

Research Reading: In Search of E.T.'s Breath

If “E.T.” is out there, whether in the form of intelligent beings or much simpler organisms, scientists may soon be hot on its trail.

In 1995, the first planet around another sun-like star was discovered by astronomers using Doppler detection—a method that scientists have used to reveal Saturn-sized (or larger) planets close to their parent suns. Today, astronomers know of more than 100 candidates for such worlds.

So far, all known extrasolar planets are gas giants (also known as Jovian planets) or possibly a kind of failed star called a “brown dwarf”—both unlikely places for life as it is currently understood. Of greater interest are Earth-size planets, which are too small to detect with current technologies. Nevertheless, many astronomers believe they exist.

If all goes as planned, an important new tool for exploring such planets will be operating within the next 10 to 15 years. A system of space telescopes, collectively known as the Terrestrial Planet Finder (TPF), will use techniques called “coronagraphy” and “interferometry” to dramatically reduce the obscuring glare from a planet’s parent star, allowing scientists to see the planet.

Planets circling other stars are many light years away. (A light-year is the distance that light travels in a year—about 9.5 trillion kilometers.) Even with the TPF’s advanced optics, Earth-like worlds would appear as a single pixel of light. How, then, will it be possible to learn much about them?

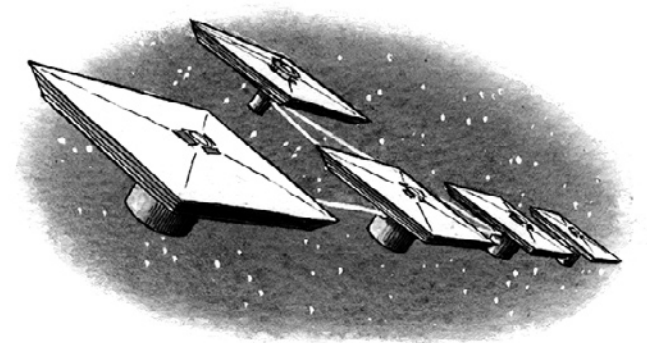
Amazingly, even a tiny speck of light can speak volumes about the planet from which it came. Embedded in the light from a planet are the “fingerprints” of the chemicals that have interacted with the light, including gases in the planet’s atmosphere. By splitting the light into its component wavelengths—through a technique known as spectroscopy—scientists can reveal these “fingerprints” and learn about the chemistry of the planet’s atmosphere.

If life is widespread on a planet, the planet’s atmosphere should show signs of the life’s presence. Just as the air you exhale has more carbon dioxide and less oxygen than the air you inhale, the combined “breathing” of all the life on a planet will change the chemistry of its atmosphere. If life is plentiful on the planet, these changes may be measurable.

A simple premise—but what would E.T.’s breath look like? Which gases should scientists search for? Scientists know the answers for Earth, but predicting how an alien biology might interact with its atmosphere is no simple matter.

“As astrobiologists we’ve got to be sure that we’re not too Earth-centric,” says Michael Meyer, senior scientist for astrobiology at NASA Headquarters in Washington, D.C.

The possibility that life elsewhere has a biology that’s radically different from our own is perhaps the most exciting and challenging part of astrobiology. If life evolves by random mutations and natural selection, why should scientists expect alien life forms to be even remotely similar to Earthly life?



Terrestrial Planet Finder

Scientists hope that this proposed design for the TPF telescope will combine light to make Earth-size planets orbiting other stars visible in the infrared range of the electromagnetic spectrum. The mission consists of several independent spacecraft orbiting in precise formation. Each spacecraft features a telescope on the shaded side of a large heat shield. NASA also plans to fly a second TPF spacecraft that could look for signs of life in visible regions of the electromagnetic spectrum.

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“We have to be very careful about how foreign biology might be different from our own, especially when you get to the bigger molecules” such as DNA, says David Des Marais, principal investigator for the Ames Research Center team of NASA’s Astrobiology Institute.

For example, people have speculated that silicon, a primary component of sand and a close cousin to carbon, could form the basis of an extraterrestrial biology. Alien life might forgo sunlight and depend instead on the geothermal energy in hydrogen and sulfur compounds emitted from the planet’s interior, much like the deep-sea vent ecosystems here on Earth. Or maybe the chemistry of alien life will be utterly different and unimaginable.

Fortunately, the chemical constraints within which life must function make it likely that simple molecules such as oxygen and carbon dioxide will play the same roles in an extraterrestrial biology as they do on Earth.

“Suppose,” says Meyer, “that there is silicon-based life. [It might be] photosynthetic, and you would still end up with oxygen in the atmosphere. You could go there and the life could be completely different, but some of the chemistry could still be the same [as on Earth].”

“The small molecules are going to be more universal,” agrees Des Marais. “Large molecules like DNA and chlorophyll represent later, highly significant innovations of life on Earth, but also the ones that may have differed elsewhere.”

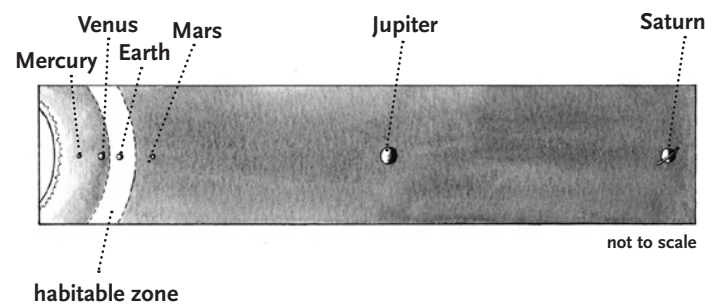
For this and other reasons, the exploration of distant Earth-like planets with TPF will focus on simple gases such as oxygen, ozone, carbon dioxide, methane, and water vapor. (For more about these chemicals, see Research Reading: Chemical Fingerprints.)

In addition to their carbon dioxide and water vapor levels, other details about these planets—such as their size, their distance from the parent star, and how bright they appear—will help scientists

interpret the likely meaning of any methane or oxygen that might be detected. Scientists hope to use TPF and other telescopes to measure (or at least estimate) these other details.

The best candidates for closer study would be located in the habitable zone, the region around a system’s star where scientists expect to find liquid water at the surface. If a planet is too hot, the water vaporizes and is lost from the atmosphere. If a planet is too cold, the water freezes. Either of these conditions would make a planet very inhospitable for life. The habitable zone for Earth’s sun starts beyond Venus and ends before Mars.

If the TPF finds a habitable planet with lots of oxygen and some methane in its atmosphere, it would be a momentous discovery. But would such data really verify the existence of life? Verification can be difficult, especially when discussing extraterrestrial life. Nevertheless, say astrobiologists, such evidence would be “very compelling.”



Sources:

In Search of ET's Breath
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Looking for Life's Signatures
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