The Big Question

Giant ears await alien broadcasts

By ERIK SKINDRUD

The radio telescopes of Pocahontas County hum like giant refrigerators as they point their faces above the white pine, red maple, and oak forest of West Virginia. With a crop of eight big, dish-shaped antennae, the National Radio Astronomy Observatory at Green Bank seems misplaced in this rural setting.

Here, in 1960, a young radio astronomer named Frank D. Drake used an 85-foot parabolic radio antenna to conduct the world's first Search for Extra-Terrestrial Intelligence, or SETI. That first project was called Ozma—for a princess in a tale by *Wizard of Oz* author L. Frank Baum—and it listened for any alien signals that might be emanating from the vicinity of two nearby stars, Epsilon Eridani and Tau Ceti.

But nothing was heard, and to this day no definite extraterrestrial signals have been recorded by the more than 70 radio searches undertaken. Two SETI searches have produced tantalizing hints, however, and astronomers are trying harder than ever for an unambiguous signal.

By the time of Drake's search, many scientists had come to believe that conditions for life might be common in the universe. Drake's calculations—though they were little more than educated guesses—suggested that sunlike stars with water-bearing planets might pepper our galaxy. On such planets, life might begin as it did on Earth, scientists thought.

Recent discoveries have confirmed many of Drake's assumptions. Within the past year, astronomers discovered several planets that orbit other stars. Scientists have found complex organic molecules floating in interstellar space. And NASA stunned the world with evidence that primitive life may have existed on Mars several billion years ago (SN: 8/10/96, p. 84).

The Mars bombshell has brought a dose of respect to SETI radio searches for alien civilizations, says Drake, who is now president of the SETI Institute in Mountain View, Calif., and has listened to two U.S. senators ridicule his efforts over the years. Six teams of astronomers are currently pushing ahead with the effort, sifting the skies for the "brrring!" of an extremely long-distance call.

The idea that life on distant planets is likely to be signaling us still generates controversy among scientists. Harvard zoologist Ernst Mayr, an outspoken critic of SETI, argues that its proponents fail to grasp the huge evolutionary odds stacked against intelligent life (see box). "We have to deal with realities—not pipe dreams," says Mayr, who calls SETI "hopeless" and "a waste of time."

Even the SETI scientists admit their goal is difficult and may take decades to achieve. "No one can promise you success in this," says Jill C. Tarter of Project Phoenix, a SETI program based in Mountain View, Calif. "We look around and do our best."

Paul Horowitz

The 84-foot Agassiz dish in Harvard, Mass., is the site of Project BETA, whose predecessor, META, also scanned the sky from this site.

SETI investigators see the possibility of receiving two types of radio signals from intelligent aliens. One source of radio waves might be leakage from communication technology. Consider the expanding sphere of radio waves sweeping outward from Earth. Like ripples sent out by a stone plunked into a pond, early commercial radio and television broadcasts and contemporaneous military radar waves are now passing the nearest stars.

Picking up this kind of leakage radiation, which weakens rapidly with distance, would probably require aliens to employ a radio telescope larger than any in use now on Earth. Similarly, our SETI searches might pick up distant broadcasts if we had large enough antennae. With the technology available, however, none of the SETI searches to date has had a reasonable chance of picking up broadcasts from civilizations around our neighbor stars, they say.

"The leakage is hard [to detect]," says Tarter, "because it requires the kind of sensitivity we're just getting down to."

If distant civilizations were deliberately signaling to Earth, scientists believe they'd have a better chance of detecting the message. Drake and his SETI colleagues argue that radio would be the obvious medium, as it can travel interstellar distances with considerably less interference than other wavelengths, such as visible or infrared light. The message could be encoded in carrier waves, modulated signals like those of AM or FM transmissions, or in pulses that would carry further given the same amount of energy.

What's more, the extraterrestrials could maximize our chance of picking up the signal by transmitting at frequencies around 1420 MHz, where interstellar gas, dust, and the Earth's atmosphere cause little interference. This was Drake's best guess in 1960, and it remains the underlying assumption of most SETI searches today.

The ongoing Project Phoenix is currently the most sensitive search and the only one capable of detecting pulsed signals. The privately funded program continued NASA's search (SN: 11/7/92, p. 317) after Congress terminated its support in 1993. Phoenix uses some of the largest radio telescopes on Earth and points them at more than 1,000 stars within 150 light-years. The program has developed special electronic equipment that the scientists carry in a trailer to the different telescopes.

In July, at the 5th International Conference on Bioastronomy in Capri, Italy, Tarter reported on the most recently completed phase of Project Phoenix. The Southern Hemisphere phase of the

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The National Radio Astronomy Observatory in Green Bank, W. Va., includes the 85-foot antenna Frank Drake employed for Ozma in 1960 (foreground) and the 140-foot antenna Project Phoenix plans to use soon (background).

search used the 210-foot Australian telescope in Parkes, New South Wales, to look at 202 sunlike stars. While it found no extraterrestrial signals, Tarter deemed this part of the project a success because it accurately detected and eliminated all interfering signals of earthly origin by comparing the Parkes telescope's data with that from a smaller telescope 230 kilometers away.

Although the failure to find an extraterrestrial signal is no proof that aliens aren't out there, Tarter reported, "it suggests that signals as powerful as terrestrial radars may not be common" in our part of the galaxy.

