WASP-69b

A global modelling of helium escape as seen with NIRPS

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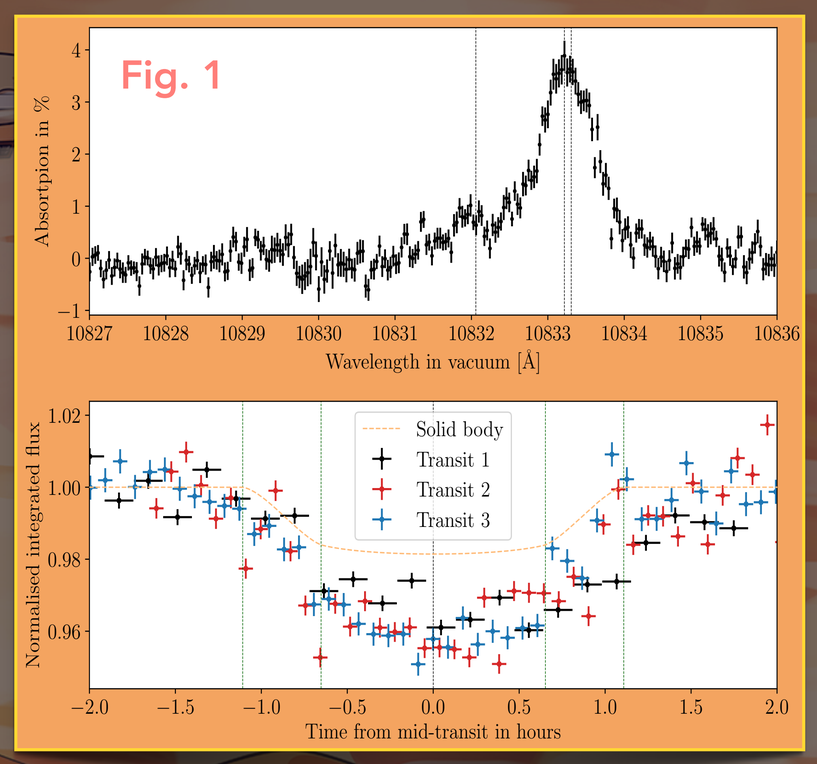
Context

Half of known planets orbit in less than 10 days around their star. Addressing their diversity is tied to the study of the **Neptunian desert and savanna** (a lack of hot Neptunes on short orbits and a milder deficit of warm Neptunes at longer periods), which bear the imprint of **evolutionary processes** (Owen+2018, Bourrier+2023). The desert is sculpted by the **evaporation** of hot Neptunes into smaller planets. Most studies assume **early escape**, kindled during disk-driven migration, yet planets may avoid the **strong irradiation** from their young star by migrating long after formation. The **interplay** between atmospheric evolution and late dynamical migration remains to be explored.

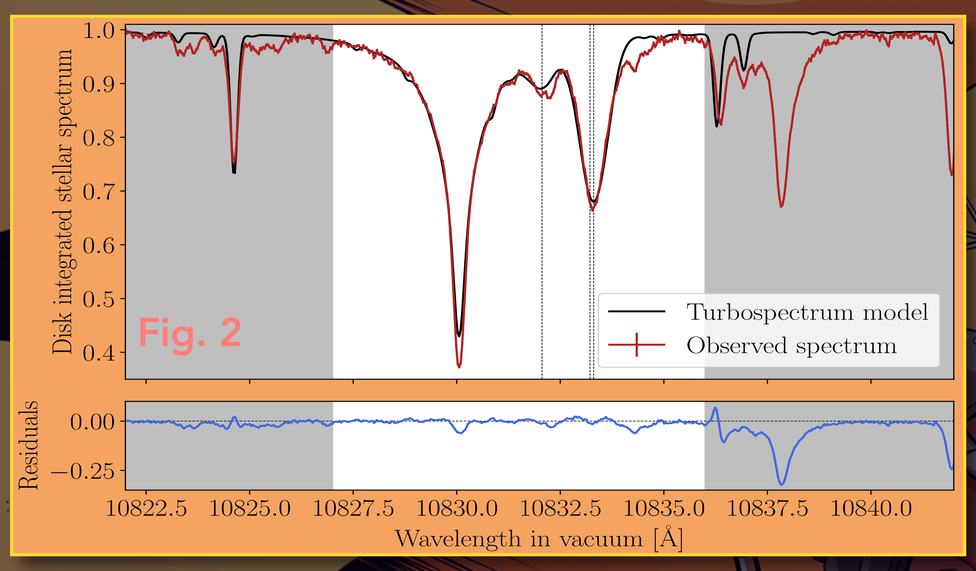
NIRPS and the WASP-69 system

- **NIRPS** (Near Infra-Red Planet Searcher, Bouchy+2017): an **infrared** Radial Velocity spectrograph that covers the range **950 nm-1800 nm** at resolution of $\mathscr{R} \sim 80'000$.
- The 2^3S **Metastable helium triplet** (~ 10833Å): traces the **upper atmospheric layers** of hot exoplanets (Seager+2000 & Oklopčić+2018).
- WASP-69b: a close-in inflated giant of $\sim 1 R_{Jup}$ and $\sim 0.25 M_{Jup}$ & the **first helium observation** of NIRPS (**Fig. 1**).



