Signals in optical band can be used as probe to detect atmosphere escape of hot Jupiters

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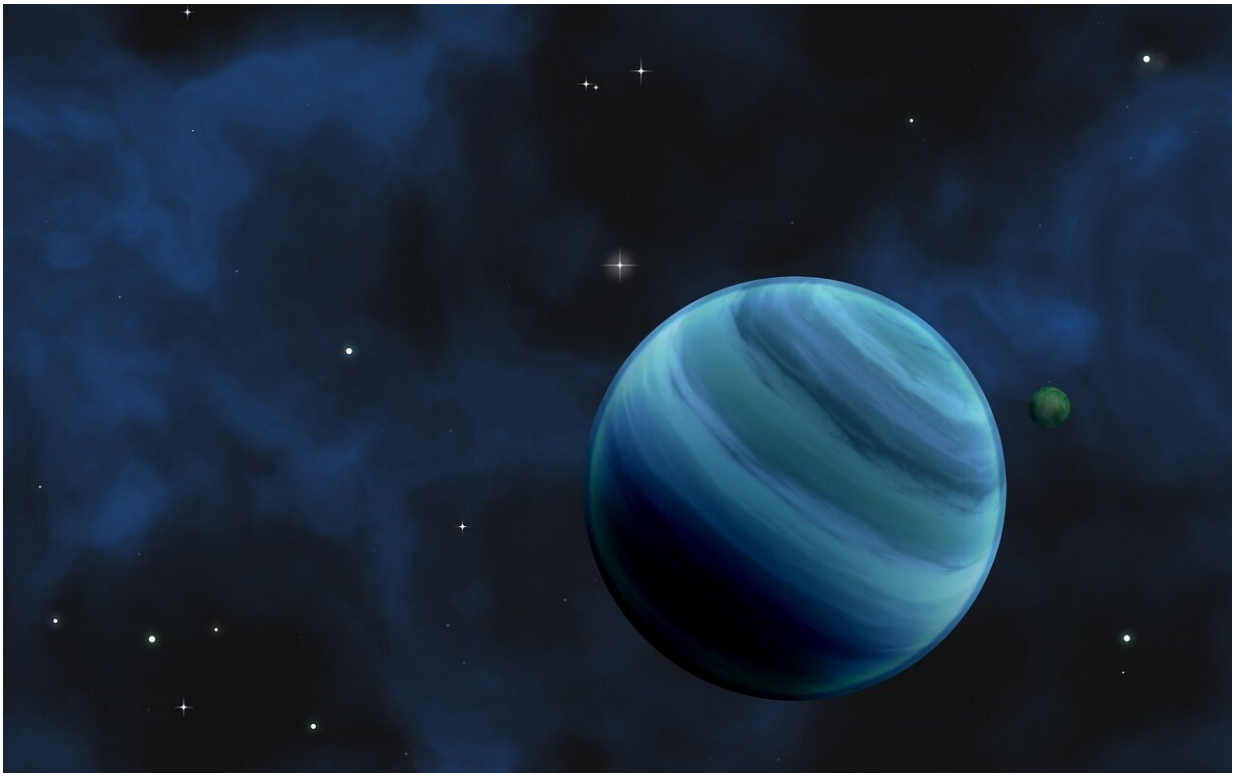

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YAN Dongdong, GUO Jianheng and Xing Lei from Yunnan Observatories of the Chinese Academy of Sciences, collaborating with Huang Chenliang from University of Arizona, deduced that there is an expanding and escaping thermal neutral hydrogen atmosphere around hot

Jupiter WASP-121b by simulating the optical transmission spectrum (Hα) of this exoplanet. The study was published in The *Astrophysical Journal Letters*.

It was found that the cooler hydrogen atoms in the atmosphere of a hot Jupiter close to its host star can escape in a dramatic fashion by analyzing the observation signals in the far ultraviolet wavelength passband. This escape is called the hydrodynamic escape. Through this mechanism, planetary atmospheres lose massive amounts of material, which has a serious impact on planetary evolution.

A small number of hot hydrogen atoms are present in the planet's atmosphere. In recent years, weak absorption signals (e.g., Hα transmission spectra of hydrogen) have been detected when hot hydrogen atoms in the planetary atmosphere shade the host star. However, there has been a lack of explanation relating the absorption signals generated by these hotter hydrogen atoms to atmospheric escape.

The researchers have developed a hydrodynamic escape atmosphere model and a radiation transfer model. The velocity, temperature and density of the atmosphere were obtained by solving the hydrodynamic fluid equation, and then the absorption of the planetary atmosphere to the stellar light was calculated frequency by frequency and point by point. Based on the models, they calculated the populations of hot and cold hydrogen atoms and then simulated the optical band (Hα) transmission spectrum observations of hot Jupiter WASP-121b at different observation times.

The researchers found that there is a huge amount of escaping neutral hydrogen gas around the planet, which could lose up to ten trillion tons of matter a year. The hot hydrogen atoms in the material ejected by the planets can travel faster than the speed of sound, causing absorption at optical wavelengths. They also found that the signals of hydrodynamic

escape from the planetary atmosphere can be detected by ground-based telescopes, and the signals in the optical band can be used as a probe to detect atmosphere escape.

Besides, the researchers found that the changes in the absorption level of the planetary atmosphere at different times may reflect the different activity characteristics of the host star, with the stronger activity level of the star leading to the deeper absorption of the planetary atmosphere.

This study helps to better understand the influence of host star activity on planetary atmosphere escape.

More information: Dongdong Yan et al. Atmosphere Escape Inferred from Modeling the Hα Transmission Spectrum of WASP-121b, *The Astrophysical Journal* (2021). DOI: 10.3847/2041-8213/abda41

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