New Avenues in Atmospheric Modelling of Exoplanets

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Abstract

We are entering the era of high-precision and high-resolution spectroscopy of exoplanets. Such observations require robust self-consistent spectral models of exoplanetary atmospheres to investigate intricate atmospheric processes and to make observable predictions. Thus there is a growing need for a new generation of models custom-built for exoplanets over a wide planetary parameter space that incorporate state-of-the-art numerical methods, opacities and conditions not seen in the solar system. We discuss a new self-consistent atmospheric modelling code, GENESIS, which models radiative-convective and chemical equilibrium atmospheres of exoplanets. We also highlight some new developments and challenges in the modelling of such planets. We investigate models of irradiated and non-irradiated planets over a range of C/O ratios and metallicities to determine the spectra and P-T profiles of such objects. In light of new high quality datasets, we introduce a new paradigm of exoplanetary remote sensing whereby a self-consistent equilibrium model is coupled with an inverse atmospheric retrieval code to allow constraints on disequilibrium processes. We use such an approach to constrain radiative-convective as well as chemical disequilibria in hot Jupiters using thermal emission spectra. We highlight the importance of both advanced numerical methods and techniques as well as the application to observations to understand the processes that occur in exoplanetary atmospheres.

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