AN ESPRESSO VIEW OF THE HD 189733 SYSTEM

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When a planet transits in front of a star, it induces a radial velocity (RV) anomaly known as the **Rossiter-McLaughlin (RM)** effect. This RV signal has historically been pivotal in **studying the architecture of planetary systems**, serving as the sole method for measuring spin-orbit misalignment angle.

Chromatic RM Technique:

The **Chromatic RM (CRM)** technique **exploits** the **strong dependence of the RM** with the **planetary radius** to measure the transit depth across different wavelengths **to retrieve** the exoplanet's **atmospheric transmission spectrum** (DiGloria et al., 2015). In this study, we utilized **CaRM** (Cristo et al., 2022) for **automated RV extraction and RM effect modeling** with the ESPRESSO data of HD189733 (Fig. a).

Methodology:

First, we extracted and averaged cross-correlation functions (CCFs) per spectral order. Then, we fit white-light velocities to determine wavelength-independent system parameters. Subsequently, **we fit chromatic RVs to construct the transmission spectrum**. To enhance our model, **we upgraded SOAP** (Oshagh et al., 2013) **to account for convective blueshift** (CB; Shporer & Brown, 2011) and **differential rotation** (e.g. Reiners, 2003) effects (**Fig. b**).

Results:

Our results show precise RV fits during transit with the upgraded RM model. We **detected differential rotation** with 93.4% confidence for a narrow equatorial rotation period of the star derived from photometry and 99.6% confidence for a broader prior. The equatorial period was determined to be 11.45 ± 0.09 days. We measured the **true spin-orbit angle to be $\psi \approx 13.6 \pm 6.9°$** and the **stellar rotation axis inclination to be $i_* \approx 71.87^{+6.91°}_{-5.55°}$**. The **convective blueshift velocity** was found to be **$V_{CB} \approx -211^{+69}_{-61}$ m/s**, typical for a K-dwarf star.
The transmission spectrum of HD 189733b shows a **radius decrease with increasing wavelength** (**Fig. c**).

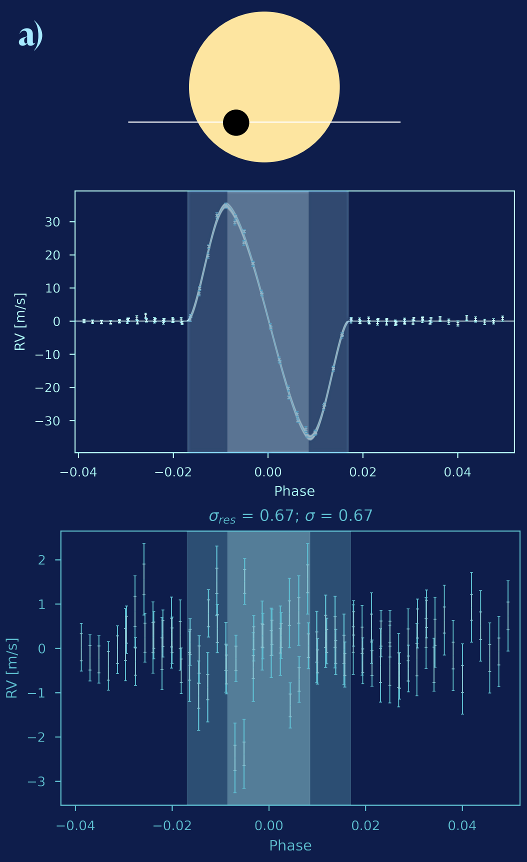
Transmission Spectrum Analysis:

We **used PLATON** (Zhang et al., 2019, 2020) for **forward modeling**, accounting for gas absorption and Rayleigh scattering. The analysis provided **strong evidence for the scattering model**. **Despite** this, some **variations** in the transmission spectrum **remained unexplained**, **potentially** due to **active regions or unidentified species**.

