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Along the Line of Sight: Changing Chemical States in Cloud Forming Exoplanet Atmospheres

Exoplanet atmospheres provide ideal atmospheric laboratories to explore atmospheres unlike anything in our Solar System. Atmosphere characterisation is also an important tool in understanding exoplanetary system formation and evolution. However, exoplanets are not globally homogeneous, as the light we observe must pass though many diverse regions any observations probe a wide variety of chemical states, for example in transmission spectroscopy. With new instruments like JWST and upcoming missions such as ARIEL, the higher quality observations will demand a detailed understanding of all these regimes. Furthermore, population studies of gas-giant exoplanet atmospheres are beginning to reveal the impacts planetary system parameters and host star properties also have on the atmospheres.

We explore the non-equilibrium formation of clouds, globally, for gas-giant exoplanets with a range of orbital parameters. Crucially, the asymmetries between the dayside and nightside and at the terminators depend on parameters like planetary rotation rate and host star spectral type. However, there is consistently formation of clouds on the nightside of these planets. Whilst the lowest rays pass through regions of chemical-equilibrium, there are also are regions of ionisation of the gas deep in the atmospheres of gas-giant exoplanets, as well as the upper atmosphere on the dayside of ultra-hot Jupiters. Furthermore, the upper atmospheres also have photochemical processes and energetic particle fluxes, which because of the slant geometry of transmission observations will have a large impact on the observed spectra. Differences in irradiation between the dayside and nightside of hot Jupiters leads to large chemical abundance changes, with ammonium and oxonium being key fingerprints for non-thermal ionisation processes. In addition these non-equilibrium process enhance the production of organic molecules on the pathway to producing amino acids such as glycine. This talk endeavours to provide insight as to how these non-equilibrium processes shape an exoplanet atmosphere.

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