V1298 Tau b: Story of a warm adolescent gas giant

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Introduction

- V1298 Tau b is a young (23 Myr) (David et al. 2019 a,b) [2,3] warm (T_{eq}=677 K), Saturn sized planet
- It orbits a pre-main sequence star, with a period of 24 days. The planetary systems consists of 3 confirmed planets and a fourth Jupiter sized candidate
- First known transiting young multi-planet system
- Presents unique opportunity of atmospheric characterization of a freshly formed product of planet formation

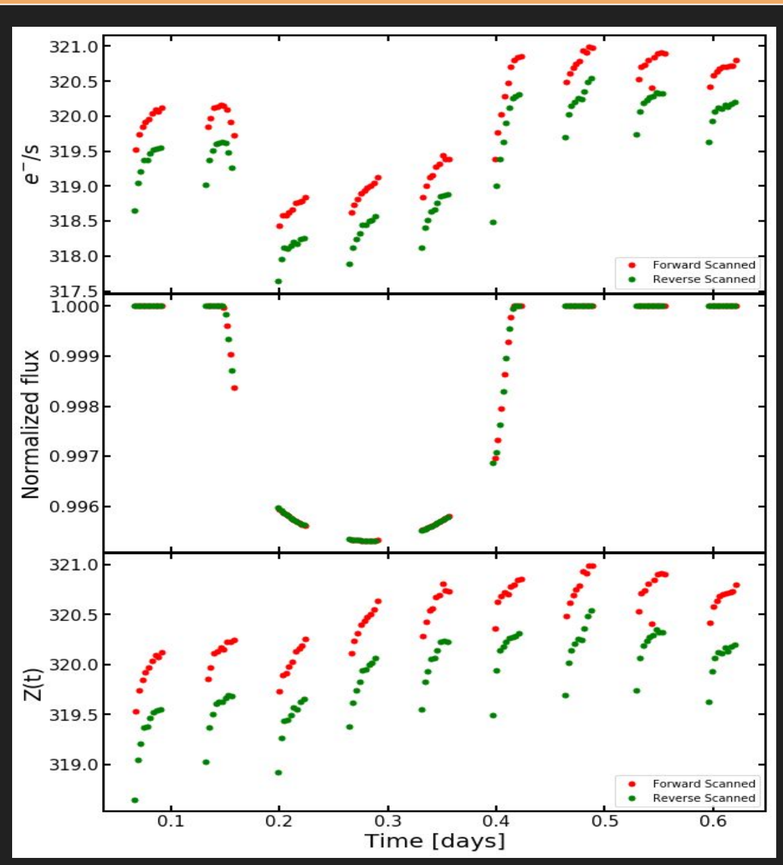

Fig 1: In the upper panel we show the 'white' lightcurve of V1298 Tau b observed with HST/WFC3. In the middle panel we show the best fit transit model for the white lightcurve and in the lower panel we show the systematics function obtained by dividing the white lightcurve by the best fit transit model.

