



# THE SCIENCE OF *THE JAMIE DRAKE EQUATION*

From wafer-sized spaceships to the extraterrestrial Wow! signal, here's more about the real-life science in *The Jamie Drake Equation*.

## Aliens don't really exist, do they?

You do the math. In our solar system, there are eight planets orbiting the Sun, but only one where we know that intelligent life exists, and that's our own—planet Earth. But our galaxy, the Milky Way, contains more than two hundred billion stars, and the Milky Way is only one of hundreds of billions of galaxies that make up the universe. That's why astronomer Frank Drake devised the Drake Equation in 1961 to try to estimate how many intelligent extraterrestrial civilizations there could be in our galaxy.

$$N = R^* \times f_p \times n_e \times f_l \times f_i \times f_c \times L$$

In the Drake Equation,  $N$  is the number of alien civilizations we might be able to receive signals from. To work out the value of  $N$ , Frank Drake said you'd need to estimate the rate at which stars that could support life are being formed in our galaxy ( $R^*$ ); what fraction of these stars will have planets ( $f_p$ ); how many of those planets could potentially support life ( $n_c$ ); the fraction of these planets that will actually develop life ( $f_l$ ); the fraction of these planets that will develop intelligent life, i.e., alien civilizations ( $f_i$ ); the fraction of these alien civilizations that will develop communications technologies capable of releasing signals into space ( $f_c$ ); and how long these civilizations could send signals for ( $L$ ). The numbers keep getting smaller as you move along the equation, and we have to guess the answer to all of them except the rate of star formation ( $R^*$ ). But by plugging his best guesses into the equation, Frank Drake estimated that there could be as many as ten thousand alien civilizations in the Milky Way.

**Ten thousand! Then why haven't we heard from any aliens yet?**

This question is known as the Fermi paradox and is named after the physicist Enrico Fermi. One day when Fermi was discussing with other scientists the possibility that there are many intelligent alien civilizations out there in our galaxy, with many of them more advanced than our own,

he asked the simple question “Where are they?” We have no evidence of the existence of alien life, even though the chance that it exists in our galaxy seems so high. Many people have come up with explanations for the Fermi paradox. One is that space is so big that an alien civilization might be too far away for us to contact; another suggests that Earth is being kept in some kind of cosmic zoo with aliens studying us but keeping their own existence a secret!

**But what about the Wow! signal? Couldn't that have been aliens trying to get in touch?**

Since the 1960s, scientists have been using radio telescopes to scour the skies in search of alien signals. This is known as the search for extraterrestrial intelligence (SETI) and, in 1977, astronomers at the Big Ear Observatory at Ohio University detected an unusually strong 72-second radio signal from the direction of the star Tau Sagittarii. In addition to its intensity, which made the astronomer who first noticed it scribble the word “Wow!” next to a printout of the radio pulse, there was something else about this signal that made scientists sit up and listen. The signal was detected at the 1420 megahertz radio frequency, which is a wavelength of 21 centimeters. The most common chemical element in the universe is hydrogen, and hydrogen atoms emit radio waves at this exact same frequency. Many scientists believe that any alien

civilizations who wanted the signals they were sending into space to be detected would use this same frequency, as they'd realize that another intelligent civilization who could detect radio waves would tune their telescopes to the frequency of hydrogen to find out more about the universe. This is why astronomers got so excited when they detected the Wow! signal. Unfortunately, no further similar radio signal has ever been detected from this area of space. So the jury's still out about whether this signal was aliens trying to get in touch!

**But if we're just listening to radio waves, how will we know if the signals we detect come from an alien civilization?**

Any signal we receive from an extraterrestrial civilization isn't going to be transmitted in any language we speak here on Earth. However, some scientists think that an intelligent alien civilization might use a language that would be understood all across the universe: the language of mathematics.

**If you think mathematics is a universal language, then you haven't seen my school report card. . . .**

Don't worry. It's unlikely that E.T. will be sending the human race a math quiz across the galaxy. However, a

more advanced extraterrestrial civilization would be likely to have the same fundamental mathematical knowledge that we have worked out as the human race. If scientists detected a signal that transmitted radio pulses in bursts that match the Fibonacci sequence or another common mathematical series of numbers, they would have evidence that the sender of the signal was intelligent. Some scientists think that an advanced alien civilization might even be able to encode information in any signals they send. So one day, if we do detect an alien transmission, we might be able to download a selfie E.T. has sent us!

### So we've just got to wait for aliens to get in touch?

Scientists aren't just sitting around waiting for evidence of alien life to land in their laps. The search for extraterrestrial intelligence is using lots of different tools: radio telescopes scan the skies for alien transmissions, and other kinds of telescopes search for extrasolar planets. By analyzing the light emitted by a star, astronomers can determine whether any planets are in orbit around it, and even the distance at which they're orbiting. This information in turn helps astronomers determine whether any planets they detect are in the Goldilocks zone, the habitable zone around a star where surface water—and life—has a chance of existing. In the book, Jamie's dad, Commander Dan Drake, is sending the Light Swarm probes to Tau

Ceti to search for evidence of alien life. In the real world, scientists have detected two extrasolar planets in orbit in the habitable zone around this star.

**But the Light Swarm probes are just science fiction, right? We can't really send tiny spaceships the size of an SD card into space, can we?**

Not yet, but world-famous scientist Professor Stephen Hawking has teamed up with Facebook founder Mark Zuckerberg and other wealthy investors to develop Breakthrough Starshot. This research and engineering project aims to develop nanotechnology and powerful lasers to launch ultralight postage stamp-sized space probes to the nearby star of Alpha Centauri, which is just over four light-years away. These tiny spaceships would be equipped with a sail, which would catch the laser beam and then be accelerated to 25 percent of the speed of light. Traveling at up to 100 million miles an hour, these probes could reach Alpha Centauri in approximately twenty years and then beam pictures of what they find there to us back here on Earth. So if Breakthrough Starshot is a success, maybe one day we'll discover whether aliens really exist. . . .