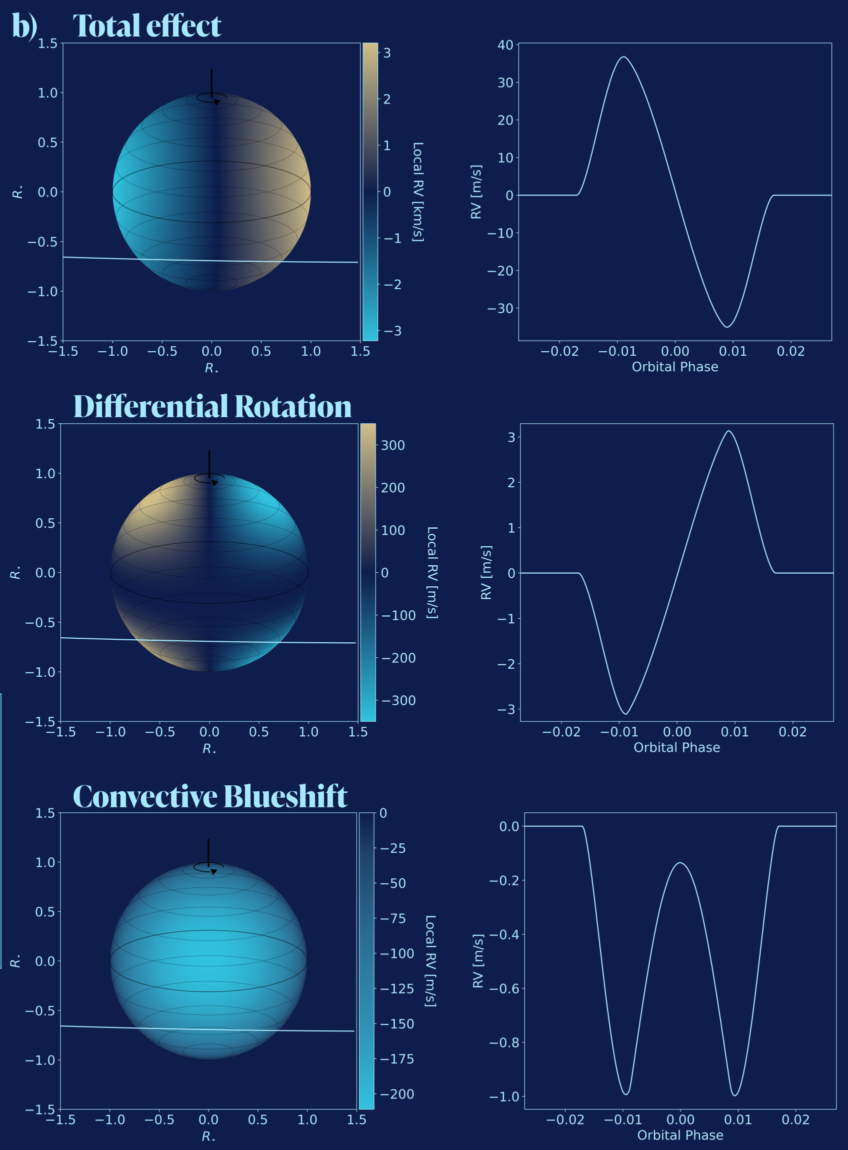
Conclusions:

Our **upgraded Rossiter-McLaughlin** model provided precise radial velocity fits, revealing the **properties** of both the **stellar disk velocities** and **architecture of the system**. The **transmission spectrum** shows a radius decrease with increasing wavelength, suggesting a **scattering-dominated atmosphere**, with some variations remaining unexplained.

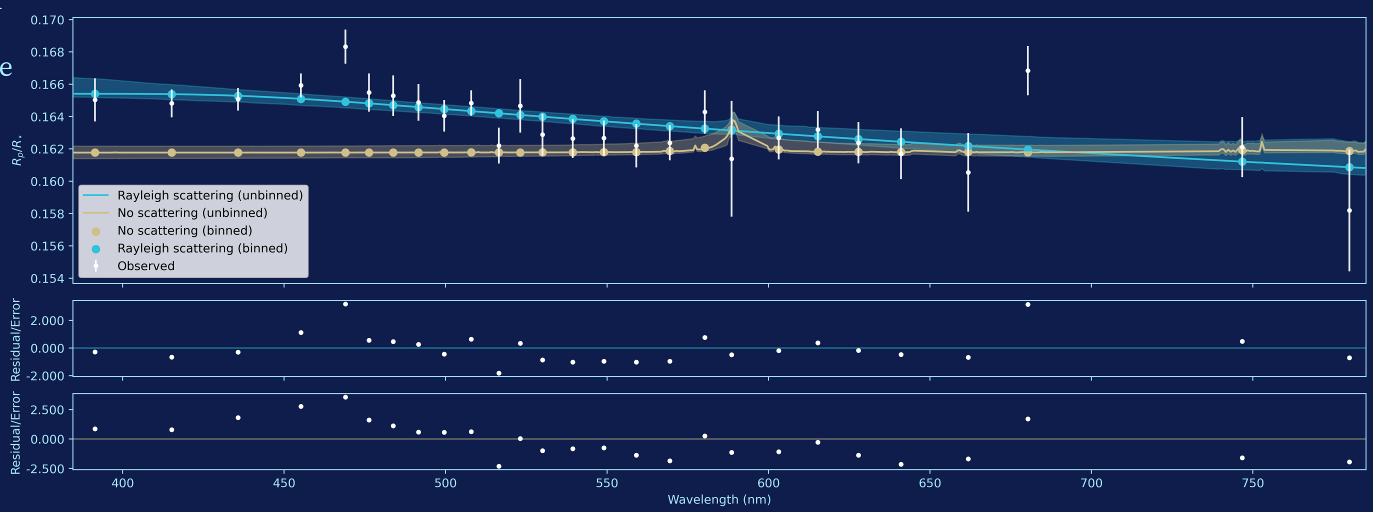
a)



b)



c)



This poster is based on the results of "An ESPRESSO view of the HD 189733 system. Broadband transmission spectrum, differential rotation, and system architecture" by Cristo+2024. **Check me!**

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