ARCHIVED REPORT

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Search for Extraterrestrial Intelligence (SETI)

Outlook

- Mission of the SETI Institute is to "explore, comprehend, and explain the origin, nature, and prevalence of life in the universe"
- Most of the SETI Institute's research is privately funded
- Forecast International believes that the SETI Institute's research projects will continue to be funded in the decade ahead

Orientation

Description. The United States' search for extraterrestrial intelligence (SETI) consists of numerous projects. The focus of this report is on those efforts undertaken by the SETI Institute.

Sponsor

SETI Institute
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Status. Ongoing research.

Application. To conduct scientific research relevant to the nature, prevalence, and distribution of life in the universe.

Contractors

Contractor(s) not selected or not disclosed.

Comprehensive information on Contractors can be found in Forecast International's "International Contractors" series. For a detailed description, go to www.forecastinternational.com (see Products & Services/Governments & Industries) or call + 1 (203) 426-0800.

Contractors are invited to submit updated information to Editor, International Contractors, Forecast International, 22 Commerce Road, Newtown, CT 06470, USA; rich.pettibone@forecast1.com

Search for Extraterrestrial Intelligence (SETI)

Technical Data

The purpose of the SETI Institute is to conduct scientific research relevant to the nature, prevalence, and distribution of life in the universe. This work includes two primary research areas: the search for extraterrestrial intelligence and the determination of the number of civilizations in the Milky Way galaxy whose radio emissions are detectable.

The Allen Telescope Array. According to the SETI Institute, the Allen Telescope Array (ATA) is a "Large Number of Small Dishes" (LNSD) array designed to be highly effective for simultaneous surveys undertaken for SETI projects (Search for Extraterrestrial Intelligence) at centimeter wavelengths.

The initiative for building the ATA emerged from a series of workshops convened by the SETI Institute beginning in 1997. These workshops were charged with defining a path for future development of SETI technologies and search strategies. The relentless advance of computer and communications technologies made it clear that LNSD arrays were more efficient and less expensive than the large antennas traditionally constructed for radio astronomy and SETI. The final report of the workshop, "SETI 2020," recommended the construction of a so-called One Hectare Telescope, having a collecting area commensurate with its name.

The SETI Institute sought private funds for such an instrument, and in 2001, Paul Allen (co-founder of Microsoft) agreed to fund the technology development and first phase of implementation, culminating in the construction of 42 antennas. In October 2007, the array began commissioning tests and initial observations.

The ATA uses commercial technology wherever possible. The dish components are manufactured through a process developed for the commercial television market, and are relatively inexpensive. The sensitivity of the array is easily increased by simply adding more dishes, an approach that is clearly impractical for large, single-dish antennas. The ATA also takes advantage of receiver and cryogenic technologies originally developed for radio communication and cell phones. The instrument employs programmable chips and software for signal processing, which allows an increase in capability as new computer technology becomes available.

Over time, and with sufficient funding, the ATA will grow to 350 dishes. It will then have a collecting area equivalent to a single dish 114 meters in diameter, and the angular resolution of a dish 700 meters across. The ATA-350 will have point source sensitivity comparable to the National Radio Astronomy Observatory's Robert C. Byrd Telescope and the Very Large Array, while being far faster and superior for imaging surveys.

Optical SETI. University of California's Lick Observatory, UC Santa Cruz, and UC Berkeley, has coupled the Lick Observatory's 40-inch Nickel Telescope with a pulse-detection system capable of finding laser beacons from civilizations many light-years distant. According to the SETI Institute, this experiment is largely immune to false alarms, due to a novel approach incorporating three light detectors.

Optical SETI requires that any extraterrestrial civilization *be deliberately signaling* in the direction of our solar system.

According to the SETI Institute, the experiment is unique in exploiting three light detectors (photomultipliers) to search for bright pulses that arrive in a short period of time (less than a billionth of a second). Light from the central star will trigger the detectors as well, but seldom will all three photomultipliers be hit by photons within a billionth of a second timeframe. The expected number of false alarms for the stars being looked at is about one per year (other optical SETI experiments use only one or two detectors and have been plagued by false alarms on a daily basis).

Starlight, cosmic rays, muon (an elementary particle similar to the electron) showers, and radioactive decay in the glass of photomultiplier tubes can all contribute confusing "events" to optical SETI searches.

