Spitzer Observations and BART Analyses of WASP-26 b and CoRoT-1b

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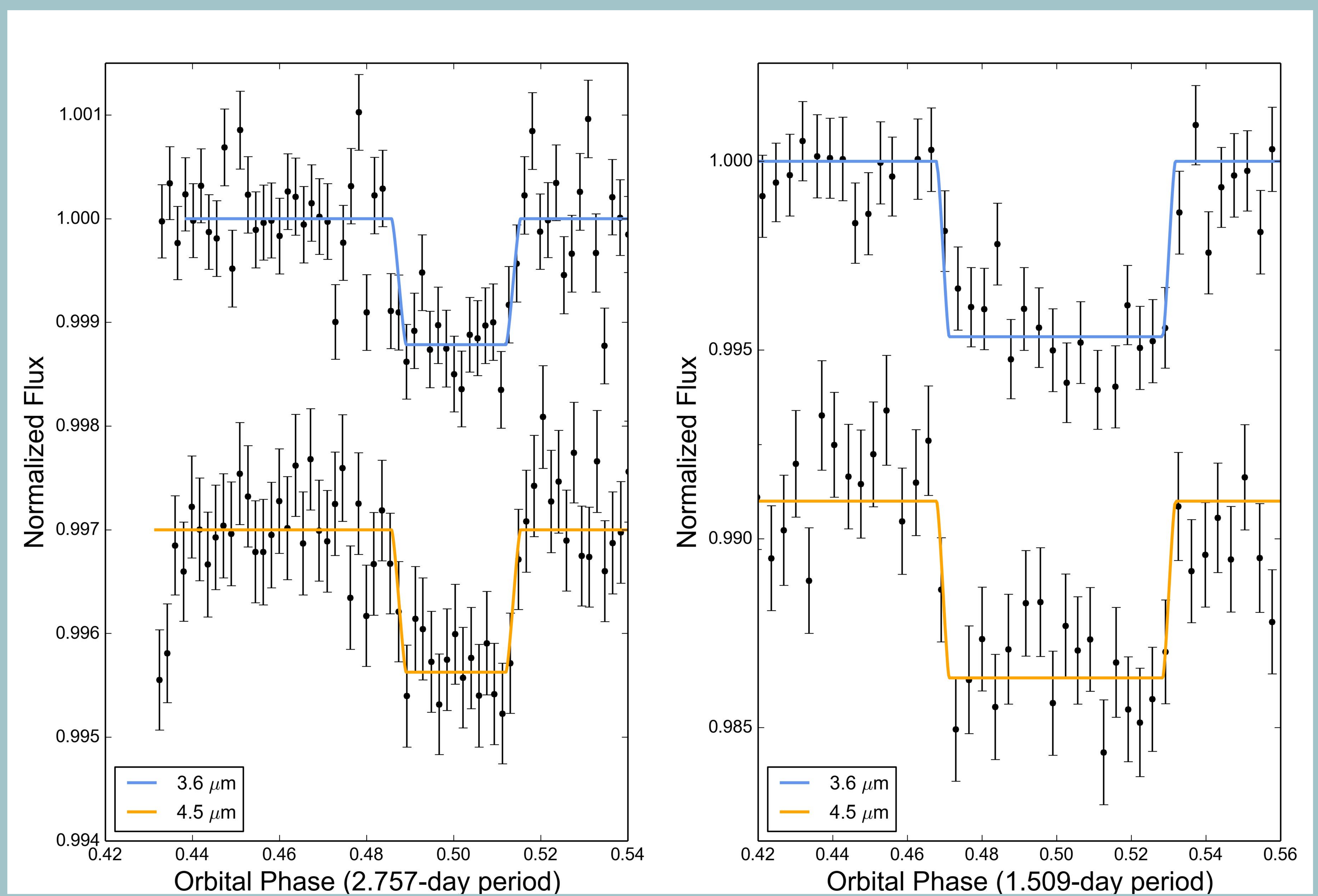
Abstract

WASP-26b is a hot-Jupiter planet that orbits an early G star every 2.7566 days at a distance of 0.03985 AU. Using the Spitzer Space Telescope in 2010 as a part of the Spitzer Exoplanet Target of Opportunity program (program 60003) we observed two secondary eclipses of the planet, one in the 3.6 μm channel on 7 September and one in the 4.5 μm channel on 3 August. We also reanalyzed archival Spitzer data of CoRoT-1b, which is another hot Jupiter orbiting a G star every 1.5089686 days at a distance of 0.0254 AU, in the 3.6 and 4.5 μm channels. The eclipse depths for WASP-26b are 0.00121 ± 0.00025 and 0.00137 ± 0.00023, for the 3.6 and 4.5 μm channels respectively. The eclipse depths for CoRoT-1b are 0.00465 ± 0.00067 and 0.00468 ± 0.00046 respectively. Using our Bayesian Atmospheric Radiative Transfer code, we characterize the atmospheres of these planets. We find roughly isothermal atmospheres for both planets.

