet Survey Satellite (TESS) - a space-based telescope used to search for anomalous time variability in optical data
- Facilities under development:
  - Giant Metrewave Radio Telescope in India
  - Nançay Radio Telescope in France
  - Vera Rubin Observatory in Chile
  - Square Kilometre Array in South Africa and Australia

## Accomplishments

- Surveyed hundreds of thousands of nearby stars, the Milky Way's galactic plane and center, and 100 nearby galaxies
- Driving discoveries in other areas of astronomy (e.g. fast radio bursts)
- Published more than 90 peer-reviewed papers including careful analysis of signals of interest such as BLC1<sup>1</sup>
- Trained over 150 early career researchers

For additional information visit [www.breakthroughinitiatives.org](http://www.breakthroughinitiatives.org)

---

<sup>1</sup> <https://www.nature.com/articles/s41550-021-01479-w> and <https://www.nature.com/articles/s41550-021-01508-8>

# BREAKTHROUGH LISTEN

The *Breakthrough Listen Initiative* is humanity's most significant effort to date to quantify the distribution of advanced life in the Universe. Headquartered at the University of Oxford, *Listen* uses the world's most powerful observing facilities to search for signatures of technology. *Listen* facilities include the Green Bank Telescope (the largest steerable radio telescope in the world), the 64-meter Parkes dish in Australia, and the South African MeerKAT array. *Listen* is also partnering with the Jodrell Bank Observatory, home to the 76-meter Lovell Telescope, and China's FAST telescope, the world's largest single dish. Partnerships are also established with Cherenkov telescopes (arrays of large optical detectors) such as VERITAS, as well as the Murchison Widefield Array, which, along with MeerKAT, is a precursor instrument for the international Square Kilometre Array.

The first small steps in the search for extraterrestrial intelligence were undertaken over 60 years ago. In the intervening decades, we have learned that our Galaxy is full of planets with both the conditions and the ingredients for life. This new knowledge, combined with the astonishing increase in computer processing and storage capabilities, and the power of modern data analytics, are enabling *Breakthrough Listen* to take a giant leap forward in our quest to answer the question: Are we alone?

The *Listen* instruments at the Green Bank and Parkes telescopes process hundreds of gigabits per second of data. The system on the MeerKAT array processes nearly five terabits per second. *Listen* performs the equivalent of tuning to billions of radio stations at once, using some of humanity's most powerful antennas. The project is undertaking a detailed census of hundreds of nearby stars, in addition to casting a wider net across millions more stars, the entire plane of our Milky Way Galaxy, and additional galaxies beyond.

The cutting-edge instrumentation and techniques developed for *Listen* are also making their mark in other areas of astronomy research. The *Listen* science team used data from Green Bank to reveal fascinating insights into powerful and mysterious “fast radio bursts” from the distant Universe.

Some of the greatest discoveries in astronomy have come from re-analysis of archival data, often by independent scientists. Public data enables involvement from non-astronomers with technical expertise, such as experts in deep learning, signal processing, and big data analytics.

One of *Listen*'s major challenges is to sift through the haystack of interference from human technology (satellites, cellphones, airplanes, and so on), to find the needle that might be a candidate for our first contact with an alien civilization. But just as the development of the first telescope technology 400 years ago enabled Galileo to understand that worlds existed beyond our own, technology is once again pushing the frontiers of discovery as we seek to understand if Earth is one jewel in a vast, sterile Universe, or if inexorable forces drive matter to eventually become minds. We are at the brink of answering one of the most profound questions in science.



The Breakthrough Listen program is headquartered at the University of Oxford



The MeerKAT telescope in South Africa is one of the facilities used by the program