'Young Jupiter' exoplanet discovery: Q&A with astronomer Eric Nielsen

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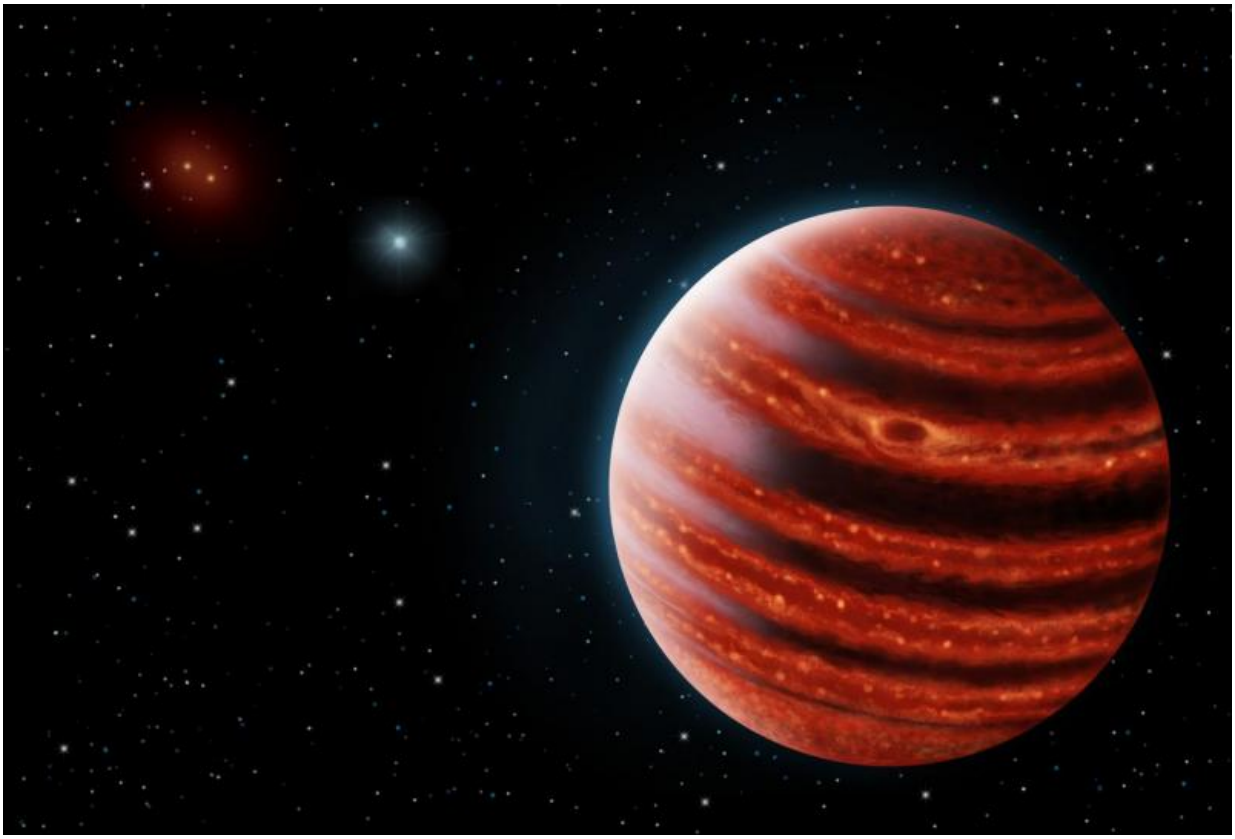

An artistic conception of the Jupiter-like exoplanet, 51 Eri b, seen in the near-infrared light that shows the hot layers deep in its atmosphere glowing through clouds. Because of its young age, this young cousin of our own Jupiter is still hot and carries information on the way it was formed 20 million years ago. Credit: Danielle Futselaar & Franck Marchis, SETI Institute.

(Phys.org)—The discovery of 51 Eridani b, a Jupiter-like exoplanet, made headlines last week as it is the lowest-mass planet ever directly imaged around another star. Significantly, the planet resembles Jupiter in its infancy and shows the strongest methane signature ever detected on an alien planet. In an interview with *Phys.org*, astronomer Eric Nielsen of the SETI Institute, a member of the team that found 51 Eridani b, talks about the importance of the discovery and characterizes the newest addition to the list of known exoplanets.

Phys.org: The discovery created a lot of buzz in various scientific media. Is it really such an important finding, a milestone in the search for exoplanets?

Eric Nielsen: The reason we're all so excited about this is that 51 Eri b is the first time we've discovered an extrasolar planet by direct imaging, where the planet looks so much like a giant planet in our own solar system. Other giant planets we have images of are interesting in their own right, but they look very different from what we're used to. For example, HR 8799 is a massive star that hosts four giant planets between seven and 10 times the mass of Jupiter, between 15 AU and 68 AU. 2MASS 1207 is a brown dwarf with a four-Jupiter-mass planet at 46 AU.