Program Review

The SETI program began in 1959 when two Cornell physicists, Giuseppi Cocconi and Philip Morrison, published an article in *Nature* concerning the possibilities of communicating with the stars via microwave radio. In spring 1960, radio astronomer Dr. Frank Drake conducted the first radio search (called Project Ozma) for signals from other planetary systems.

In 1961, Dr. Drake developed an equation estimating the number of intelligent communicating civilizations existing in the Milky Way. The Drake Equation can be viewed as a series of queries, as follows:

- How many stars are in the Milky Way galaxy?
- What percentage of these stars have planetary systems?

Search for Extraterrestrial Intelligence (SETI)

- For each star that has a planetary system, how many of these planets are capable of sustaining life?
- Of the planets capable of sustaining life, on what percentage does life actually evolve?
- Of the planets where life evolves, what percentage develop intelligent life?
- What percentage of intelligent races have the desire and means to communicate?

Through this equation, Dr. Drake provided the first framework for thinking about how extraterrestrial life, if it exists, might communicate with its celestial counterparts.

In 1988, NASA officially funded the search for extraterrestrial intelligence. For approximately five years, NASA swept the sky for signs of life beyond the Earth. However, in 1993, the U.S. Congress discontinued NASA's funding. Since 1993, the search for extraterrestrial intelligence has been funded under the auspices of the SETI Institute.

In February 1995, the SETI Institute initiated Project Phoenix. Under Project Phoenix, scientists use the 1,000-foot radio telescope at Arecibo, in Puerto Rico, to observe stars. By mid-1999, Project Phoenix had examined approximately half of the stars on its target list.

In 2000, Paul Allen and Nathan Myhrvold contributed $12.5 million to the SETI Institute to develop the most powerful instrument for locating signals from civilizations elsewhere in our galaxy. The instrument is called the Allen Telescope Array (ATA).

In April 2000, members of the SETI Institute and the Berkeley Radio Astronomy Lab revealed a prototype of the ATA. In June 2002, the first eight reflector dishes of the SETI Institute's Allen ATA arrived at the Hat Creek Observatory.

In March 2004, the SETI Institute unveiled a three-tier construction plan for the Allen Telescope Array. This announcement followed the successful completion of a three-year research and development phase for the ATA.

In August 2005, the SETI Institute announced that 30 ATA antennas had been installed at the Hat Creek Observatory. In November 2005, Discovery Semiconductor Inc delivered wide-bandwidth optical receivers for the ATA.

In April 2006, a demonstration was performed on the new direct drive motors installed on the ATA antenna, designated 3B. These motors met the specified aggressive, fast-tracking speed and quiet performance requirements of the ATA project. In July 2006, 10 ATA antennas were outfitted with drive motors, receivers, and electronic controls.

On October 11, 2007, the SETI Institute officially "turned on" the initial 42 antennas of the Allen Telescope Array. According to the SETI Institute, the 42 antennas pivoted toward the sky, and the first official observations with the ATA began.

On July 12, 2008, the SETI Institute used a beamformer to combine 12 ATA antennas to detect the faint carrier signal from the Voyager 1 spacecraft. On October 9, 2008, the X-band signal from the Rosetta spacecraft was detected by the Allen Telescope Array.

In November 2010, the SETI Institute used the ATA for observations of radio and laser signals from civilizations circling five new stars. The ATA examined each star for approximately 30 minutes between 1:00 a.m. and 5:00 a.m. PDT on November 6.

In August 2011, the SETI Institute announced that scientists at the SETI Institute and NASA's Ames Research Center believe traces of Mars' "wet past" (areas that once contained water) are hidden from the scrutiny of spaceborne instruments under a thin varnish of iron oxide, or rust. Their research suggests that Mars could be spotted with many more patches of carbonates – minerals that form readily in large bodies of water and can point to a planet's wet history – than originally suspected. "The plausibility of life on Mars depends on whether liquid water dotted its landscape for thousands or millions of years," said Janice Bishop, a planetary scientist at Ames and the SETI Institute and the lead researcher.

