Studying the upper atmosphere of exoplanets with LUVOIR – hot Jupiters and star-planet interaction

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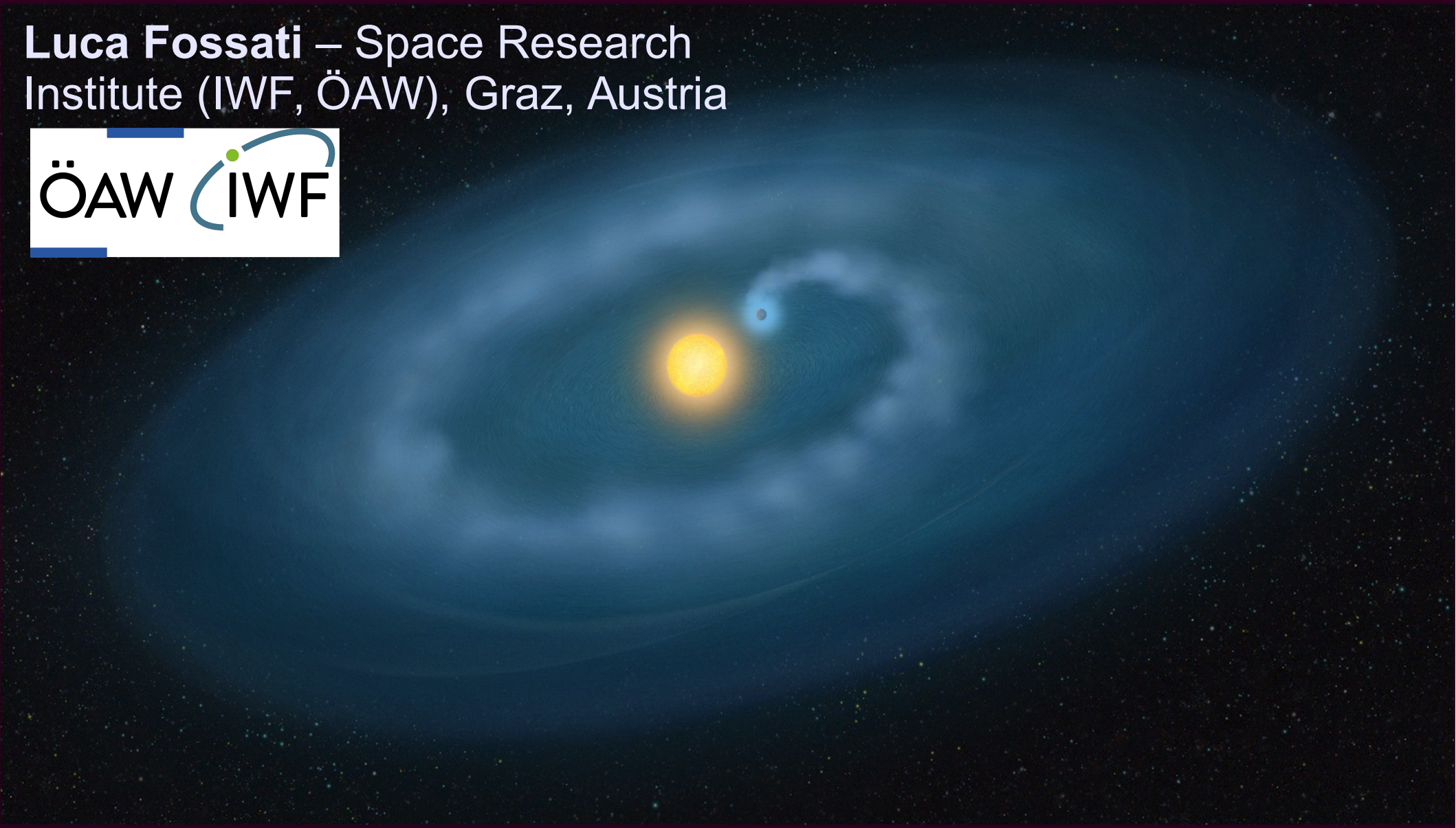
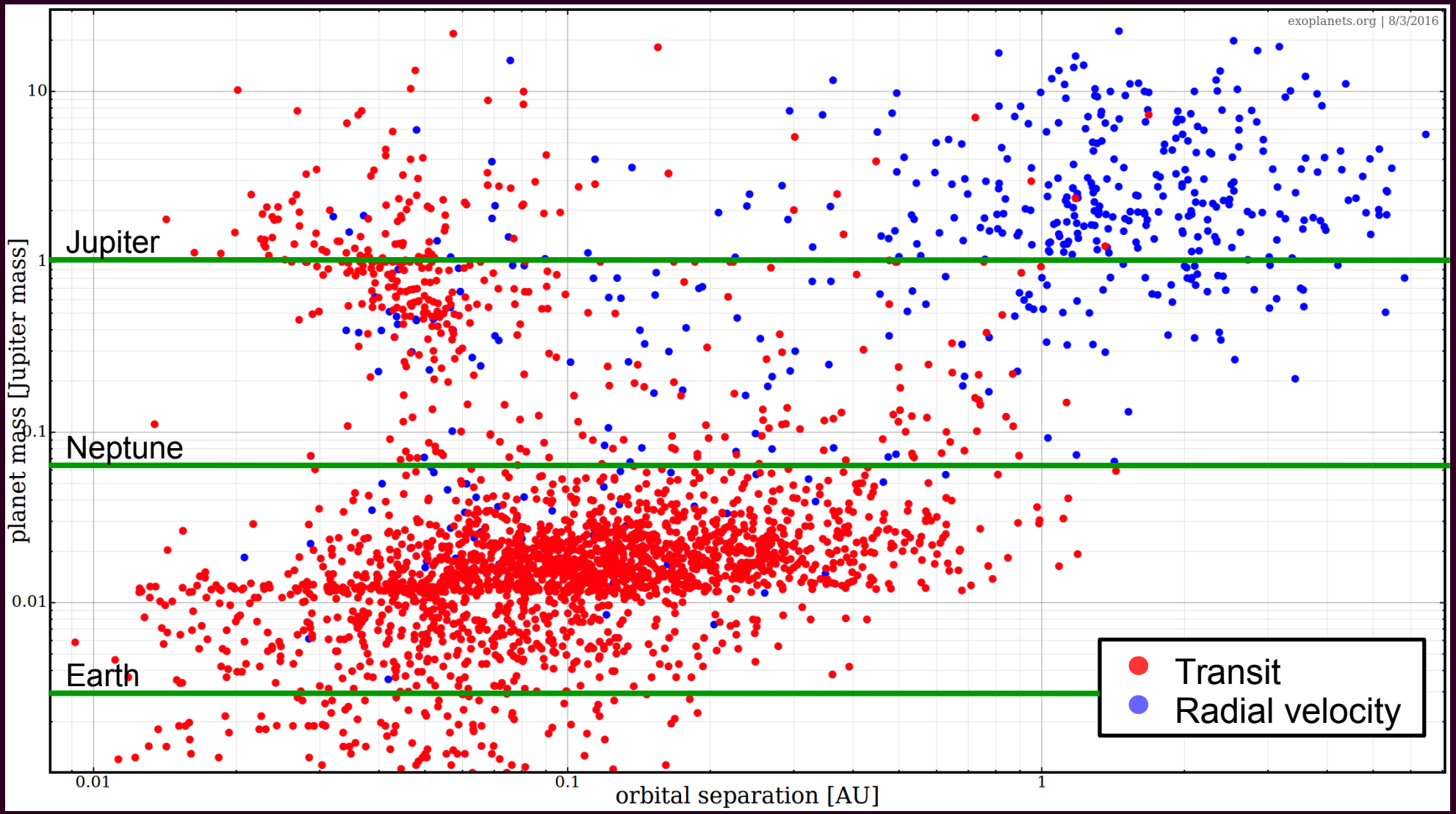
