Secondary Eclipses of Hot-Jupiter HAT-P-16b

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Abstract

HAT-P-16b is a hot (equilibrium temperature 1626 ± 40 K, assuming zero Bond albedo and efficient energy redistribution), 4.19 ± 0.09 Jupiter-mass exoplanet orbiting an F8 star every 2.775960 ± 0.000003 days (Buchhave et al 2010). We observed secondary eclipses at the 3.6 µm and 4.5 µm channels of the Spitzer Space Telescope's Infrared Array Camera (program ID 60003) and measured eclipse depths of 0.135% ± 0.013% and 0.211% ± 0.015%, respectively, with corresponding planetary brightness temperatures of 1817 ± 81 K and 1965 ± 89 K.

Methodology

HAT-P-16b was analyzed using our pipeline, Photometry for Orbits, Eclipses, and Transits (POET). The pipeline is described in detail by Campo et al. (2011). POET begins by correcting for *Spitzer* systematics and removing bad pixels. A two-dimensional Gaussian fit determines the center of the star in each frame and interpolated aperture photometry is then performed. The best aperture is selected by finding the minimum standard deviation of the normalized residuals (SDNR) of all apertures, and ramp models are compared via the minimum Bayesian Information Criterion (BIC). For HAT-P-16b, the best results were obtained without a ramp model. We then use BLISS mapping (Stevenson et al 2012) to correct for the intrapixel effect present in the data. POET utilizes Markov chain Monte Carlo to determine uncertainties and correlations between parameters.

Results

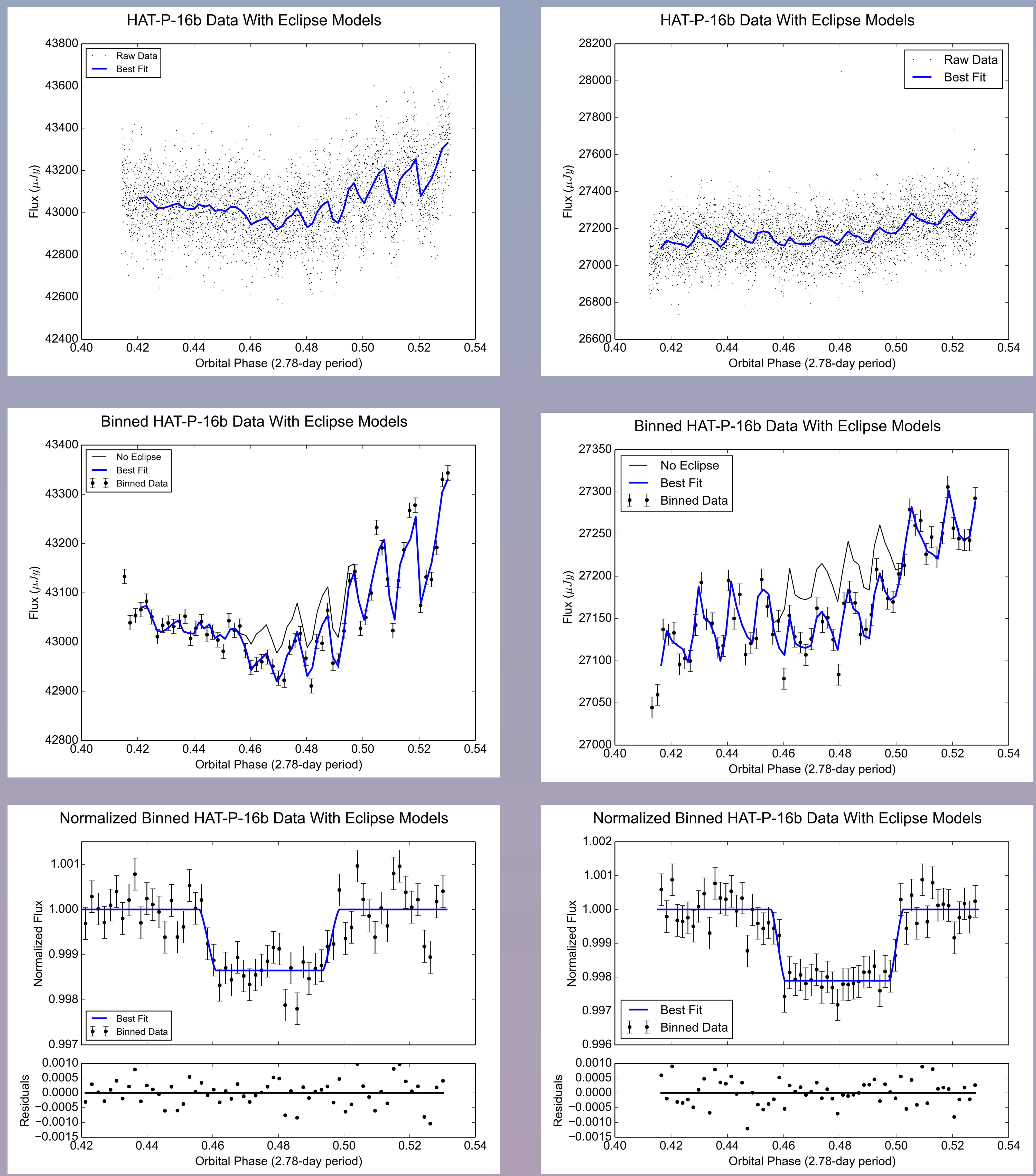

Figure 1 (above): Raw (top), binned (middle), and normalized (bottom) eclipse light curves for HAT-P-16b. The blue line is the eclipse model, while the black line (in the middle panel) simulates a curve with no eclipse. Panels on the left and right represent the 3.6 µm and 4.5 µm *Spitzer* channels, respectively.

Parameter	Channel 1 (3.6 µm)	Channel 2 (4.5 µm)
Eclipse Depth (%)	0.1351 ± 0.0129	0.2105 ± 0.0151
Brightness Temperature (K)	1817 ± 81	1965 ± 89
Eclipse Midpoint (orbits)	0.4772 ± 0.00061	0.4790 ± 0.00048
BIC Value	3638.2	3779.1
SDNR	0.002741	0.003704

Table 1: Select best-fit light curve parameters from the 3.6 µm and 4.5 µm *Spitzer* channels. The data are consistent with a blackbody, as the two brightness temperatures are within 1σ of each other.

What Comes Next?

Subsequent analysis of HAT-P-16b will be performed through the application of our open-source Bayesian Atmospheric Radiative Transfer (BART) code (Harrington et al 2015). BART consists of three separate modules, which determine thermochemical equilibrium abundances (TEA), perform line-by-line radiative-transfer calculations (Transit), and implement Markov chain Monte Carlo statistics for model-data comparison (MCcubed). We will utilize BART to constrain the temperature-pressure profiles and atmospheric molecular abundances of HAT-P-16b.

References

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Campo et al 2011ApJ...727...125C
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Stevenson et al 2012ApJ...754...136S

A preliminary analysis for HAT-P-16b was presented by Hardin and Foster at DPS 45.
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