On June 13, 2012, the SETI Institute announced that a team of 29 Danish and American astronomers (led by Lars Buchhave of the Niels Bohr Institute in Copenhagen) had discovered that even star systems that contain only sparse amounts of the heavy elements that make up planets can still amass enough of this material to form small worlds the size of Earth or Mars. This finding was based on an analysis of data from both NASA's Kepler space telescope and ground-based observatories. The SETI Institute says this new evidence has two consequences in the search for extraterrestrial life: 1) the tally of small worlds is even greater than what the SETI Institute once believed, and 2) even relatively ancient stars, billions of years older than the Earth's sun and generally deficient in such relatively heavy elements as silicon and iron, could host planets that are potential homes to life. According to the SETI Institute, these research findings may help in the discovery of intelligent life beyond Earth.

Search for Extraterrestrial Intelligence (SETI)

Recent Activity. In July 2013, the SETI Institute announced that one of its scientists, Mark Showalter, discovered a new moon orbiting the distant blue-green planet Neptune, the 14th known to be circling the giant planet. The moon, designated S/2004 N 1, is estimated to be no more than 12 miles across, making it the smallest known moon in the Neptunian system. It is so small and dim that it is roughly 100 million times fainter than the faintest star that can be seen with the naked eye.

Funding

Businesses, individuals, and U.S. federal government agencies provide funding for SETI Institute projects.

Contracts/Orders & Options

No recent contracts have been identified.

Timetable

Year	Major Development
1959	Giuseppi Cocconi and Philip Morrison publish article on microwave-radio space communications
1960	Frank Drake conducts first microwave-radio astronomical search, called Project Ozma
1970s	U.S. becomes involved in SETI; NASA develops a distinct method for detecting extraterrestrial intelligence
1984	SETI Institute incorporated
1985	SETI Institute receives its first research grant from NASA
1988	NASA officially funds the search for extraterrestrial intelligence
1992	NASA's SETI program begins observations
1993	U.S. Congress cancels funding for NASA's search for extraterrestrial intelligence
1995	SETI Institute's Project Phoenix begun
1999	Project Phoenix completes examination of approximately half of the stars on its target list
2000	Paul Allen and Nathan Myhrvold contribute $12.5 million to the SETI Institute to develop the Allen Telescope Array
2001	SETI Institute announces it will work with NASA to seek evidence of Earth-sized planets in orbit around sun-like stars
2002	First eight reflector dishes of the SETI Institute's ATA arrive at the Hat Creek Observatory
2003	Scientists involved in the SETI Institute's SETI@home program complete a three-day session searching for life in space with the world's largest radio telescope
2004	SETI Institute selects Superconductor Technologies Inc to supply cryocoolers for use in highly sensitive receivers being used in the ATA project
2005	Thirty ATA antennas installed at Hat Creek Observatory
2006	Ten Allen Telescope Array antennas outfitted with drive motors, receivers, and electronic controls
2007	First 42 antennas of the ATA begin search for extraterrestrial intelligence
2008	The X-band signal from Rosetta spacecraft detected by the Allen Telescope Array
2010	SETI Institute conducts observations for radio and laser signals from civilizations circling five new stars using the Allen Telescope Array
2011	Scientists at the SETI Institute and NASA's Ames Research Center report that traces of Mars "wet past" are hidden from spaceborne instruments under a thin varnish of iron oxide, or rust
2012	A team of astronomers discover that star systems that contain sparse amounts of the heavy elements that make up planets can amass enough of this material to form small worlds the size of Earth or Mars; SETI Institute says this new evidence suggests that the number of small worlds is even greater than what it once believed
2013	SETI Institute scientist Mark Showalter discovers a new moon orbiting the planet Neptune

Worldwide Distribution/Inventories

This report focuses on the search for extraterrestrial intelligence undertaken by the SETI Institute on behalf of the **United States**.

Search for Extraterrestrial Intelligence (SETI)

Forecast Rationale

The mission of the SETI (Search for Extraterrestrial Intelligence) Institute is to "explore, comprehend, and explain the origin, nature, and prevalence of life in the universe." To achieve this, the SETI Institute carries out scientific research projects via its two centers: the Center for SETI Research and the Carl Sagan Center for the Study of Life in the Universe. Most of the SETI Institute's research is privately funded. The amount of funding allocated to its research projects is consequently unknown. Nevertheless, Forecast International believes that the SETI Institute's research projects will continue to be funded in the decade ahead.

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