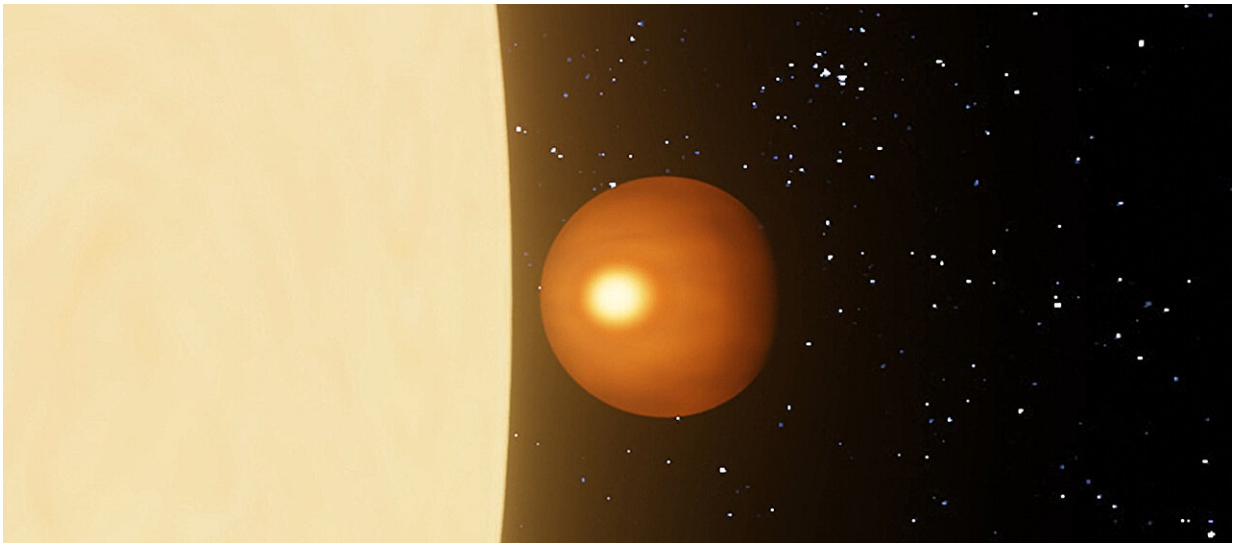
Astronomers discover iron winds on an ultra-hot exoplanet

September 5 2024



WASP-76 b has been the subject of numerous studies since its discovery in 2013. The temperature there reaches 2,400 degrees Celsius. Credit: Tania Cunha (Planetário do Porto - Centro Ciência Viva/Instituto de Astrofísica e Ciências do Espaço)

An international team of astronomers, including scientists from the University of Geneva (UNIGE) and the PlanetS National Center of Competence in Research, has identified the presence of iron winds in the atmosphere of the ultra-hot Jupiter WASP-76 b.

This planet with its extreme conditions—over 2,000 degrees Celsius—is

a prime target for researchers, who for several years have been dissecting the slightest physical mechanisms at work in its atmosphere. The presence of a "rainbow" was detected there last April, for example.

The discovery of iron winds sweeping across the day side of the planet offers new insight into the complex climatic dynamics of this distant world. These results can be found in the journal *Astronomy & Astrophysics*.

The ultra-hot exoplanet WASP-76 b has been the subject of numerous studies since its discovery in 2013, revealing numerous extreme atmospheric phenomena. Previous research by international teams, including those at the UNIGE, has identified iron rain on its night side, the presence of barium in its upper atmosphere and the existence of a "rainbow" at the boundary between its day and night sides.

"The work on WASP-76 b shows us just how extreme atmospheric conditions can be on ultra-hot Jupiters," explains David Ehrenreich, associate professor in the Astronomy Department at the UNIGE Faculty of Science, member of the NCCR PlanetS and co-author of the study. "In-depth analysis of this type of planet provides us with valuable information for a better understanding of planetary climates as a whole."

Flux of iron atoms

For this new study, the team of astronomers focused on the day side of WASP-76 b, which has a temperature of 2400 degrees Celsius, by observing it at high spectral resolution in the visible light. The main result was the detection of a stream of iron atoms moving from the lower to the upper layers of the planet's atmosphere.

"This is the first time that such detailed optical observations have been made on the day side of this exoplanet, providing key data on its

atmospheric structure," explains Ana Rita Costa Silva, a doctoral student at the Instituto de Astrofísica e Ciências do Espaço (IA), on a long term visit at the Astronomy Department of the UNIGE Faculty of Science and first author of the study.

"Our observations indicate the presence of powerful iron winds, probably fueled by a hot spot in the atmosphere."

Thanks to the ESPRESSO spectrograph

This breakthrough was made possible by the use of the ESPRESSO spectrograph, renowned for its precision and stability. The instrument, built largely by the UNIGE and installed on ESO's Very Large Telescope (VLT) in Chile, was used to acquire high-resolution spectra of the planet.

By analyzing this light, the team was able to identify the chemical signatures of iron moving in the planet's atmosphere. This technique, known as high-resolution emission spectroscopy, is particularly powerful for studying the atmospheres of exoplanets.

"ESPRESSO's ability to make such precise measurements is crucial," says Christophe Lovis, associate professor in the Astronomy Department at the UNIGE Faculty of Science, member of the NCCR PlanetS and co-author of the study. "This level of precision allows us to explore the dynamic processes in the atmospheres of exoplanets like WASP-76 b with an unprecedented level of detail."

A window on exoplanetary climates

The successive discoveries made on WASP-76 b are paving the way for a better understanding of exoplanetary climates, particularly in the case

of gas giants subjected to extreme irradiation from their host star.

The detailed mapping of atmospheric winds and their chemical composition is helping astronomers to develop a complete model of the evolution of these distant worlds. By detecting iron winds on WASP-76 b, the astronomers are providing crucial new information for building 3D models of this exoplanet's climate, which could one day help them predict similar phenomena on other distant planets.

More information: A. R. Costa Silva et al, ESPRESSO reveals blueshifted neutral iron emission lines on the dayside of WASP-76 b, *Astronomy & Astrophysics* (2024). DOI: 10.1051/0004-6361/202449935

Provided by University of Geneva