Interpretation of low resolution optical and IR exoplanetary measurements

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Efforts to constrain the molecular abundances to within several orders of magnitude are thwarted by the degenerate effects that the temperature and composition have on the emission spectra, recorded during secondary eclipse. Similarly, transmission spectra recorded during primary transit, while less sensitive to atmospheric temperatures, provide a degenerate set of solutions, because the composition derived is highly dependent on the assumed radius. Problems in the interpretation of both spectra also arise from the potential variability of host stars. Yet these problems can be surmounted by the combination of selected wavelength sampling of optical and IR measurements and when possible the joint analysis of transit and secondary eclipse data of exoplanets. Here we explore the nature of the degenerate solution sets resulting from the interpretations of measurements of ``Hot Jupiter'' exoplanets from radiative transfer models, analytical approximations and data. As demonstrated with simple analytical expressions, primary transit measurements probe roughly 4 atmospheric scale heights at each wavelength band. Derived mixing ratios are sensitive to errors in the assumed radius in planet (at a reference pressure), which depends on the line regime (whether the strong or weak line limit) and the atmospheric scale height. (For example, a 1000 K H$_2$-based exoplanet with Jupiter's radius and mass , an uncertainty of 1\% in the planet's radius causes an uncertainty of 100 in the derived optical depth.) Temperature degeneracies, manifesting their effects through the scale height and absorption coefficients, are smaller for primary transit data. Simple radiative transfer models of exoplanetary data indicate the advantages of coupled analyses of primary and secondary transit measurements. The current understanding of exoplanets, both observations and theory, taken together, indicate the need for both space-based large mirror platforms (e.g. JWST) and smaller survey telescopes.