Transmission and emission spectra of three cool exoplanets

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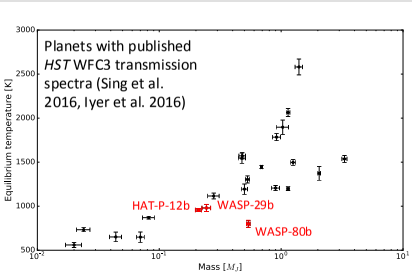
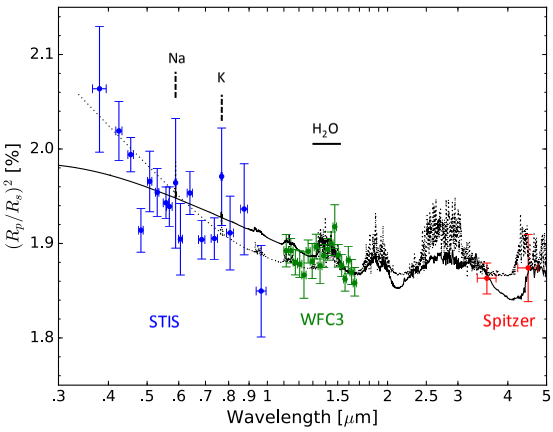
The dependence of atmospheric composition on planetary properties and the conditions in which clouds and hazes form remain poorly understood. Transmission spectroscopy helps us study the effects and prevalence of clouds and hazes and yields constraints on atmospheric metallicity and the abundances of a wide range of absorbing species. Analyzing the thermal emission spectra of planets using secondary eclipse photometry provides an independent constraint on metallicity and offers a complementary picture of the dayside atmosphere in a wavelength range where high-altitude clouds are optically thin.

We present new preliminary *HST* Wide Field Camera 3 (WFC3) transmission spectra and *Spitzer* emission spectra for three cool exoplanets, as part of a large program to analyze the transmission spectra of planets spanning a broad range of masses and temperatures.

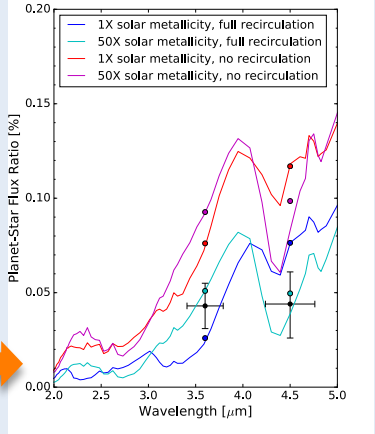


HAT-P-12b: *a low-density 0.21 M_{Jup} sub-Saturn (Hartman et al. 2009) with a moderately enhanced metallicity, efficient day-night recirculation, and a water vapor absorption feature visible through thick clouds/hazes*



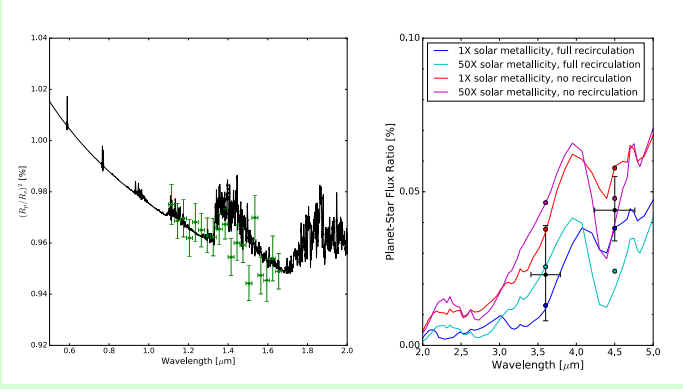
Solid line: ATMO model atmosphere (Tremblin et al. 2015, 2016) with enhanced metallicity and high haze opacity.
Dotted line: Solar composition atmosphere with an opaque cloud deck at 1 mbar and a haze with 600 times the absorption of H_2 Rayleigh scattering (Fortney et al. 2008, 2010). In both cases, the water absorption feature at 1.4 microns is visible through the haze

Comparison of the measured Spitzer secondary eclipse depths with 1D radiative transfer models (Fortney et al. 2008). The data is consistent with efficient recirculation and moderately enhanced metallicity



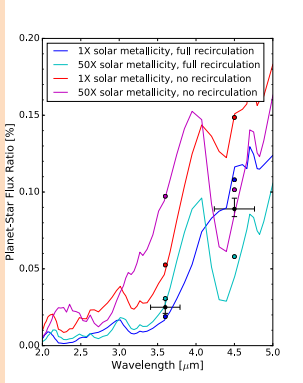
[Global fit of 2 eclipses at 3.6 μm and 2 eclipses at 4.5 μm]

WASP-29b: *a 0.24 M_{Jup} sub-Saturn (Hellier et al. 2010) with roughly solar metallicity, moderately efficient day-night recirculation, and very strong hazes*



The transmission spectrum model shown assumes solar composition and a very strong haze with 1000 times the absorption of H_2 Rayleigh scattering.
Eclipse data are from a global fit of 1 eclipse at 3.6 μm and 1 eclipse at 4.5 μm.

WASP-80b: *a 0.54 M_{Jup} warm gas giant (Triaud et al. 2013) with somewhat enhanced metallicity and efficient day-night recirculation*



[Global fit of 4 eclipses at 3.6 μm and 2 eclipses at 4.5 μm, including data previously published in Triaud et al. 2015]