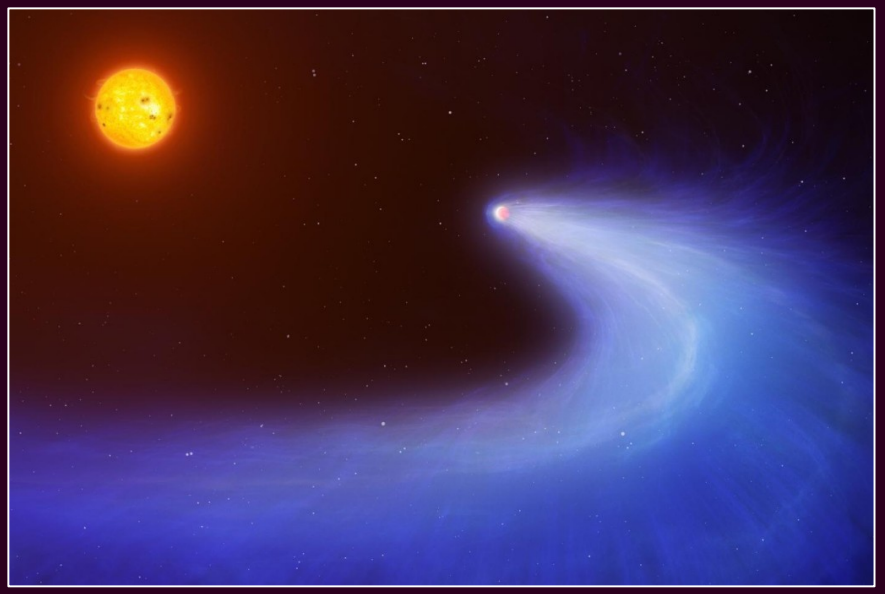
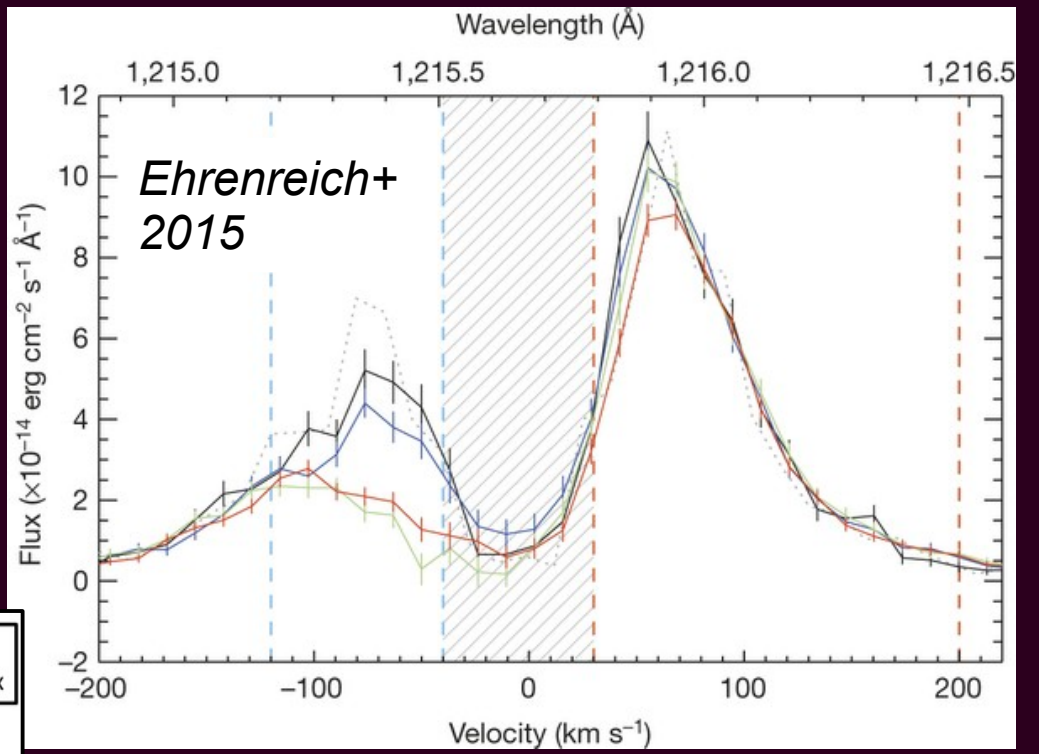


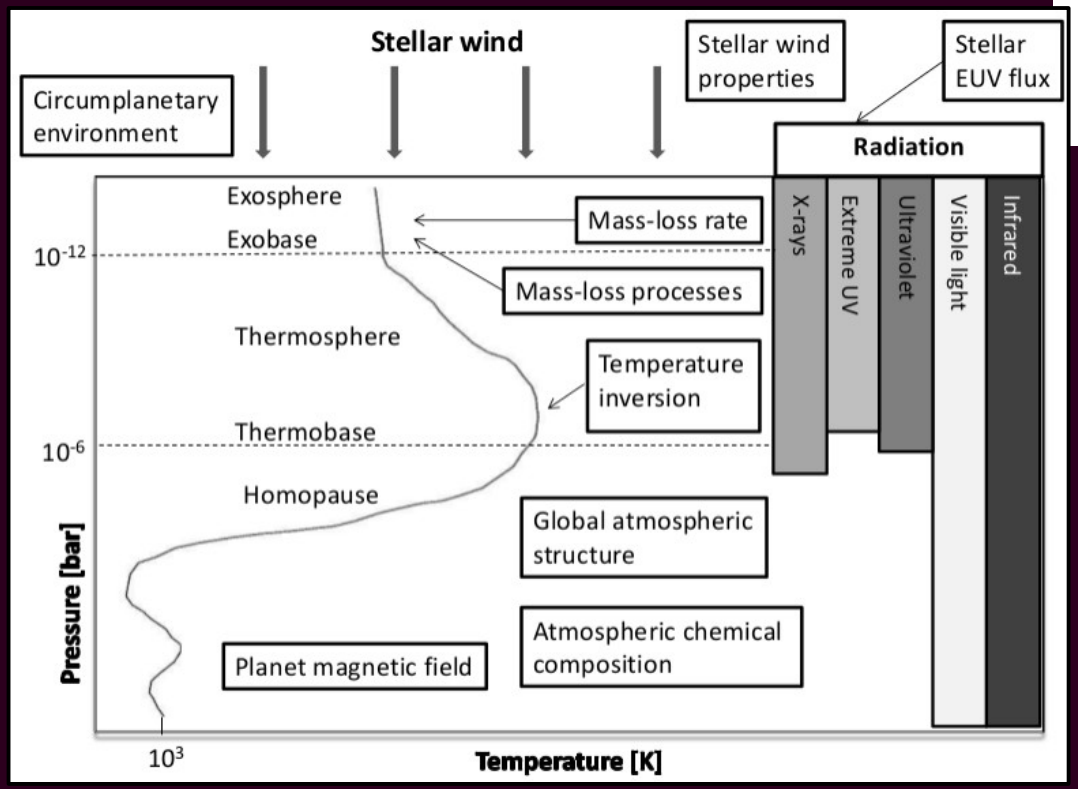
