Ground-based secondary eclipse observations of HAT-P-1b

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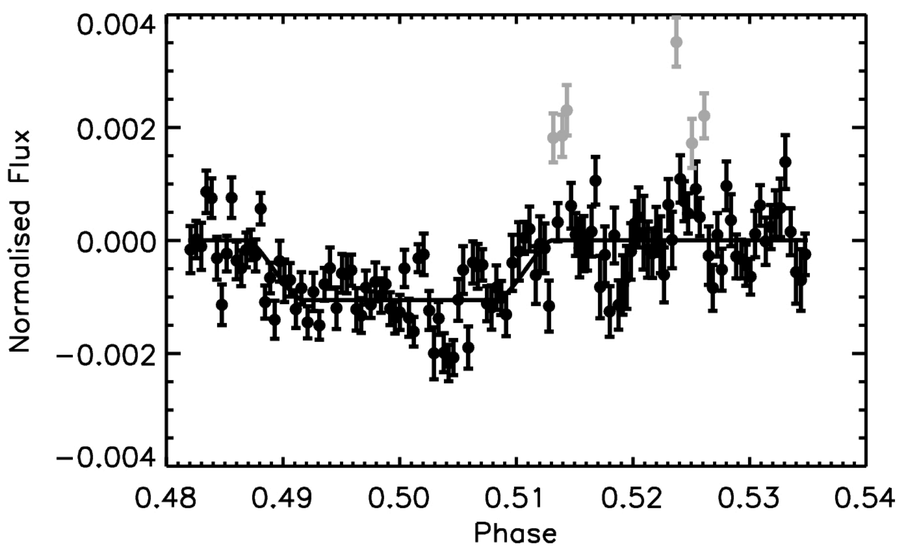
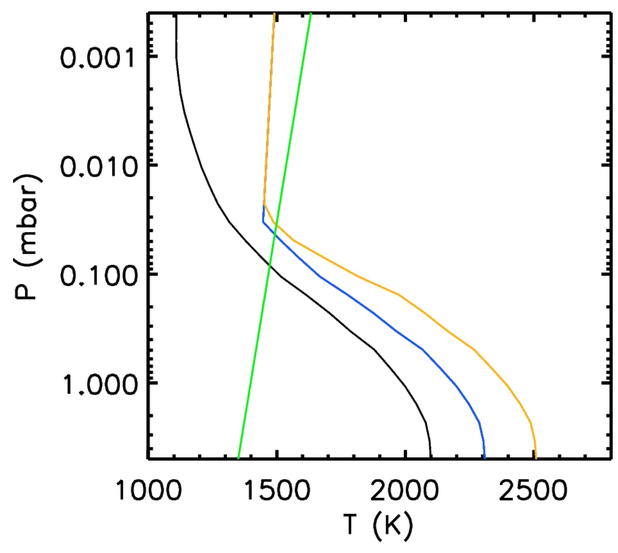
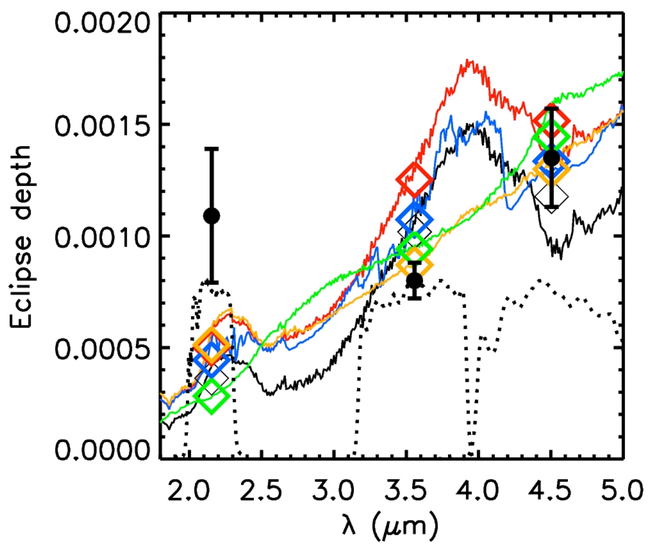
Abstract:
Here we show the results of observations of the secondary eclipse of the hot-Jupiter HAT-P-1b with the WHT. We find an eclipse depth of **0.105 ± 0.03 %**, where the main uncertainty comes from different treatment of systematic effects, especially the determination of the background.







