Novel technique boosts hunt for water on planets around other stars

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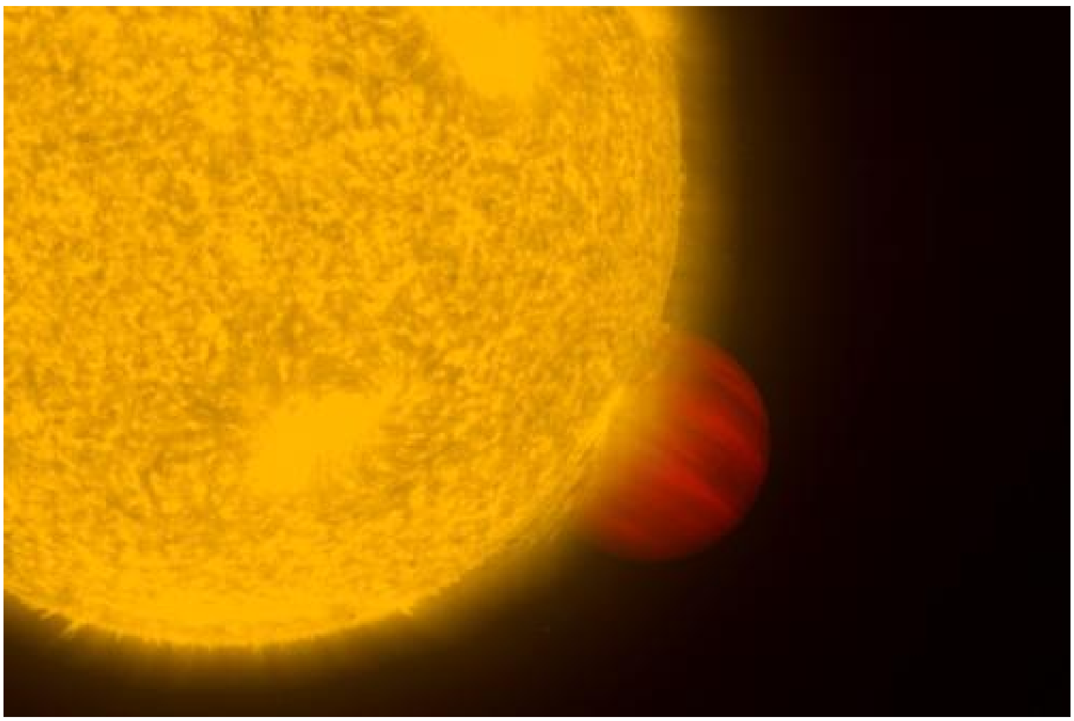

An artist's impression of a hot Jupiter (at bottom right), a giant planet that orbits extremely close in to its host star. Credit: Leiden Observatory

(Phys.org) —Using ESO's Very Large Telescope (VLT), a team of astronomers have been able to detect the tell-tale spectral fingerprint of water molecules in the atmosphere of a planet in orbit around another star. The discovery endorses a new technique that will let astronomers efficiently search for water on hundreds of worlds without the need for space-based telescopes. Dr Jayne Birkby of Leiden University will present the new result on Friday 5 July at the RAS National Astronomy Meeting in St Andrews, Scotland.

Since the early 1990s scientists have found almost 1000 planets in orbit around other stars. These so-called exoplanets are mostly much larger than the Earth and many are much closer to their stars than we are to the Sun, leading them to be described as 'hot Jupiters'. In the new work the team studied the exoplanet HD 189733b, a world that orbits its star every 2.2 days and is heated to a temperature of over 1500 degrees Celsius.

Astronomers usually find exoplanets by measuring the gravitational influence of the planet on the star, which acts to pull the star around in a very small orbit, at velocities of a few kilometres per hour. This movement causes a small shift in the lines of the stellar spectrum (known as the Doppler shift), which move back and forth with the wobble of the star.

The Leiden University-led team have flipped the technique on its head by measuring the gravitational influence of the star on the planet, which is much larger, hurling the planet around its orbit at some 400,000 km per hour. They measured this by tracing the Doppler shift of the water lines in the exoplanet's spectrum as it orbited the star. Despite the much larger velocity of the planet, it is nearly a thousand times fainter than the star, which makes detecting it very difficult. The team were able to detect the spectral line of water in the exoplanet atmosphere by using the CRyogenic high-resolution InfraRed Echelle Spectrograph (CRIRES) instrument mounted on the VLT.

Using the same technique, scientists were recently able to find the simple molecule carbon monoxide (CO) in the atmosphere of the same planet, but this is the first time it has been used to identify a more complex molecule like water (H_2O). The detection means that the door is now open for a much more detailed census of the chemical make-up of many other exoplanet atmospheres, including molecules such as methane (CH_4) and carbon dioxide (CO_2), which are key ingredients for unravelling a planet's formation history. It also paves the way for future observations with the coming generation of large telescopes like the European Extremely Large Telescope (E-ELT) that will begin operations from its site in Chile in 2020. These instruments will be able to use the technique to hunt for potential signs of life, such as oxygen, in the atmospheres of planets similar to the Earth.

Dr Jayne Birkby, who led the team, said, "We knew our technique worked for simple molecules at shorter wavelengths, but in order to hunt for water, we had to go to longer wavelengths where the Earth's atmosphere really starts to obstruct the signals we are looking for, so we weren't sure we would find anything. Of course we were delighted when we saw the signal jump out at us. It means we can do much more with this technique.

'In the next decade our work will help astronomers refine their search for Earth-like planets – and even life – in orbit around other stars. It's incredibly exciting to think that in my lifetime we will reach a day when we can point up to a star and say with confidence that it has a world just like our own."

More information: The new work appears in "Detection of water absorption in the dayside atmosphere of HD 189733 b using ground-based high-resolution spectroscopy at 3.2 microns", J. L. Birkby, R. J. de Kok, M. Brogi, E. J. W. de Mooij, H. Schwarz, S. Albrecht, I. A. G. Snellen, submitted to *Monthly Notices of the Royal Astronomical Society*. A copy of the paper can be viewed at arxiv.org/abs/1307.1133

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