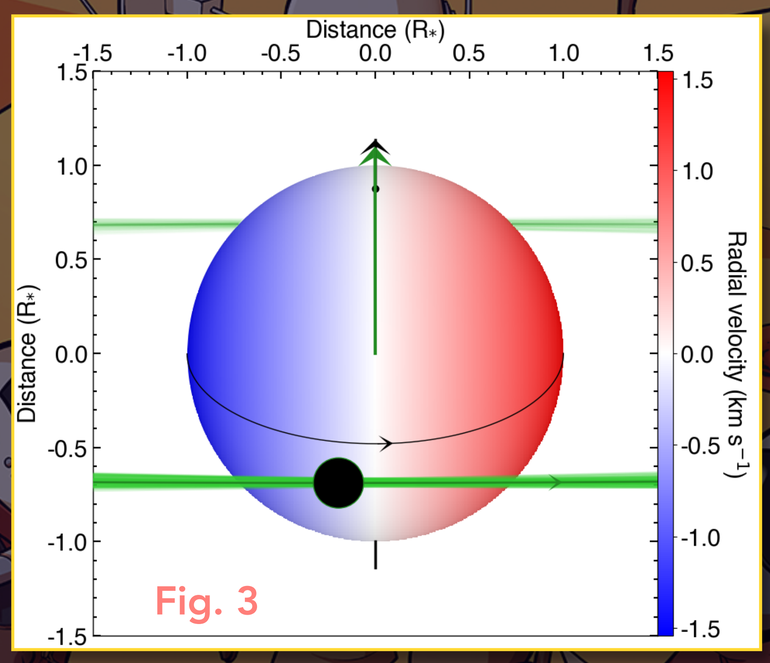
WASP-69 model

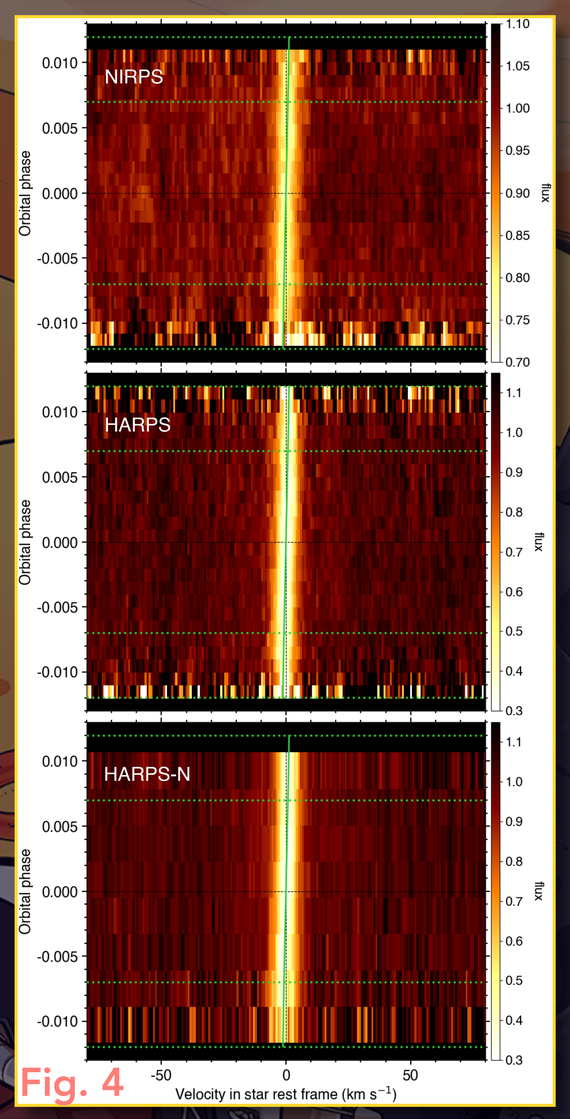
- **Out-of-transit** (stellar) spectrum modelled using a **photospheric** code: *Turbospectrum* (Alvarez&Plez1998).
- Helium triplet originating from the **chromosphere** added on top (**Fig. 2**).
- Stellar grid includes the main **stellar contaminations**: limb-darkening, rotation and centre-to-limb variations.



