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Testing the Effects of Metallicity on the Atmospheric Chemistry of Exoplanets

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Abstract

Observations of transiting planets at secondary eclipse allows their dayside thermal emission to be separated from that of the host star. Such measurements are critical to our understanding of exoplanet atmospheres since a planet's thermal spectrum is determined by its temperature structure and composition.

Results for hot Jupiter planets have shown that spectra often deviate significantly from blackbodies. In some cases planetary spectral features are seen in absorption, in line with early theoretical expectations, however in others spectral emission features are seen. In these cases it is thought that an opacity source high in the atmosphere results in a hot stratosphere and that molecular bands are driven into emission by the temperature inversion. However, the nature of this opacity and the mechanism behind its presence or absence from the upper atmosphere are still being debated. Initial work suggested a split between inverted and non-inverted atmospheres based on planetary irradiation levels, but more recent observations have not been consistent with this, implying other parameters are playing a significant role.

One possibly important parameter on the emission spectrum of an exoplanet is its metallicity. Since potential inversion-driving opacity sources are expected to be less prominent in low metallicity atmospheres, we can hypothesise that such planets will lack temperature inversions (and vice-versa). In order to test this we carried out secondary eclipse observations of planets orbiting metal deficient host stars using the Spitzer Space Telescope's Infrared Array Camera. While it is not expected that gas giants have the same metallicity as their hosts, we used host star metallicity as a proxy for the planet since a correlation seems likely. For each of our 3 targets we detect thermal emission at 3.6 and 4.5 μm, and we characterise the spectral slope across these bands, which has been shown to relate to the nature of the inversion. Adding this to data already in the literature, our initial results show tentative evidence for a correlation between host-star metallicity and the $3.6-4.5$ μm spectral slope.

1. Figures

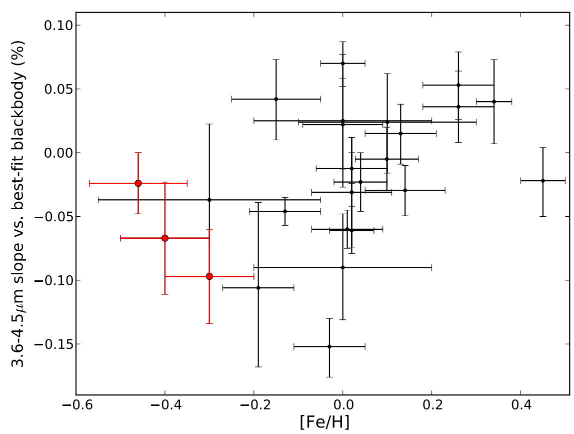

Figure 1: $3.6-4.5$ μm slope *vs.* host-star metallicity for hot Jupiter exoplanets. Red points are our sample of low metallicity planets. A tentative correlation can be seen, with planets orbiting low-metallicity hosts displaying shallower $3.6-4.5$ μm slopes, as expected from spectral absorption features.