The other planets we've imaged around other stars tend to be at larger orbital distances and hotter, simply because those are easier to detect, but GPI's (Gemini Planet Imager) incredible ability to detect faint companions close to their stars means we're sensitive for the first time to these closer, cooler planets. We still don't know how often planets like this form, and finding and studying 51 Eri b is an important clue to uncovering how planets form around other stars, and whether the formation of the giant planets in our own solar system was an unlikely fluke or a common process.

Phys.org: Does 51 Eridani b resemble Jupiter?

Nielsen: 51 Eri b just looks more like something we're used to seeing in our own solar system, orbiting a star that's a little more massive than ours, and only twice the mass of Jupiter and at a separation between the orbits of Saturn and Uranus.

In addition, the spectrum of 51 Eri b shows that it has a lot of methane in its atmosphere, which is an important component of the atmosphere of our solar system's giant planets. The other giant planets we've imaged around other stars either have very weak or no signs of methane in their spectra, so seeing something more similar to what we're used to locally is pretty exciting. 51 Eri b is at intermediate temperature, too, at 800 degrees Fahrenheit, it sounds pretty hot by human standards, and certainly compared to Jupiter at -200 degrees Fahrenheit, but it's significantly cooler than other extrasolar planets which are closer to 1200 degrees Fahrenheit.

Phys.org: Why is this planet so much hotter than Jupiter?

Nielsen: The main reason this planet is so much hotter than Jupiter is that it's so much younger, so it still has a lot of the heat it got when it first formed. Over hundreds of millions of years, it'll radiate away that heat and cool down, and come to look more and more like Jupiter. So this planet represents a great opportunity to see what Jupiter probably looked like when our solar system was much younger, before the Earth had even finished forming.

Phys.org: What was the role of Gemini Observatory's Planet Imager in this discovery?

Nielsen: Discovering 51 Eri b wouldn't have been possible without GPI. The Gemini Planet Imager was designed from the start to do exactly what it's doing now, detecting the faintest planets very close to their parent stars and characterizing their atmospheres. Previous instruments at large telescopes have looked at the star 51 Eri over the past decade, but the planet was invisible to them because it just got lost in the glare of the star. As part of the Gemini Planet Imager Exoplanet Survey (GPIES) we have an incredible opportunity to search for these previously-hidden planets and learn about them, and really place our own solar system into context.

Phys.org: Is it actually possible that 51 Eridani b could host alien life?

Nielsen: While we don't have the capabilities to detect life or rule it out, based on what we know now, it's very unlikely that 51 Eri b hosts life. As a gas giant like our own Jupiter, it has no surface or liquid ocean, both important to development of life on Earth. It might be possible for 51 Eri b to have rocky and icy moons, because all the giant planets in our own solar system have multiple moons, which might provide a location for life to develop. However, such hypothetical moons would be completely invisible to our current technology.

There's speculation that life could arise in the oceans of Jupiter's moon Europa, beneath the 10 to 30 km icy surface, where the liquid water ocean is heated by tidal forces from Jupiter. Though confirming whether life really does or has lived on Europa will require a future probe that can somehow get beneath that surface of ice. Timescale is an important factor. It took about a billion years after Earth formed before life first appeared, and 51 Eri b orbits a star that only formed 20 million years ago, so if moons do form around 51 Eri b that are a good place for life to arise, it's probably much too early for life to have appeared.

Phys.org: What do we know about this planet's atmosphere?

Nielsen: The atmosphere is pretty interesting, and it's a good deal cooler than extrasolar planet atmosphere we've taken spectra of to date. From the spectrum, we can tell that there's methane and water in its atmosphere, which looks a lot like the inner parts of Jupiter's atmosphere. Also like Jupiter, 51 Eri b probably has bands of clouds on its surface giving it a striped appearance.

Phys.org: Do you plan further observations of the planet? If so, what kind of observations? What instruments do you plan to use?

Nielsen: Right now, our sun is between the Earth and 51 Eri, so it'll be another one to two months before we can observe this planet again. But once it's visible again, we have lots of plans for future observations, many with GPI. We want to track the orbit of this planet over time, and see if it's in a mostly circular orbit like the giant planets of our solar system, or if it's in a very eccentric orbit like many of the closer-in giant planets astronomers have detected around other stars using the radial velocity technique. GPI also allows us to take spectra at shorter and longer wavelengths than our current data, so we can do a more complete comparison to other planets and theoretical models, and really understand what the atmosphere is made of and the bulk properties of the planet.