The peculiar atmospheric chemistry of KELT-9b

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The atmospheric temperatures of the ultra hot-Jupiter KELT-9b straddle the transition between gas giants and stars, and therefore between two traditionally distinct regimes of atmospheric chemistry. It also makes the atmosphere of KELT-9b, which is expected to be cloudfree, a tightly constrained chemical system that lends itself to a clean set of theoretical predictions and an ideal target for spectral characterisation.

In this talk, we will present the peculiar chemical composition of this ultra hot atmosphere and its implications for observations. For example, we predict the abundance of water to vary by several orders of magnitude across the atmospheric limb depending on temperature, which makes water a sensitive thermometer. Carbon monoxide is predicted to be the dominant molecule under a wide range of scenarios, rendering it a robust diagnostic of the metallicity and allowing to directly obtain the C/H or O/H element abundance from spectroscopic measurements.

Additionally, we will show that atoms and ions of metals are abundantly present in Kelt-9b's atmosphere and could potentially be directly observed. For example, neutral atomic iron is predicted to be seen through a forest of optical and near-infrared lines, which makes KELT-9b an ideal target for high-resolution, ground-based spectroscopy with HARPS-N or CARMENES. We will present theoretical predictions for detecting iron at high spectral resolution and summarise the future observational prospects of characterising the atmosphere of KELT-9b with the Hubble Space Telescope, James Webb Space Telescope, and CHEOPS.

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