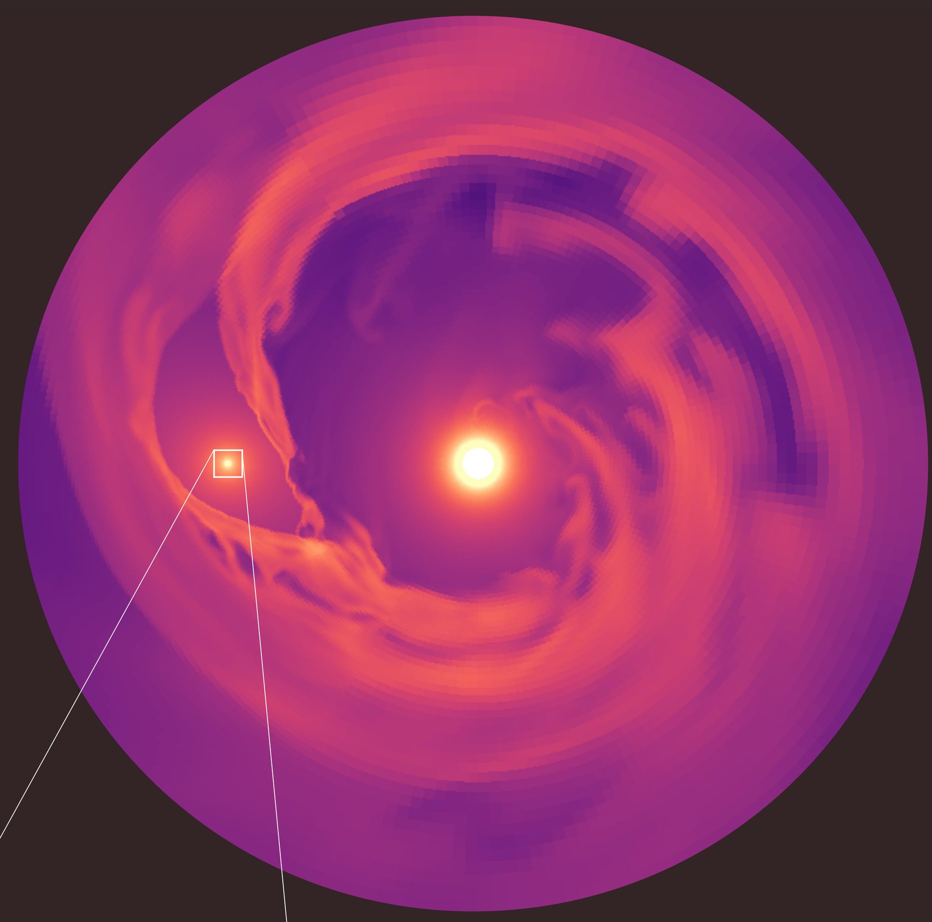
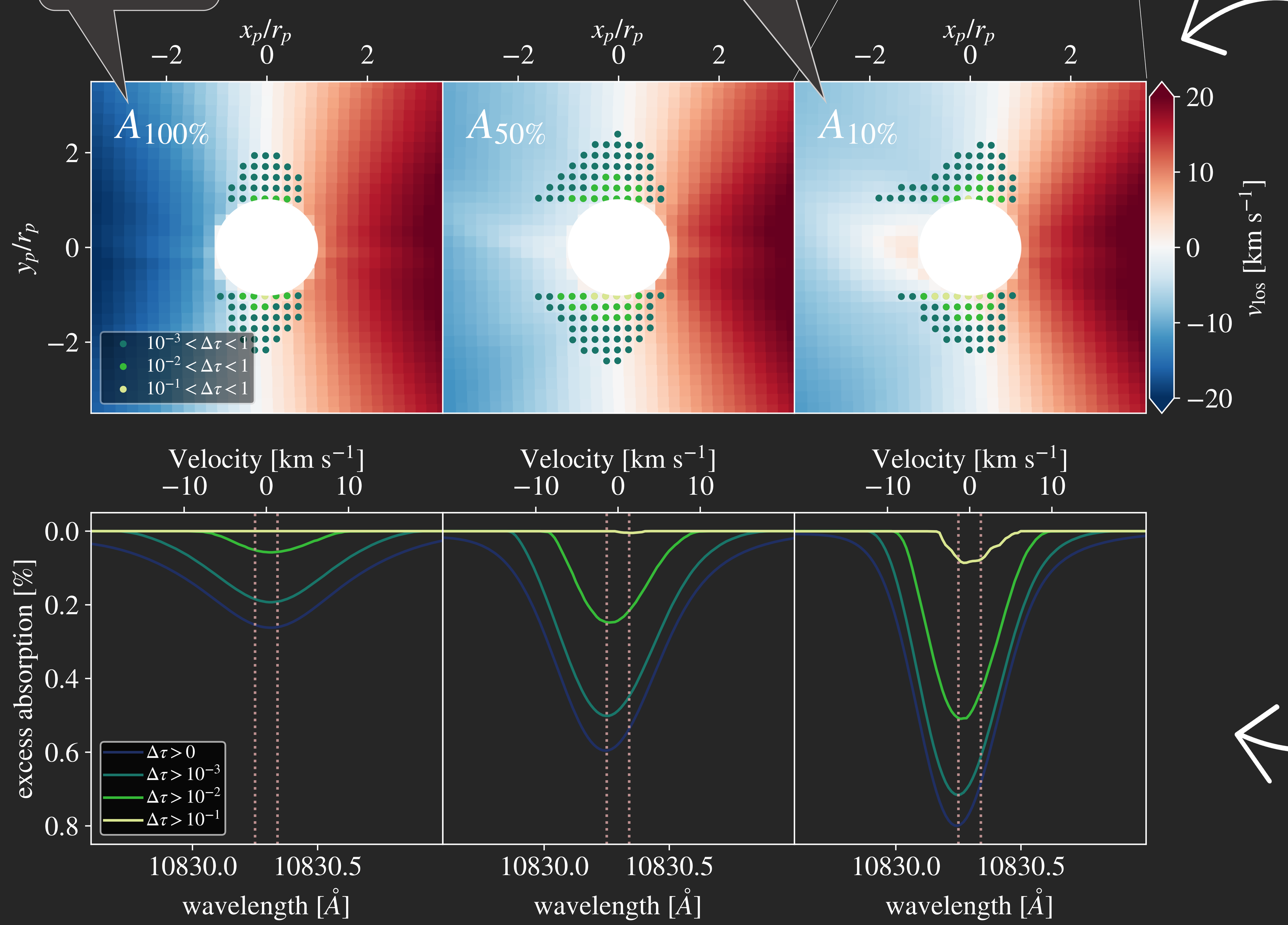
ANISOTROPIC PLANETARY WINDS