Exoplanet population



Extended atmospheres and escape







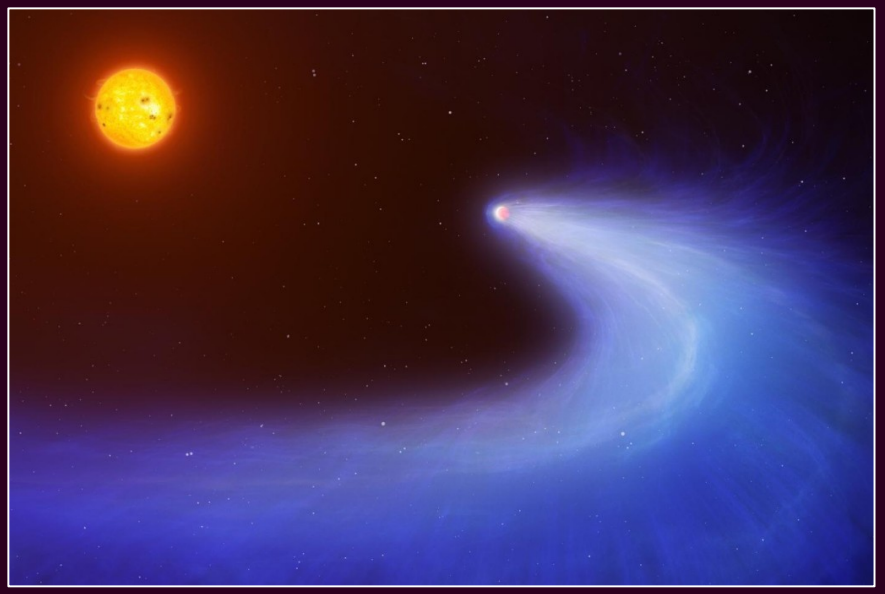
– XUV-driven atmospheric escape

