Avoiding 'false positives' in the search for living worlds

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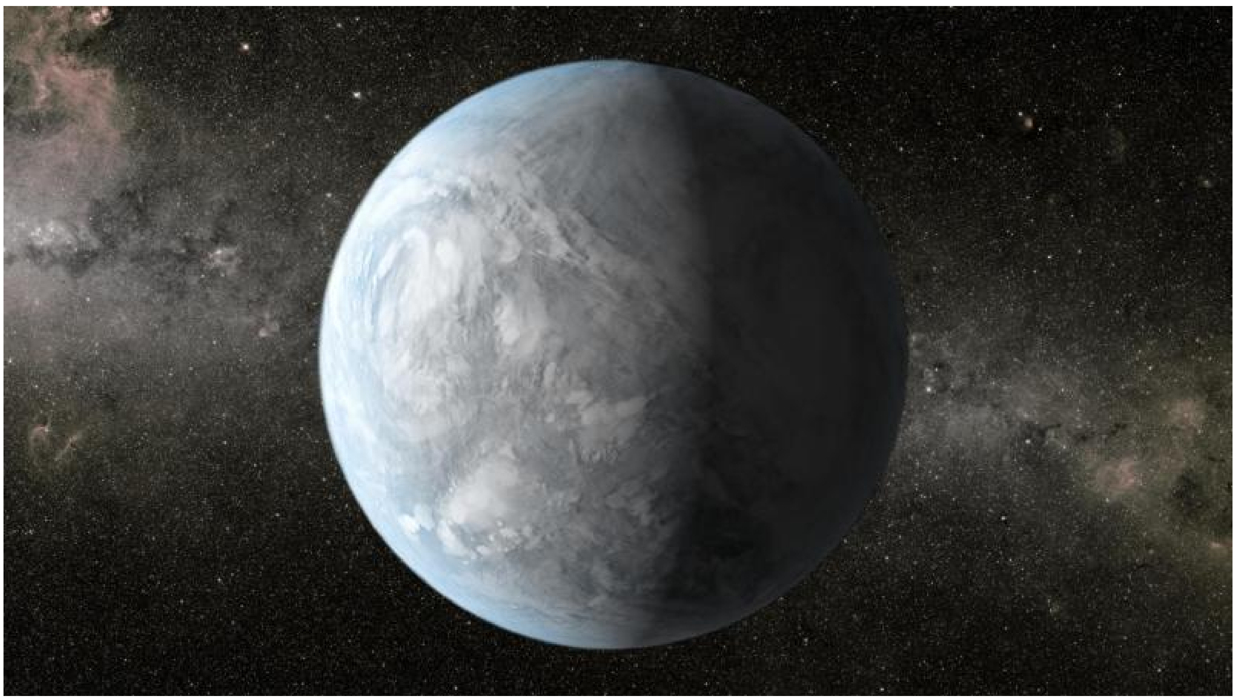

New research from the University of Washington-based Virtual Planetary Laboratory will help astronomers better identify and rule out "false positives" in the ongoing search for life. Shown is a NASA illustration of Kepler 62E, about 1,200 light-years away in the constellation Lyra. Credit: NASA

Is it life, or merely the illusion of life?

Research from the University of Washington-based Virtual Planetary

Laboratory published Feb. 26 in *Astrophysical Journal Letters* will help astronomers better identify—and thus rule out—"false positives" in the search for life beyond Earth.

Powerful devices such as the James Webb Space Telescope, set for launch in 2018, may help astronomers look for life on a handful of faraway worlds by searching for, among other things, evidence of oxygen—a "biosignature"—in their atmospheres. This is done by transit spectroscopy, or studying the spectral features of light visible through a planet's atmosphere when it transits or passes in front of its host star.

"We wanted to determine if there was something we could observe that gave away these 'false positive' cases among exoplanets," said lead author Edward Schwieterman, a doctoral student in astronomy. "We call them 'biosignature impostors' in the paper.

"The potential discovery of life beyond our solar system is of such a huge magnitude and consequence, we really need to be sure we've got it right—that when we interpret the light from these exoplanets we know exactly what we're looking for, and what could fool us."

Here on Earth, oxygen is produced almost exclusively by photosynthesis—plants and algae converting the sun's rays into energy to sustain life. And so Earth's oxygen biosignature is indeed evidence of life. But that may not be universally true.

Previous research from the Virtual Planetary Laboratory has found that some worlds can create oxygen "abiotically," or by nonliving means. This is more likely in the case of planets orbiting low-mass stars, which are smaller and dimmer than our sun and the most common in the universe.

The first abiotic method they identified results when the star's ultraviolet light splits apart carbon dioxide (CO_2) molecules, freeing some of the oxygen atoms to form into O_2, the kind of oxygen present in Earth's atmosphere.

The giveaway that this particular oxygen biosignature might not indicate life came when the researchers, through computer modeling, found that the process produces not only oxygen but also significant and potentially detectable amounts of carbon monoxide. "So if we saw carbon dioxide and carbon monoxide together in the atmosphere of a rocky planet, we would know to be very suspicious that future oxygen detections would mean life," Schwieterman said.

The team also found an indicator for abiotic oxygen resulting from starlight similarly breaking down atmospheric water, H_2O, allowing hydrogen to escape and leaving vast quantities of oxygen—far more than the Earth has ever had in its atmosphere.

In such cases, Schwieterman said, oxygen molecules collide with each other frequently, producing short-lived pairs of oxygen molecules that become O_4 molecules, with their own unique signature.

"Certain O4 features are potentially detectable in transit spectroscopy, and many more could be seen in reflected light," Schwieterman said. "Seeing a large O_4 signature could tip you off that this atmosphere has far too much oxygen to be biologically produced."

"With these strategies in hand, we can more quickly move on to more promising targets that may have true oxygen biosignatures," he said.

"It's one thing to detect a biosignature gas, but another thing to be able to interpret what you are looking at, said Victoria Meadows, UW professor of astronomy and principal investigator of the Virtual Planetary Laboratory. "This research is important because biosignature impostors may be more common for planets orbiting low-mass stars, which will be the first places we look for life outside our solar system in the coming decade."

More information: Edward W. Schwieterman et al. Identifying planetary biosignature impostors: spectral features of CO and O_4 resulting from abiotic O_2/ O_3production , *The Astrophysical Journal* (2016). DOI: 10.3847/2041-8205/819/1/L13

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