Observational constraints on the atmospheric dynamics of the inspiraling ultra-hot Jupiter WASP-12 b

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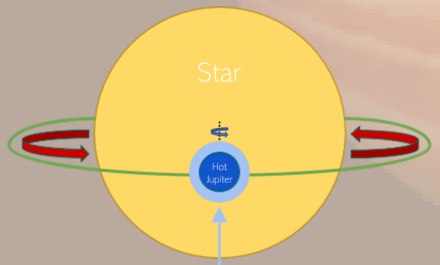
GFORSE

MOTIVATION

- WASP-12 b is an ultra-hot Jupiter known for its inspiraling orbit and extreme tidal distortion.
- Previous works *report empirical evidence of WASP-12 b's mass loss* (Li et al. 2010, Haswell et al. 2012, Jensen et al. 2018).
- Jensen et al. 2018 note that their simultaneous detection of Hα and non-detection of Hβ is inconsistent. This discrepancy remains unresolved.

TRANSMISSION SPECTROSCOPY

We analyze two optical, high-resolution transit data sets from PEPSI (LBT).



The semi-transparent terminator of WASP-12 b's atmosphere will show excess in-transit absorption at wavelengths that correspond to different atomic and molecular species.

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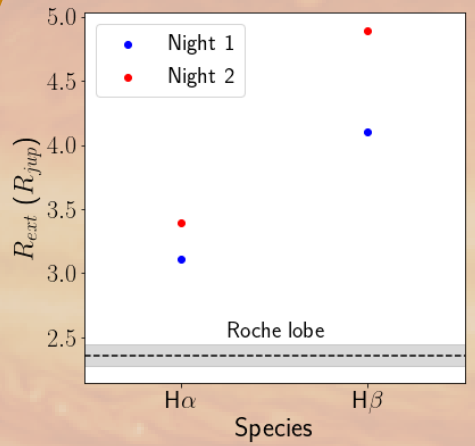
BALMER ABSORPTION ANALYSIS

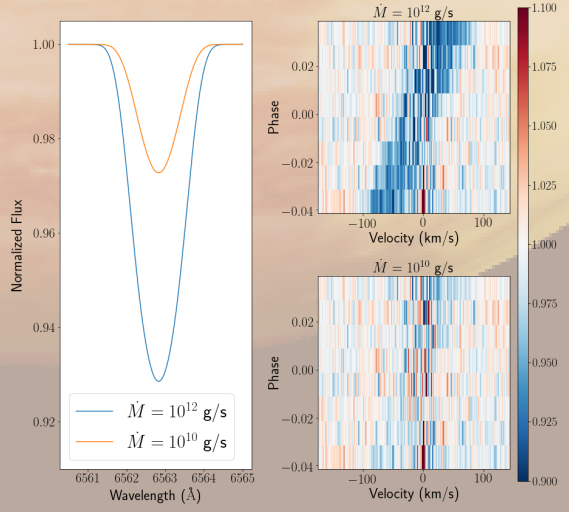


3σ *upper limits on hydrogen envelope*

Contrary to previous literature, we ***do not observe statistically significant detections of Hα or Hβ*** absorption in WASP-12 b's atmosphere.

We run an injection-retrieval analysis to place an upper-limit constraint on the radial extent of WASP-12 b's hydrogen envelope. A 3σ detection of either Hα or Hβ would *not be sensitive down to the planet's Roche lobe* with our data quality. The status of the planet's atmospheric escape is *inconclusive* from this analysis.

We use the `p-winds` code (Dos Santos et al. 2022) to model a planetary outflow in combination with the formalism in Huang et al. 2017 to estimate the Balmer series population levels. We inject the resulting Hα and Hβ absorption signals and find that an outflow rate of $\dot{M} > 10^{10}$ *g/s would produce a detectable (>3σ) Hα signature* under the model assumptions.

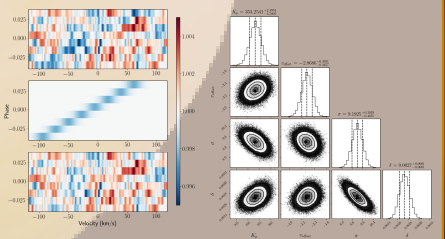


Hα absorption from `p-winds` *model*

COMPARISON WITH JENSEN ET AL. 2018

Upon injecting an Hα signal of comparable strength to the detection in Jensen et al. 2018, we conclude that we should be able to observe such strong absorption (depth ~ 6%) with our data quality. Our non-detection could indicate that WASP-12 b's atmospheric outflow is *time-variable.*

SEARCHING FOR OTHER ABSORBERS



4.7σ detection of Fe I

Species	Detected?
Fe I	✓
Fe II	✗
Ti I	✗
Ti II	✗

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