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Astronomer and astrophysicist Frank Drake, seen here in Santa Cruz, California, was instrumental in shaping scientific searches for other possible civilizations in the galaxy.
PHOTOGRAPH BY MARK THIESSEN, NATIONAL GEOGRAPHIC

SCIENCE

Frank Drake, pioneer in the search for alien life, dies at 92

During a lifetime studying the sky, Drake's scientific contributions—and his namesake equation—became foundational to scientists' search for life beyond Earth.

BY **MICHAEL GRESHKO**

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Frank Drake, the American radio astronomer and astrophysicist who pioneered work on the search for extraterrestrial life, died on September 2 at his home in Aptos, California, at the age of 92.

Drake's contributions to science were numerous. A founder of the scientific field engaged in the search for extraterrestrial intelligence (SETI), he developed the Drake Equation, a framework for estimating the number of possible civilizations in the Milky Way galaxy. He made the first observations of Jupiter's radiation belts, and he was one of the first astronomers to measure Venus's searing surface temperature and the greenhouse effect of its thick atmosphere. Drake served as the director of the Arecibo radio observatory in Puerto Rico. He was a mentor and inspiration to generations of astronomers and astrophysicists.

"When the history of science is written a few hundred years from now, after we have made the detection of intelligent life beyond Earth—which I absolutely believe at some point we will—I believe Frank will take a place among the greatest scientists who ever lived," says astrophysicist Andrew Siemion, director of the Berkeley SETI Research Center at the University of California, Berkeley. "It was amazing to have the chance to know him."

Frank Drake was born on May 28, 1930, in Chicago. He began his intellectual journey to the stars around the age of eight, when his father told him that there were other worlds in space. Drake's father had meant the other planets of the solar system, but young Drake's mind conjured other worlds like Earth strewn throughout the galaxy: habitable planets with beings smart enough to have their own versions of cars, streets, and his hometown.

Drake nurtured his fascination with space throughout his education. He graduated from Cornell University in 1951 with a bachelor's degree in engineering physics. A member of Cornell's Navy ROTC program, he served from 1952 to 1955 as an electronics officer in the U.S. Navy. Drake

then studied astronomy at Harvard University from 1955 to 1958, where his Ph.D. adviser was Cecilia Payne-Gaposchkin, the astrophysicist who first proposed that stars were primarily made of hydrogen and helium.

While at Harvard, Drake had his first opportunity to test his childhood ideas of other Earths. One night, he was observing the Pleiades star cluster with a radio telescope when he observed a curious signal that appeared to move alongside the cluster. Might this be faraway creatures sending out a broadcast? It turned out to be a transmission from a nearby amateur radio operator, but it led Drake to calculate whether an artificial radio signal could have come from the distant star system.

After receiving his Ph.D., Drake went to the National Radio Astronomy Observatory (NRAO) in Green Bank, West Virginia, where he set up new telescopes and made his breakthrough observations of Jupiter and Venus. In 1960, using the observatory's 85-foot-wide Tatel telescope, Drake embarked on what he called Project Ozma, named after the leader of the realm in L. Frank Baum's *Wizard of Oz* books. The moniker was intended to evoke a land similar to our own but also strange and alien.

For three months Drake observed the sun-like stars Tau Ceti and Epsilon Eridani for radio signals from planets with extraterrestrial civilizations. None were found, "but it was a start—and it did stimulate a lot of other people to start searching," Drake recalled in a 2012 interview.

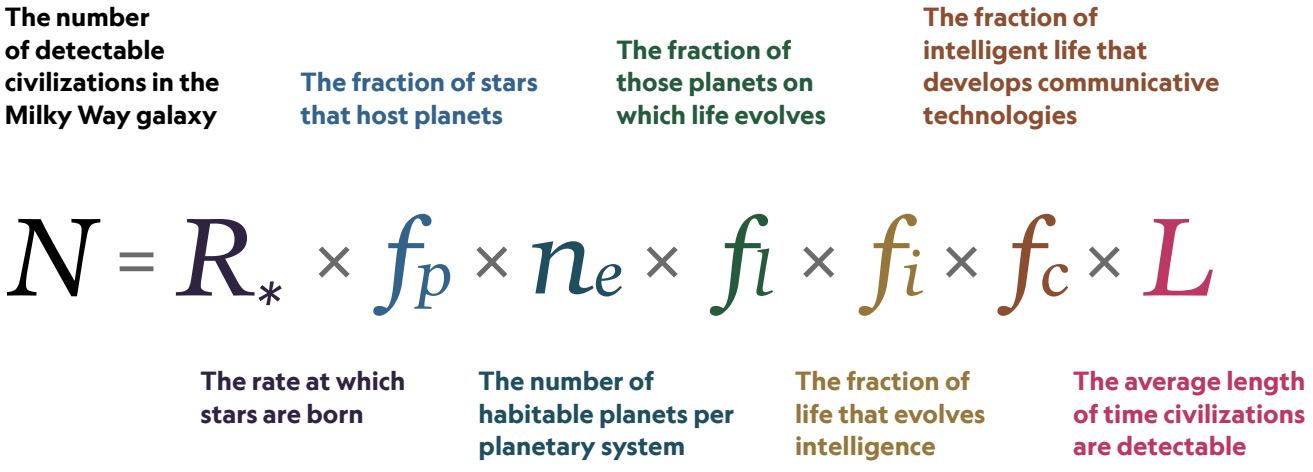
Project Ozma quickly drew public attention, and when Drake was 31, he got support from the U.S. National Academy of Sciences to lead a first-of-its-kind workshop at Green Bank to discuss the search for life beyond Earth. With a brilliant slate of scientists coming to West Virginia—

including astronomer Carl Sagan and plant biochemist Melvin Calvin, who won a Nobel Prize during the summit—Drake realized he needed a way to organize the meeting's discussions.

