

Very Large Telescope observes exoplanet where it rains iron

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This illustration shows a night-side view of the exoplanet WASP-76b. The ultra-hot giant exoplanet has a day side where temperatures climb above 2400 degrees Celsius, high enough to vaporise metals. Strong winds carry iron vapour to the cooler night side where it condenses into iron droplets. To the left of the image, we see the evening border of the exoplanet, where it transitions from day to night. Credit: ESO/M. Kornmesser

Researchers using ESO's Very Large Telescope (VLT) have observed an extreme planet where they suspect it rains iron. The ultra-hot giant exoplanet has a day side where temperatures climb above 2400 degrees

Celsius, high enough to vaporise metals. Strong winds carry iron vapour to the cooler night side where it condenses into iron droplets.

"One could say that this planet gets rainy in the evening, except it rains [iron](#)," says David Ehrenreich, a professor at the University of Geneva in Switzerland. He led a study, published today in the journal *Nature*, of this exotic exoplanet. Known as WASP-76b, it is located some 640 light-years away in the constellation of Pisces.

This strange phenomenon happens because the 'iron rain' planet only ever shows one face, its day side, to its [parent star](#), its cooler night side remaining in perpetual darkness. Like the Moon on its orbit around the Earth, WASP-76b is 'tidally locked': it takes as long to rotate around its axis as it does to go around the star.

On its day side, it receives thousands of times more radiation from its parent star than the Earth does from the Sun. It's so hot that molecules separate into atoms, and metals like iron evaporate into the atmosphere. The extreme temperature difference between the day and night sides results in vigorous winds that bring the iron vapour from the ultra-hot day side to the cooler night side, where temperatures decrease to around 1500 degrees Celsius.

Not only does WASP-76b have different day-night temperatures, it also has distinct day-night chemistry, according to the new study. Using the new ESPRESSO instrument on ESO's VLT in the Chilean Atacama Desert, the astronomers identified for the first time chemical variations on an ultra-hot gas giant planet. They detected a strong signature of iron vapour at the evening border that separates the planet's day side from its night side. "Surprisingly, however, we do not see the iron vapour in the morning," says Ehrenreich. The reason, he says, is that "it is raining iron on the night side of this extreme exoplanet."

"The observations show that iron vapour is abundant in the atmosphere of the hot day side of WASP-76b," adds María Rosa Zapatero Osorio, an astrophysicist at the Centre for Astrobiology in Madrid, Spain, and the chair of the ESPRESSO science team. "A fraction of this iron is injected into the night side owing to the planet's rotation and atmospheric winds. There, the iron encounters much cooler environments, condenses and rains down."

This result was obtained from the very first science observations done with ESPRESSO, in September 2018, by the scientific consortium who built the instrument: a team from Portugal, Italy, Switzerland, Spain and ESO.

ESPRESSO—the Echelle SPectrograph for Rocky Exoplanets and Stable Spectroscopic Observations—was originally designed to hunt for Earth-like planets around Sun-like stars. However, it has proven to be much more versatile. "We soon realised that the remarkable collecting power of the VLT and the extreme stability of ESPRESSO made it a prime machine to study exoplanet atmospheres," says Pedro Figueira, ESPRESSO instrument scientist at ESO in Chile.

"What we have now is a whole new way to trace the climate of the most extreme exoplanets," concludes Ehrenreich.

More information: Nightside condensation of iron in an ultrahot giant exoplanet, *Nature* (2020). [DOI: 10.1038/s41586-020-2107-1](https://doi.org/10.1038/s41586-020-2107-1) , www.nature.com/articles/s41586-020-2107-1

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