Evidence for substance at liquid-gas boundary on exoplanet WASP-31b

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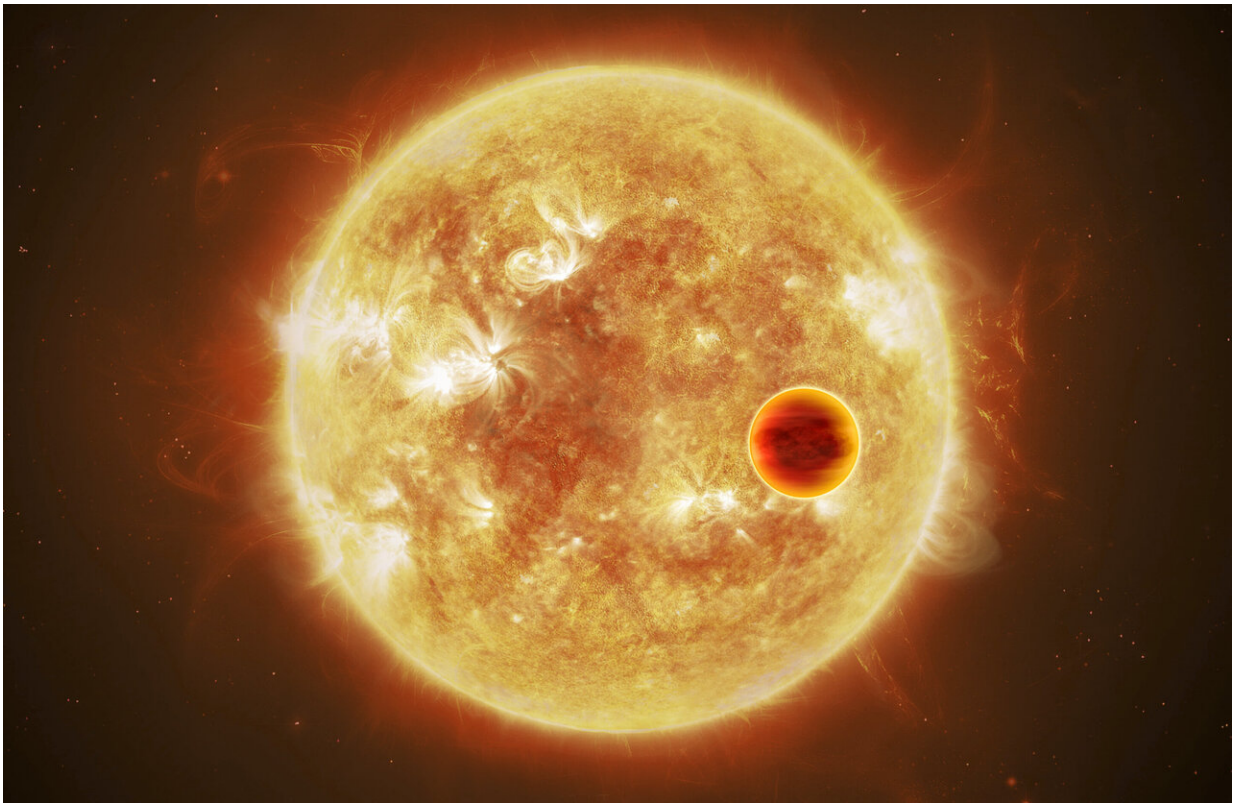

Artist impression of an exoplanet. Credit: ESA/ATG medialab, CC BY-SA 3.0 IGO

One of the properties that make a planet suitable for life is the presence of a weather system. Exoplanets are too far away to directly observe this, but astronomers can search for substances in the atmosphere that make a

weather system possible. Researchers from SRON Netherlands Institute for Space Research and the University of Groningen have now found evidence on exoplanet WASP-31b for chromium hydride, which at the corresponding temperature and pressure is on the boundary between liquid and gas. The study is published in *Astronomy & Astrophysics*.

While space probes scan the planets and moons around our Sun for extraterrestrial life, there are hundreds of billions of other stars in our galaxy, most of which probably also surrounded by planets. These so-called exoplanets are too far away to travel to, but we can study them with our telescopes. Although the spatial resolution is usually insufficient to make a picture of an exoplanet, astronomers can still get a lot of information from the fingerprints the atmosphere leaves behind in the light rays of the host star.

From those fingerprints—so-called transmission spectra—astronomers deduce which substances are in the atmosphere of an exoplanet. Those could one day give an indication of extraterrestrial life. Or they can show that there is a condition for life, such as a weather system. For the time being, however, this type of research is limited to giant planets close to their stars, so-called hot Jupiters. These planets are too hot to expect life, but they can already teach us a lot about how possible weather systems work. A research team from SRON Netherlands Institute for Space Research and the University of Groningen has now found evidence for a substance at the boundary between liquid and gas. On Earth this is reminiscent of clouds and rain.

First author Marrick Braam and his colleagues found evidence in Hubble data for chromium hydride (CrH) in the atmosphere of exoplanet WASP-31b. This is a hot Jupiter with a temperature of about 1,200 °C in the twilight zone between day and night—the place where starlight travels through the atmosphere towards Earth. And that happens to be around the temperature at which chromium hydride transitions from

liquid to gas at the corresponding pressure in the outer layers of the planet, similar to the conditions for water on Earth. "Chromium hydride could play a role in a possible weather system on this planet, with clouds and rain," says Braam.

It is the first time that chromium hydride is found on a hot Jupiter and therefore at the right pressure and temperature. Braam: "We should add that we only found chromium hydride using the Hubble space telescope. We did not see it in the data from the ground telescope VLT. There are logical explanations for this, but we therefore use the term evidence instead of proof."

When Hubble's successor—the James Webb Space Telescope (JWST)—is launched later this year, the team plans to use it for further investigation. "Hot Jupiters, including WASP-31b, always have the same side facing their host star," says co-author and SRON Exoplanets program leader Michiel Min. "We therefore expect a day side with chromium hydride in gaseous form and a night side with liquid chromium hydride. According to theoretical models, the large temperature difference creates strong winds. We want to confirm that with observations."

Co-author Floris van der Tak (SRON/UG) says, "With JWST we are looking for chromium hydride on ten planets with different temperatures, to better understand how the weather systems on those planets depend on the temperature."

More information: Marrick Braam, Floris F. S. van der Tak, Katy L. Chubb, and Michiel Min, 'Evidence for chromium hydride in the atmosphere of hot Jupiter WASP-31b', *Astronomy & Astrophysics*, 2021.