Orbital configuration

- Combined transits from NIRPS, HARPS, and HARPS-N (**Fig. 4**).
- **Rossiter-McLaughlin Revolutions** (Bourrier+2021) to derive stellar **rotational velocity** & **geometrical configuration** (**Fig. 3**).

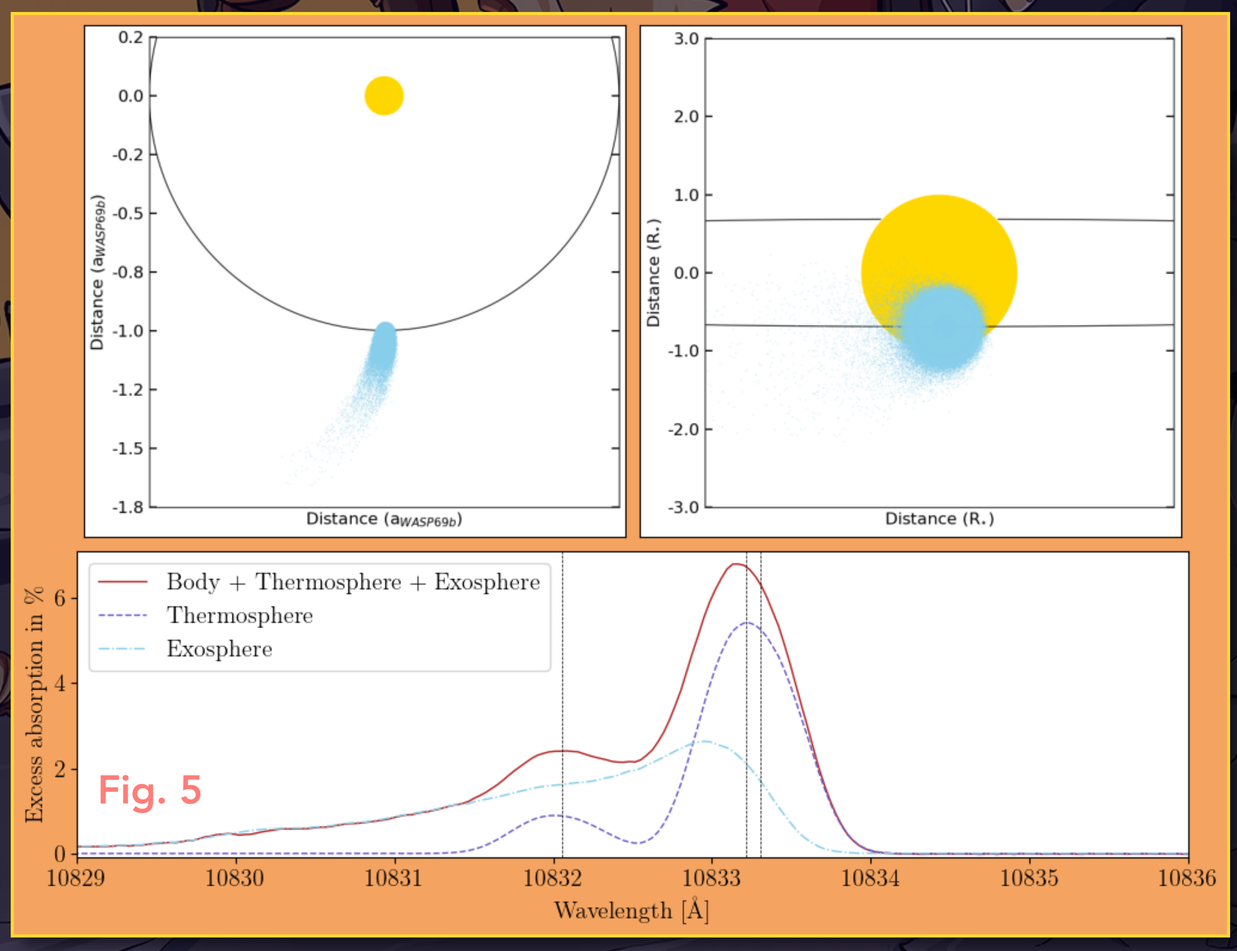




Atmospheric escape

- **Same datasets** to analyse the RM and atmospheric signals: reduces the uncertainties over the absorption signature from **stellar contamination** & **orbital configuration**.
- Transit simulated with the *EVE* code (Bourrier+2013).
- Atmosphere modelled using *p-winds* (DosSantos+2022).
- Signature includes absorption from the **opaque layers**, the **thermosphere** and **escaping helium** (exosphere) at the same time (**Fig. 5**).
- Modeling of the **cometary tail** structure responsible of the post-transit absorption seen in the data.

Work in progress



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