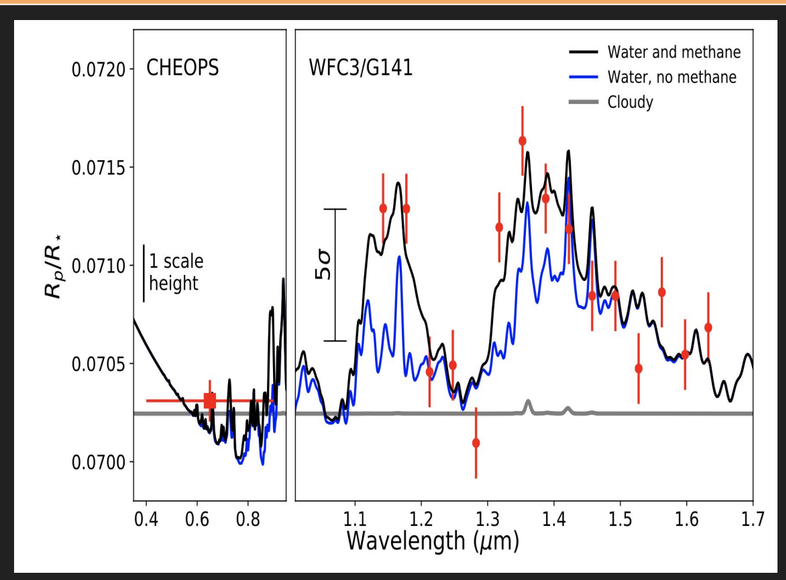

Fig 2: The red points represent simulated transmission spectra of V1298 Tau b generated using the *Pandexo* package and the red square represents a simulated *CHEOPS* observation. The black and blue models are *Exo-Transmit* models for solar metallicity, in case of the blue model methane has been suppressed to highlight the detectability of methane for this planet. We expect a strong water signal for this planet.

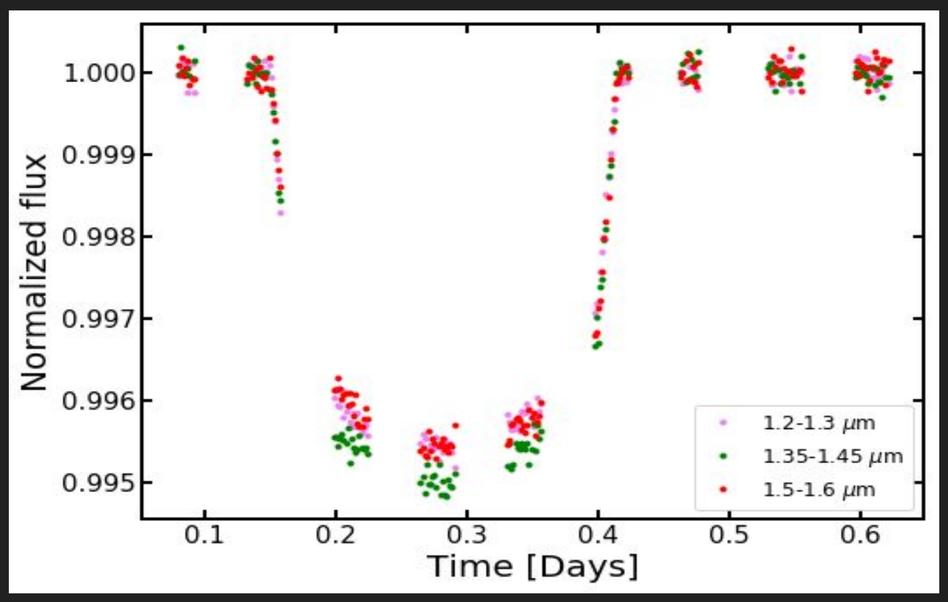

Fig 3: The systematics corrected lightcurves of V1298 Tau b in three bands 1.2-1.3μm (pink), 1.35-1.45μm (green) and 1.5-1.6μm (red). The 'green' band coincides with a water absorption band and hence shows evidence of a deeper transit.

Lightcurve analysis

- We observe one primary transit of V1298 Tau b with HST/WFC3 (1.1-1.7μm) and reduce the observations using a custom pipeline [1]
- We find the white lightcurve to affected by stellar activity such as occulted spots, flares and deviations from standard HST systematics
- We use a common mode **divide-white** approach. In Figure 1 we show the white lightcurve along with the derived systematics function for this observation
- In Figure 3 we show the lightcurves divided into smaller bands and corrected using the common mode approach. Evidence for deeper transit in the 1.35-1.45 μm band indicating the **presence of water vapour** in the atmosphere can be seen

Discussion

- The work to extract the spectra of this planet is ongoing as the main challenge is to understand the weak lined T Tauri star V1298 which shows strong evidence of stellar activity. The simulated spectrum for this planet is shown in Figure 2.
- Proposals to observe V1298 Tau b and c with **JWST** has been accepted, planet c will be observed by HST and we have submitted a proposal to observe planet d with HST. This system offers us the unique opportunity to do comparative atmospheric studies on multiple young planets in the same system

References

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[3] David, T. J., Petigura, E. A., Luger, R., et al. 2019, ApJL, 885, L12