EPSC Abstracts
Vol. 14, EPSC2020-315, 2020
https://doi.org/10.5194/epsc2020-315
Europlanet Science Congress 2020

Exploring Non-LTE Effects in Exoplanet Atmospheres

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Great advances have been made over the last few decades in probing the atmospheres of extra-solar planets, enabling us to further constrain the conditions that exist on these worlds. When modelling these atmospheres however, the work done to date has assumed that the species present are in local thermodynamic equilibrium (LTE). However it is known, for instance on Earth, that non-LTE effects are present in planetary atmospheres and give rise to spectra that vary from the LTE case.

Fast, high altitude jet streams in the atmospheres of hot Jupiters will produce shock regions where molecules may be found in non-LTE. Such effects are also likely in the upper atmospheres of planets barraged by solar flares, where the heavy stellar radiation drives the molecules to a state of non-LTE. This poster presents a preliminary exploration into non-LTE effects in exoplanet atmospheres, showing the differences that arise in some notable molecular spectra due to these effects. This is achieved with the atmospheric retrieval framework TauRex 3, using custom cross sections generated with the ExoCross software's capability to approximate non-LTE spectra via splitting the rotational and vibrational temperatures.

An initial evaluation of the detectability of these differences by current and next generation space telescopes is presented through simulation with the PandExo package, showing forward atmospheric models with non-LTE variations clearly visible in spectra. It can be seen that the differences in spectra are resolvable, notably the absence of 'shoulders' in the case of the non-LTE water transmission models.