GJ 1214b : a mystery for EChO to solve

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We have investigated temperature, aerosol and compositional models for the atmosphere of super-Earth GJ 1214b based on currently available transmission spectra and broadband photometry (Barstow et al. 2013). Using the NEMESIS radiative transfer and retrieval tool (Irwin et al. 2008), we retrieve cloud optical depths and trace gas volume mixing ratios for an H2-He-dominated atmosphere. We perturb the a priori atmospheric state to investigate the dependence of the retrieval on prior assumptions, and we find that the current data do not provide sufficient information to constrain cloud optical depths or volume mixing ratios ; in other words, the derived solution depends sensitively on the prior for the optimal estimation retrieval. For the specific case of GJ 1214b, we cannot distinguish between a H2-He dominated mini-Neptune or a H2O dominated water-world atmosphere, as both scenarios produce synthetic spectra that fit the data within the errors.

We also generate synthetic, noisy EChO transmission spectra for various GJ 1214b model atmospheres. We find that an EChO spectrum for an extended H2-He atmosphere could not be adequately reproduced by a water-dominated model atmosphere, and the input atmospheric state can be reliably retrieved using NEMESIS if 30 primary transits are observed and the data combined. This would be perfectly feasible as the orbital period of GJ 1214b is only 1.5 days. The infrared region of the spectrum longwards of 5 microns is very important for distinguishing between different scenarios, due to the presence of broad methane and carbon dioxide absorption features. In addition, there may be enough information to break degeneracies between gaseous absorption and absorption/scattering by cloud. EChO could be the mission to finally solve the mystery of this fascinating planet, due to its continuous coverage between 0.5 and 16 microns, and this example shows that it will be an asset for further exploration of the super-Earth parameter space.