A helium exosphere was recently detected around the exoplanet WASP-107b, a low-density, warm Neptune (Spake et al. 2018), based on absorption features from the decay of metastable helium at 10833 Å (predicted by Seager & Sasselov 2000; Oklopčić & Hirata 2018). The helium feature provides a new probe of atmospheric escape that is advantageous in several ways: (1) it is observable with near-infrared facilities (in contrast to other signposts of atmospheric escape that appear in the ultraviolet) and (2) it is minimally affected by interstellar absorption, thus opening the door to studying atmospheric escape in a greater number of systems.

Inspired by the WASP-107b detection, we searched archival HST observations of another evaporating exoplanet, WASP-12b, for signs of a helium exosphere. WASP-12b is a good candidate for this search: it is one of the hottest known hot Jupiters ($T_{\rm eq} = 2500$ K; Hebb et al. 2009). At this level of intense irradiation, theory predicts a high rate of escaping atoms and molecules from the planet's atmosphere, and indeed, transit observations in the ultraviolet have revealed a patchy cloud of escaping material (Nichols et al. 2015).

For this Note, we reanalyzed three transits observations of WASP-12b from the Hubble Space Telescope/Wide Field Camera 3 (originally published in Kreidberg et al. 2015). These observations used the G102 grism, which spans the 10833 Å helium feature. In our analysis, we used the same methodology as Kreidberg et al. (2015), except with different spectral binning to include a narrow band (70 Å, the spectrograph's native resolution) centered on the He feature. The transmission spectrum (shown in Figure 1) is consistent with that reported in Kreidberg et al. (2015) and shows no evidence for variability between epochs. There is no significant increase in transit depth at 10833 Å.

To estimate the expected absorption signal of WASP-12b at 10833 Å, we used the theoretical model described in Oklopčić & Hirata (2018). In this 1D model, the thermosphere of the planet is assumed to be composed of atomic hydrogen and helium in 9:1 number ratio. For the thermospheric density and velocity profiles we adopt the isothermal Parker wind model, assuming the gas temperature of $T = 10^4$ K and the total atmospheric mass loss rate of 4×10^{11} g s^{-1} (based on the results of hydrodynamic simulations of atmospheric escape in WASP-12b by Salz et al. 2016). We use the solar irradiance spectrum as the input spectrum. We consider two cases: one with all the gas included (Model 1), and the other restricted to gas within the Roche radius (Model 2).

We predict a Model 1

Under these assumptions, the calculated population of metastable helium within the Roche radius of the planet produces very little absorption at 10830 Å, consistent with the observed non-detection. However, theoretical results are highly dependent on the assumed geometry and parameters of the model, as well as the input stellar spectrum. Although WASP-12 and the Sun are stars of similar spectral types, WASP-12 shows a much lower level of stellar activity (Haswell 2017), and hence its EUV flux, responsible for populating the metastable helium state, might differ considerably from that of the Sun.

point us to the conclusion that either the gas is dispersed, the star is faint at EUV wavelengths, or both. These factors should be considered in the design of future searches for helium exospheres.

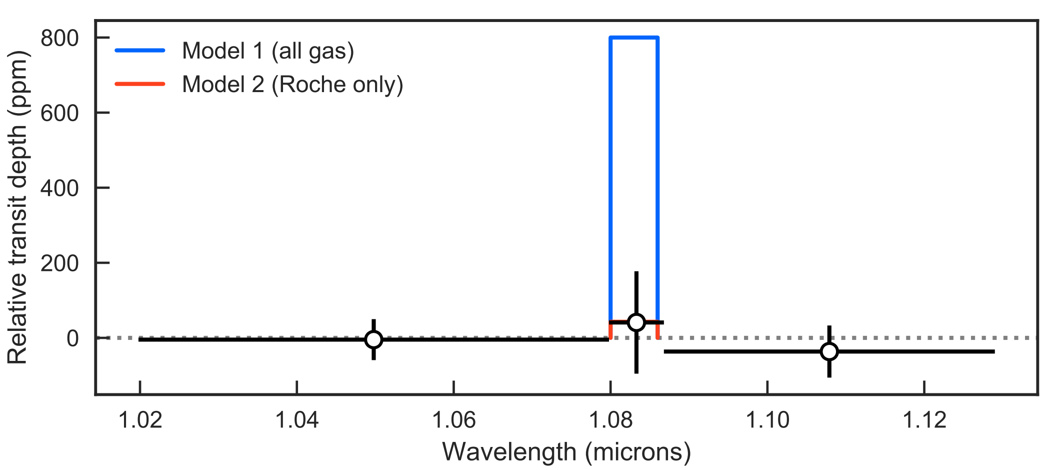

Figure 1. Transmission spectrum of WASP-12b, compared to model predictions for the strength of the 10833Å helium line.

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