The escape of atmospheres from short-period exoplanets is crucial in shaping the characteristics of observed planetary populations. Most helium observations at 1083 nm exhibit a blueshift, suggesting a possible flux from the planet's day to night side.



We hydrodynamically simulate the interactions between planetary and stellar winds in 3D. Applying a radiative transfer analysis, we generate synthetic helium spectra. We find a correlation between anisotropy and line properties.



Close-in and tidally locked planets should have an enormous **temperature difference between the day- and night side.**

As the degree of night-to-dayside anisotropy increases, the helium line at 1083 nm becomes more **narrow and blue-shifted.**

Fig. 1 – *Top:* 2D slice of the planet in the orbital midplane, anisotropy increasing from left to right. *Bottom:* The red component of the metastable helium triplet, calculated only from cells that reach a certain threshold in optical depth.

The velocity shifts found are in the range of observational measurements of gas giants.

Models with varied stellar wind strength (A weak, B intermediate, C strong), orbital distance D, and planetary hydrodynamic escape parameter L

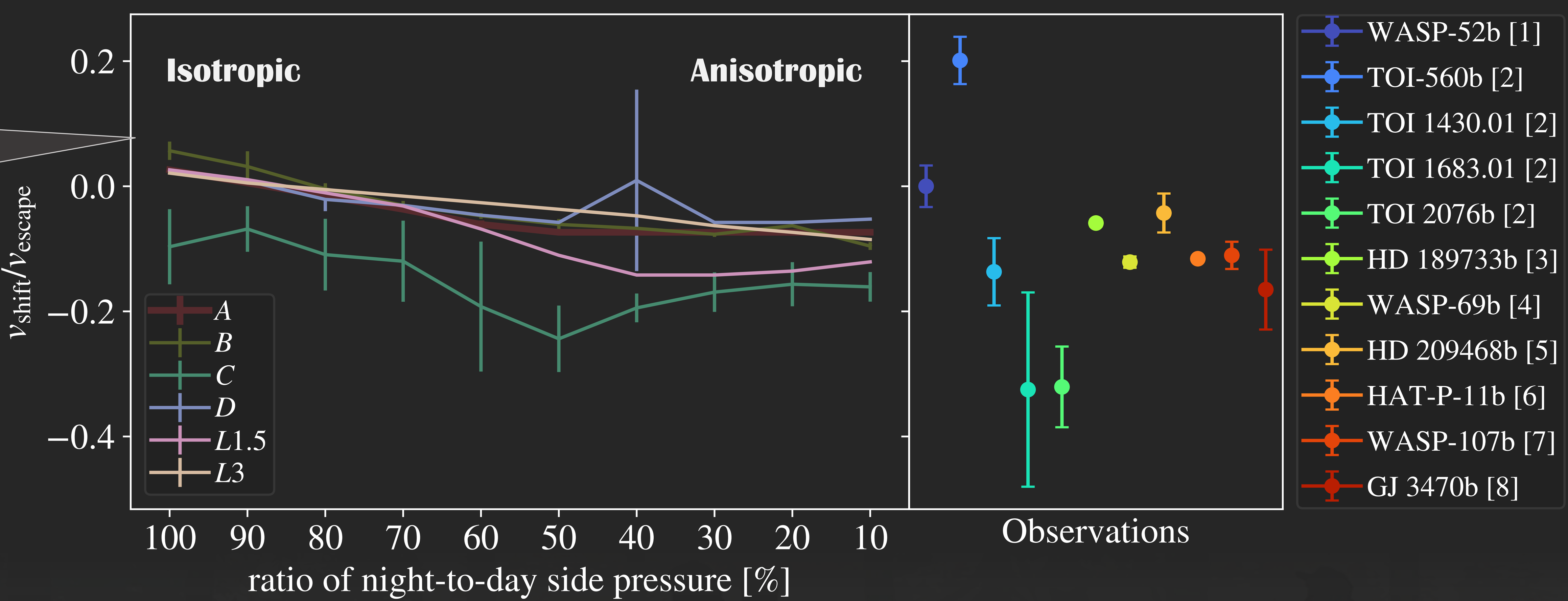


Fig. 2 – *Left:* The mid-transit velocity shift of the helium 1083 nm line as a function of the night-to-day side pressure ratio. *Right:* In comparison, the observational measurements of the helium velocity shift during mid-transit.

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[1] Kirk et al. (2022), [2] Zhang et al. (2023), [3] Salz et al. (2018), [4] Nortmann et al. (2018), [5] Alonso-Floriano et al. (2019), [6] Allart et al. (2018), [7] Kirk et al. (2020), [8] Palle et al. (2020).

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