	Mass	Radius	Star Type	Metallicity	Equilibrium Temperature
WASP-26b	1.02 ± 0.03	1.32 ± 0.08	G0	-0.02 ± 0.09	1660 ± 46
CoRoT-1b	1.13 ± 0.07	1.48 ± 0.06	G0V	-0.3 ± 0.25	1895 ±56



Final POET light curves for WASP-26b (left) and CoRoT-1b (right)

Planet	Eclipse Depth at 3.6 μm	Brightness Temperature at 3.6 μm	Eclipse Depth at 4.5 μm	Brightness Temperature at 4.5 μm
WASP-26b	0.121 ± 0.025 %	1794 ± 80	0.137 ± 0.023 %	1649 ± 92
CoRoT-1 b	0.465 ± 0.067 %	2462 ± 95	0.468 ± 0.046	2232 ± 114

Acknowledgements

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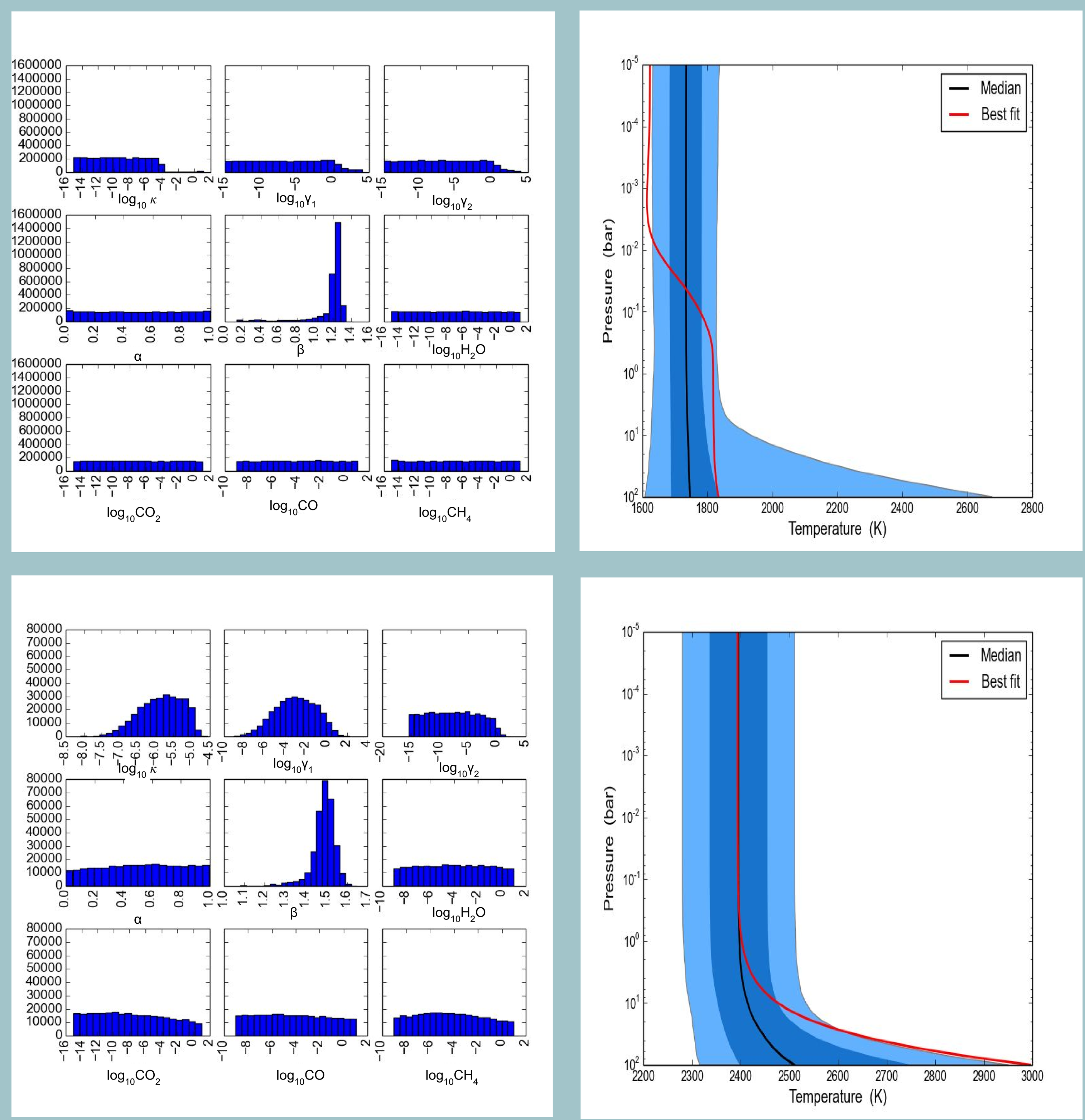
BART

We use the Bayesian Atmospheric Radiative Transfer (BART) code (see poster by Harrington). BART starts with plausible atmospheric abundances provided by the Thermochemical Equilibrium Abundance (TEA) code of Blecic et al. (2016). It then inputs these into an atmospheric model generator, which creates atmospheric profiles, which get passed to our radiative transfer code `transit` (Rojo 2006). `Transit` produces spectra of those atmospheric profiles, which then get integrated to match the data source. These modeled points are then compared to the data points in the MCMC, which produces the next set of parameters to input to the atmospheric model generator.

We use the abundances of H_2O, CO_2, CO, and CH_4. We also use the thermal parameterization of Line et al. (2013), which has five parameters. These are **κ**, the thermal IR opacity, α, the visible two stream partitioning parameter, β , a catch all term representing the albedo, redistribution and emissivity, γ_1 and γ_2,the ratios of the opacities in the visible streams to the thermal stream.



Posterior distributions (left) and PT profiles (right) for WASP-26b (top) and CoRoT-1b (bottom). The dark blue sections of the PT profiles are the 1σ regions and the light blue sections are the 2σ regions.

Conclusions

It is unsurprising that, with two data points that are within 1σ of each other, one finds an isothermal pressure-temperature profile. Two data points cannot strongly constrain nine atmospheric parameters. However, these two absolutely calibrated data points from Spitzer provide a starting point for further atmospheric characterization with ground based or space based data at shorter wavelengths.

References

Blecic, Jasmina et al. 2016. ApJS. 225. 4B.
Rojo, Patricio. 2006. PhD Dissertation.
Line, Michael R. et al. 2013. ApJ. 775. 137L.