A Hot, Black Planet

Research lead by MSI master's student Taylor Bell, showed that an oddball planet, WASP-12b, reflects almost no light and may teach us about how clouds form on hot Jupiters, massive exoplanets that orbit extremely close to their host stars.

The planet originally discovered in 2008, is unlike anything that exists in our solar system. It is about 1.4 times Jupiter's mass and orbits its star every 1.1 days. This extremely close orbit means that the planet is probably tidally locked to its host star, with one side of the planet always facing the star and one side always facing away from the star. This creates a huge temperature difference between the permanent day- and nightside of the planet, 2500 degrees Celsius on the side facing the star and 1500 degrees Celsius on the side that faces away.

Bell's observations showed that WASP-12b reflects remarkably little light (less than 6%), making it as black as fresh asphalt. This very low reflectivity, or albedo, means there cannot be any clouds on the dayside of the planet, even though previous publications report evidence that there may be clouds along the boundary between day and night.

When Bell initially tried to model the atmosphere of WASP-12b using standard planetary atmosphere models, he got some puzzling results. "When my code spat out an extremely low value we were all pretty baffled" said Bell. "Later we considered another model based on stellar atmospheres, rather than Earth's atmosphere, which was able to explain this very low albedo."

It turns out that the dayside of Wasp 12-b behaves more like a star than a planet. The molecular hydrogen (along with other molecules with water) in the planet's extremely hot dayside is broken down into individual atoms, which means that different effects, typically seen only in stars, lower the planet's albedo.

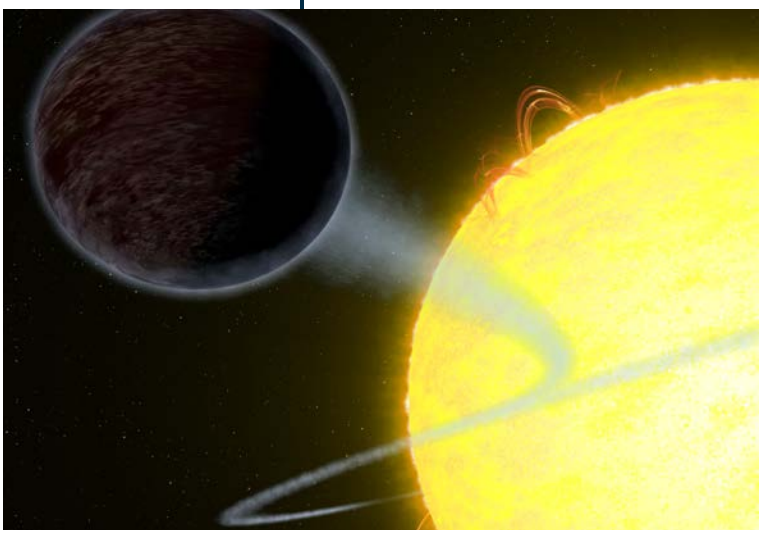
While the results from WASP-12b were unexpected, this is par for the course in the emerging field of modeling exoplanet atmospheres. According to Bell "there are a vast number of exoplanets that have been discovered, but we know little about most of them. Each planet that is characterized tends to surprise us."

Bell, T. J., Nikolov, N., **Cowan, N. B.**, et al. 2017, *The Very Low Albedo of WASP-12b from Spectral Eclipse Observations with Hubble*, ApJL, 847, L2

Why this is important

If hydrogen chemistry explains the very low albedo of WASP-12b, then all hot Jupiters with dayside temperatures as hot or hotter than WASP-12b should have equally low albedos. Currently there are only a few such planets known, but the upcoming TESS mission is expected to find hundreds more which could be easily characterized. The dissociation and recombination of molecular hydrogen should also have observable signatures in the orbital phase variations which will allow researchers to directly measure the wind strengths on the planet.

Taylor Bell *is a MSI graduate Fellow and Master's student under the supervision of Prof. Nicolas Cowan. His research focuses on better understanding the atmospheres of hot Jupiter-mass exoplanets using observations of thermal and reflected light.*



» Artist's impression of WASP-12b. NASA, ESA, and G. Bacon (STScI)