The Phoenix electronic components are now being hooked up to the 140-foot antenna at Green Bank—near the smaller dish used by Ozma. There the Phoenix scientists plan to continue scanning likely stars until 1998, when the program is scheduled to move on to the giant 1,000-foot dish at Arecibo, Puerto Rico.

While Phoenix listens to one star at a time, other SETI searches sweep the whole sky, looking for powerful but intermittent signals that may drift in frequency, or "chirp." These sky surveys are led by Project SERENDIP, a search almost as sensitive as Phoenix.

SERENDIP, which is sponsored by the University of California, Berkeley, has gone from 100 channels 20 years ago to its present capacity of 4 million channels. According to current plans, the project will soon advance to 168 million channels when the giant Arecibo antenna returns to service after a $24 million retrofit and begins using an improved software package called SERENDIP IV to scan the sky.

Still, the kind of searches capable of registering radar, radio, or TV leakage are some way off. "We're still just scratching the surface," says SERENDIP program manager Dan Werthimer. "The technology's changing very fast; we're just getting in the game."

Harvard University's BETA search at the 26-meter dish in the Massachusetts town of Harvard rounds out the big three of SETI searches. While its smaller antenna gives less sensitivity than those of Phoenix and SERENDIP, BETA boasts an electronic brain that scans more than 2 billion frequency channels every 16 seconds. It lacks the backup dish that Phoenix employs to screen out radio-frequency interference, but its single dish checks three parallel beams that can sort out Earth-based noise.

BETA is a step up from its predecessor, META, which was funded in 1985 by *ET* creator Steven Spielberg. META recorded 37 radio signals that appeared to be of extraterrestrial origin but were never repeated. They were reminiscent of the strong signal that scientists at Ohio State University in 1977 picked up in the constellation Sagittarius. That signal, however, also disappeared before scientists could recheck it.

In the Sept. 20, 1993 ASTROPHYSICAL JOURNAL, Harvard University physicist Paul Horowitz and Cornell University's Carl Sagan noted that most of these promising signals originated along the galactic plane—where stars, planets, and possible life sites are concentrated.

"We know of no astrophysical processes that could account for the narrowband candidate signals META has recorded," Horowitz and Sagan wrote, "and we have been unable to find any correlation of source positions with unusual astrophysical objects."

Was it ET? As Sagan often chides, "Extraordinary claims require extraordinary evidence," and extraterrestrial intelligent life is no modest claim. Only a signal that persists long enough to allow independent confirmation by other radio telescopes would have a chance of convincing the scientific community.

The SETI researchers remain patient. "Our capability is doubling every year," Werthimer says. Still, he thinks "earthlings would be lucky" to winnow the golden signal from the chaff anytime soon. Proposals for 21st-century SETI projects are already on the table.

The most ambitious and international of these is the Square Kilometer Array Interferometer, SKAI, which would assemble a large observing area from an array of smaller dishes. It would allow detection of the kind of leakage that Earth broadcasts to space every day.

But to the investigators, SKAI's not the limit. "The ideal is a telescope the size of Arecibo on the dark side of the Moon," Drake says. "It's the only place in the solar system that never has Earth [with its radio noise] in its sky." □

"Where is everybody?"

At a Los Alamos, N.M., lunch in 1950, Italian physicist Enrico Fermi asked Emil Konopinski, Edward Teller, and Herbert York this provocative question: If life is common in the universe, why haven't "they" shown up on Earth yet?

There are plenty of stars more ancient than our sun, Fermi noted, and if life is plentiful, it would have arisen on planets around these stars billions of years before it arose on Earth. In that case, shouldn't Earth have been visited or colonized by a race much older than our own? Even with relatively slow means of space travel, a civilization with a will to homestead could settle the galaxy in 5 million years or so.

This is Fermi's Paradox, and it's been the starting point for scientific debate over extraterrestrial life for almost half a century. It's the right question to ask, scientists say, because it begins not with fantasy but with a fact: We don't see aliens here now.

At least three broad hypotheses have been put forward to reconcile our lack of visitors with the supposed life-friendliness of the universe.

To former NASA scientist Michael H. Hart, the absence of exotics on Earth is compelling evidence that we are, if not the first, then among the first intelligent life forms to evolve anywhere in the galaxy. Both Harvard zoologist Ernst Mayr and astronomer Benjamin M. Zuckerman of the University of California, Los Angeles, second this position. The evolutionary path that leads to higher life is more complicated than others suppose, they hold. Since the beginning of life on Earth, Mayr says, as many as 50 billion species have arisen, and only one of them has acquired technology. "If intelligence has such high survival value, why don't we see more species develop it?"

A more moderate position is taken by astronomers Frank Drake of the SETI Institute in Mountain View, Calif., and Carl Sagan of Cornell University, who explain the paradox by pointing to the daunting distances of interstellar space. Radio communication, rather than space travel, makes the most sense, they say. Interstellar travel would be expensive and difficult—though for all we know, Drake says, aliens could show up here tomorrow.

At the far end of the spectrum, John A. Ball of the Massachusetts Institute of Technology's Haystack Observatory in Westford, Mass., solves the riddle with his "zoo hypothesis," which portrays Earth as a nature preserve in the galaxy. Intelligent life forms exist, he says, but they have chosen not to interfere with our development. Maybe they're watching us from a distance, or perhaps they're bored by us all. *— E. Skindrud*