TRANSMISSION AND EMISSION STUDIES OF THE EXO-ATMOSPHERE OF HD 189733b

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Abstract: Transmission and emission spectroscopy in the primary transit and secondary eclipse of an exoplanet have proven to be very useful for obtaining information of their atmospheres from both ground-based facilities and space telescopes [1-3]. The Calar Alto high-Resolution search for M dwarfs with Exoearths with Near-infrared and optical Échelle Spectrographs (CARMENES, R=82000, [4]) has recently started observing Hot Jupiter transits in order to study their atmospheres. Here we present a grid of synthetic near-infrared (NIR, 0.96−1.7 μm) transmission spectra of HD 189733b at the CARMENES spectral resolution in order to analyze those measurements. The spectra are computed for the current uncertainty of the atmospheric pressure-temperature profiles (see Figure 1) and abundances for the main absorber in this region, i.e., H_2O. Figure 2 shows an example that clearly presents the two major absorption bands of H_2O at 1.15 and 1.4 μm.
In addition, we are also presenting our analysis of the Hubble Space Telescope's Wide Field Camera 3 (HST/WFC3) measurements of this exoplanet [5]. Figure 3 shows that our best fit is obtained for the coldest profile (p-T 1) and a H_2O volume mixing ratio of $1x10^{-5}$.
Furthermore, we present exploratory results of the emission spectrum of this Hot Jupiter in the infrared and near-infrared. These emission studies are oriented to the analysis of future James Webb Space Telescope measurements.

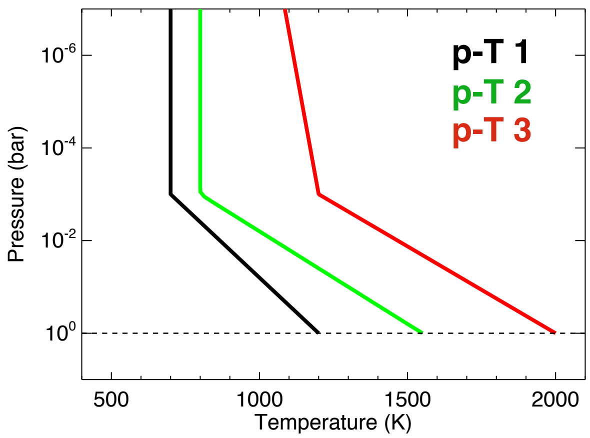

Figure 1: Atmospheric pressure-temperature profiles used for the study of HD 189733b's atmosphere.

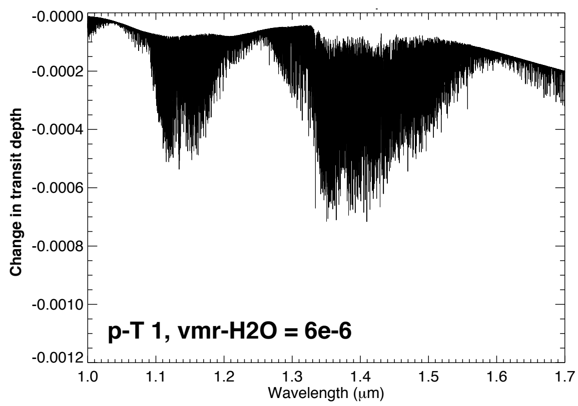

Figure 2: An example of the absorption of water vapour for the coldest atmosphere (p-T 1) and the lowest H_2O volume mixing ratio ($6x10^{-6}$) computed at the CARMENES spectral resolution (of 0.1 cm^{-1}).

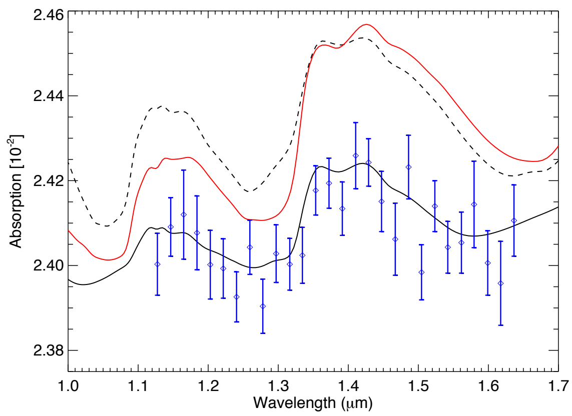

Figure 3: Absorption of water vapour during transit for the coldest (p-T 1 in black, solid and dashed lines indicate H_2O volume mixing ratios of $1x10^{-5}$ and $1x10^{-3}$, respectively) and the hottest atmosphere (p-T 3 in red, solid line indicates a H_2O volume mixing ratio of $1x10^{-5}$). The spectra are computed at the HST/WFC3 spectral resolution (of 100 cm^{-1}). In blue, HST/WFC3's data points and error bars extracted from [5].

Acknowledgments: This work is partly financed by the spanish MINECO through project ESP2014-54362-P.

References:

[1] Madhusudhan N., & Seager S., ***ApJ***, *707*(1), 24, 2009. [2] Snellen I. A. G., *et al.*, **Nature**. 24;465(7301):1049-51, 2010. [3] Brogi M., *et al.*, ***ApJ***, *817*(2), 106, 2016. [4] Quirrenbach A., Amado P. J., Caballero J. A., *et al.*, **SPIE** 9908, 990812, 2016. [5] Madhusudhan N., *et al.*, **ApJ Letters**, 791(1), L9, 2014.