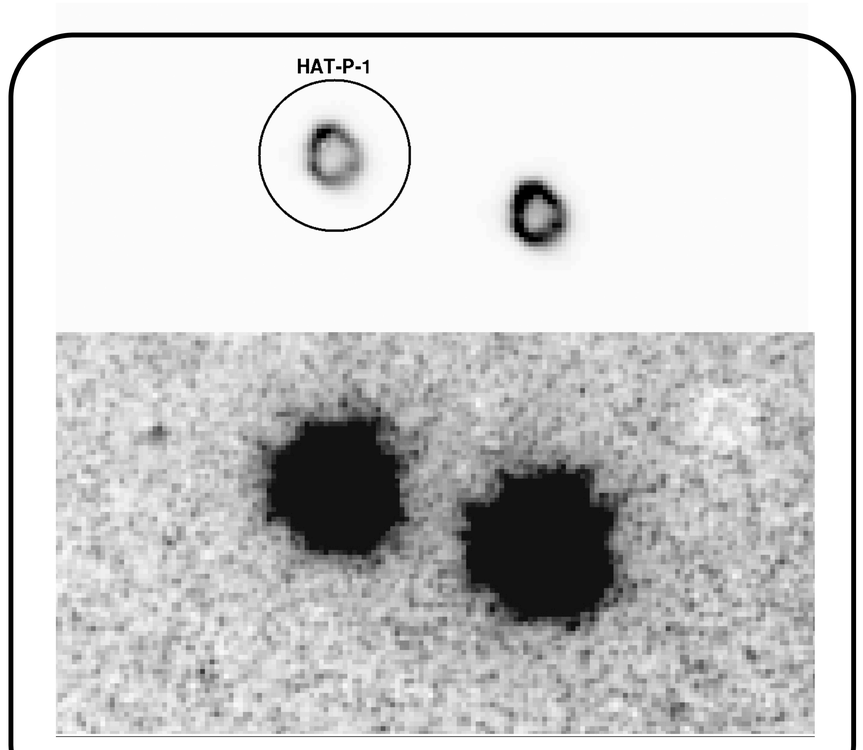
Results

We simultaneously fit for systematic effects as well as the eclipse depth (modeled using the prescription from Mandel and Agol (2002)). The binned lightcurve, corrected for systematic effects, with the best fitting secondary eclipse model overplotted is shown on the top left.

By combining our data with Spitzer IRAC measurements at 3.6μm and 4.5μm from Todorov et al. (2009), we can construct the spectral energy distribution from 1.8μm to 5μm. This SED is shown in the top right figure. Overplotted in this figure are several models for the atmosphere of HAT-P-1b, using different temperature pressure profiles (shown above in the middle figure) and compositions. Our Ks-band observation is brighter than the models at the 2σ-level. We caution, however, that it is difficult to determine the true uncertainties for these observations

Observations

We have used the William Herschel Telescope (WHT) to observe the secondary eclipse of HAT-P-1b. The observations were performed in staring mode and lasted for 6.5 hours, although we only use the first 5.7 hours, because after that time, there was a gap in the observations, because the observer got locked in a bathroom. A total of 5300 frames were obtained during this period, of which ~2740 were measured during the eclipse. We significantly defocused the telescope to allow for the observation of this very bright star, a typical image is shown to the right, where we show both the structure at high and low count-levels.



PSF of our observations

Data reduction:

The images were corrected for non-linearity prior to flatfielding with a domeflat. We subsequently performed aperture photometry, on both HAT-P-1b and the bright star located ~11” away, using an aperture of R=14 pixels (~3.5”).

Due to the close separation between the two stars, and the fact that the WHT is an Alt/Az telescope, the spokes from one stars will periodically contaminate the flux from the other star. We measure this contamination using an aperture which is offset from the star by the same amount as the other star, and scaling the flux by the measured flux-ratio, and subtract that value from the flux of the stars. We remove a hot-pixel in the PSF of HAT-P-1 by measuring the flux on the same region of the reference star, and scaling this with the flux ratio of the two stars.

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References: Todorove et al., 2010, ApJ 708, 498
Mandel & Agol, 2002, ApJ 580, L171;