To brainstorm, Drake descended into the basement beneath the observatory's cafeteria and started writing down a list of factors that astronomers would need to know to estimate how common detectable civilizations were throughout the Milky Way. These quantities included the number of planets orbiting other stars and the probability that life emerges on a given planet. He then realized that his outline could be converted into an equation to compute the number of detectable civilizations in our galaxy based on the values of the variables.

Thus, the Drake Equation was born: not as a Eureka moment, but as a sensible outline to guide discussions in a set of meetings.

"He had obviously no idea at the time what this equation was going to become, what it was going to represent," says Drake's daughter Nadia, a contributing writer at *National Geographic*. "The fact that people would actually have it tattooed on themselves, that it would be on the side of a U-Haul, that it would be routinely cited as one of the most well-known equations in science is still so amusing to him."



After his time at NRAO, Drake worked briefly at NASA's Jet Propulsion Laboratory as the chief of its lunar and planetary sciences section, and in 1964, he joined the astronomy faculty at Cornell University. He also served as the director of the Arecibo Observatory in Puerto Rico from 1966 to 1968 and Cornell's National Astronomy and Ionosphere Center, which managed Arecibo, from 1971 to 1981.

During his tenure, Drake oversaw updates to Arecibo—originally built to monitor the upper atmosphere for missile defense research—to make the observatory better suited for astronomy research. He presided over the installation of a new surface on the telescope's massive radio dish, making the instrument much more sensitive, as well as the addition of a powerful new radar that could detect the motions of asteroids and other planetary bodies.

Drake also played a pivotal role in conceptualizing how humankind would represent itself in our messages to faraway worlds. He designed the 1974 "Arecibo message," a radio signal that was beamed to a star cluster some 22,000 light-years away.

In 1972 Drake co-designed the Pioneer Plaque, a picture message installed on the Pioneer 10 and Pioneer 11 spacecraft that included an illustration of a male and female human, our solar system, and a map that pinpointed the sun's position in the galaxy. He also served as technical director of the

Voyager Golden Record, the iconic compendium of sights and sounds of Earth that, like the Pioneer Plaque, is humankind's message in a bottle upon the seas of space.

Drake left Cornell in 1984 and moved with his family to California, where he took up a job as the dean of the Division of Natural Sciences at the University of California, Santa Cruz. When he stepped down from that role in 1988, he remained as a professor and was recruited to the recently founded SETI Institute, where he served as president of the board of trustees and director of its Carl Sagan Center for the Study of Life in the Universe. Drake retired from teaching in 1996.

Drake's academic accolades are voluminous, as his UC Santa Cruz obituary attests: a fellow of the American Academy of Arts and Sciences, a member of the National Academy of Sciences, president of the Astronomical Society of the Pacific, chair of the National Research Council's Board on Physics and Astronomy, and vice president of the American Association for the Advancement of Science.

But there was more to Drake than his work. Channeling his yen for mathematical precision, Drake was also an amateur lapidarist, cutting and polishing gemstones to make jewelry for friends and family. He loved cultivating orchids and at one point had hundreds in his home greenhouses. And for a time, he made his own red wine, winning a few medals for his handiwork at the New York State Fair.

Drake also had a lifelong sense of mischievousness, his daughter Nadia Drake attests. When he was living in Ithaca in the early 1980s, he spent one Christmas evening jumping around in the woods outside his house

with a cellophane-covered flashlight—all to give Nadia and her younger sister the joy of seeing the glowing schnoz of Rudolph the Red-Nosed Reindeer.

His impish streak extended to his professional life, too. When U.S. Senator William Proxmire gave a NASA SETI proposal the "Golden Fleece" award—meant to insult what Proxmire deemed to be wasteful government-funded research—Drake attempted to sign up Proxmire for membership in the Flat Earth Society. (Drake's petition was rejected.)

In his later years, Drake watched as a revolution unfolded in 21st-century astronomy that would deepen scientific interest in SETI and hone the parameters of his namesake equation: the discovery of thousands of planets orbiting other stars in the Milky Way.

Nadia Drake recalls one day in 2011, when the NASA Kepler space telescope released a chart that plotted more than 1,200 newfound planet candidates across the telescope's field of view. When Nadia showed it to her father, "he just paused for a beat," she recalls, "and then he just said: 'There are so many planets,'" his voice filled with awe.

Thanks to Kepler and other missions, astronomers now know that there are about as many planets in the Milky Way as there are stars, some 100 to 400 billion. Of these, hundreds of millions could be Earth-size rocky planets orbiting stars at the correct distance to harbor liquid water. One day, many astronomers believe, we could find hints of life on one of these distant worlds.

As a young Frank Drake fancifully predicted more than 80 years ago, maybe some of these planets even have their own version of cars, streets, and Chicago.

In addition to his daughter Nadia, Drake is survived by his wife of 44 years, Amahl Shakhashiri Drake; his daughter Leila Drake Fossek; sons

from a previous marriage Steve Drake, Richard Drake, and Paul Drake; brother Bob Drake; and a niece, a nephew, and four grandchildren.