Reflections on the habitability of Earth

February 3 2016, by Peter Kelley

Astronomers at the UW-based Virtual Planetary Laboratory have created an index to rank the habitability of exoplanets, or those outside the solar system. But what ranking might Earth itself get, if spotted from light-years away? Credit: NASA

We know the Earth is habitable because—well, here we are. But would it look like a good candidate for life from hundreds of light-years away?

Good, but perhaps not great, according to astronomer Rory Barnes of the University of Washington-based Virtual Planetary Laboratory. It's a question, among many others, that he and co-authors asked in a recent paper.

Barnes, a research assistant professor of astronomy, colleagues are drawing up a "habitability index for transiting planets" that ranks exoplanets to help prioritize the search for life.

Astronomers spot possible exoplanets, or those beyond the solar system, not through direct observation but by the dimming of light that happens when the worlds pass in front of, or "transit" their host star. Many factors go into judging a world's possible habitability, including the amount of energy it gets from its star, the distance and radius of its orbital path and the behavior of its neighbor planets. Spectrometry is used to estimate the mass and radius of the host star, from which astronomers can the estimate the size of the planet itself.

They use this data to create a model of a planet—"an idea of a planet," Barnes said, which is then compared with information about other worlds. "And you basically try and sort out, do I think that could reasonably be a planet that's habitable?"

But validating, or confirming planets is methodical, time-consuming work, and access to the big telescopes needed is expensive. The habitability index helps astronomers rank and prioritize planets to help determine which are worthy of closer study.

Managing these myriad calculations, the index gives the Earth, if observed from afar as we now observe faraway planets, about an 82 percent chance of being right for life.

But wait—only 82 percent?

Why wouldn't the Earth—the single example of a life-hosting world in all our experience—score a perfect, 100 percent rating?

"Basically, where we lose some of the probability, or chance for life, is that we could be too close to the star," Barnes said. "We actually are kind of close to the inner edge of the habitable zone. If we spotted Earth with our current techniques, we would reasonably conclude that it could be too hot for life."

The habitable zone is that swath of space around a star where an orbiting rocky planet might be able to keep liquid water on its surface, thus giving life a chance.

But distance to the host star is only one of many data points Barnes and colleagues account for with the habitability index. Others are the composition of the planet, the details of its orbital path and the behavior of nearby worlds.

In the paper, Barnes and co-authors argue that potential habitability could as effectively be thought of as "a cooling problem." That is, just as there is a habitable zone or "Goldilocks" sweet spot in distance, so too is there one in how successfully a planet sheds energy to maintain the right conditions for liquid water on a planet's surface.

So, why doesn't our presence on the Earth, all things considered, earn a perfect, 100 percent score? Because again, here we are, living proof. But the astronomers would not know that, if Earth were spotted hundreds or thousands of light-years away in the Kepler field of vision.

"Remember, we have to think about the Earth as if we don't know anything about it," Barnes said. "We don't know that it's got oceans, and whales and thing like that—imagine it's just this thing that dims some of the light around a nearby star when it passes."

It becomes a sort of sociology question, Barnes said. People would get pretty excited if astronomers did spot an exact Earth twin orbiting an exact Sun twin out there, Barnes allowed.

But if there came a choice between spending money and time to study the Earth twin—so close to the superheated inner edge of its habitable zone—or another planet located by Kepler with a higher habitability index rating, which should we choose to spend millions on and study?

Sorry, Earth twin.

"The point of the paper is that the other one is the best to spend our time on. Because it's less in danger."

"But," Barnes added, "it's obviously based on this very limited information."

More information: Comparative Habitability of Transiting Exoplanets. arxiv.org/abs/1509.08922

Provided by University of Washington