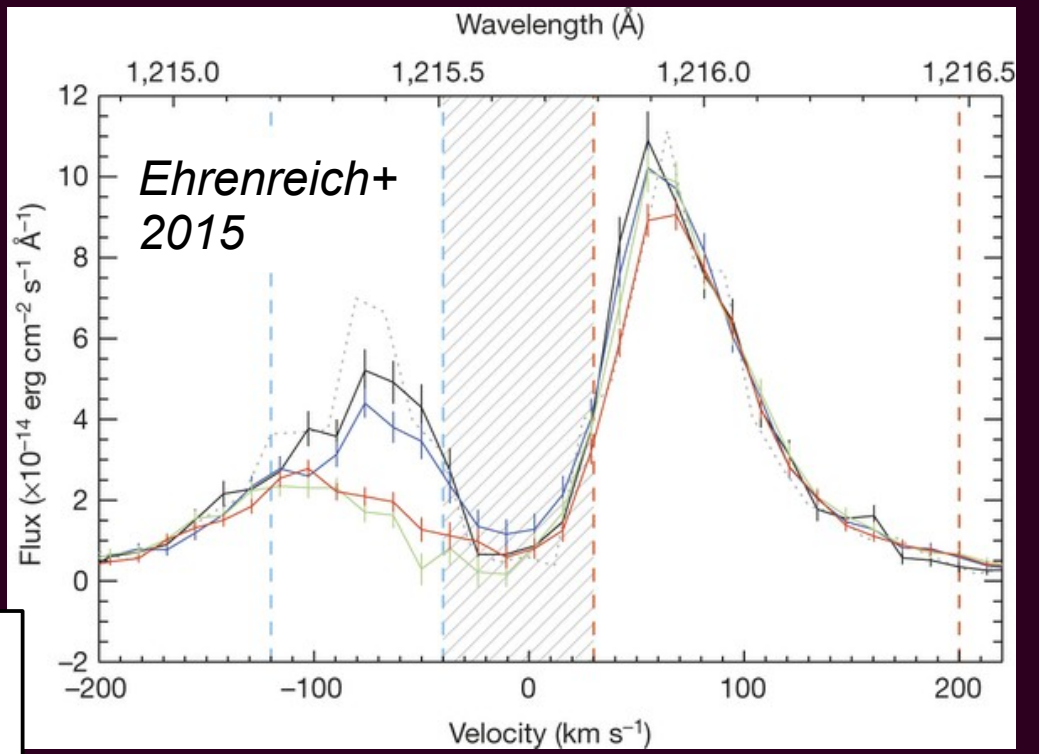
– typical mass-loss rates ~ 10^{10} g/s, about 10^{-4} M_J in 1 Gyr

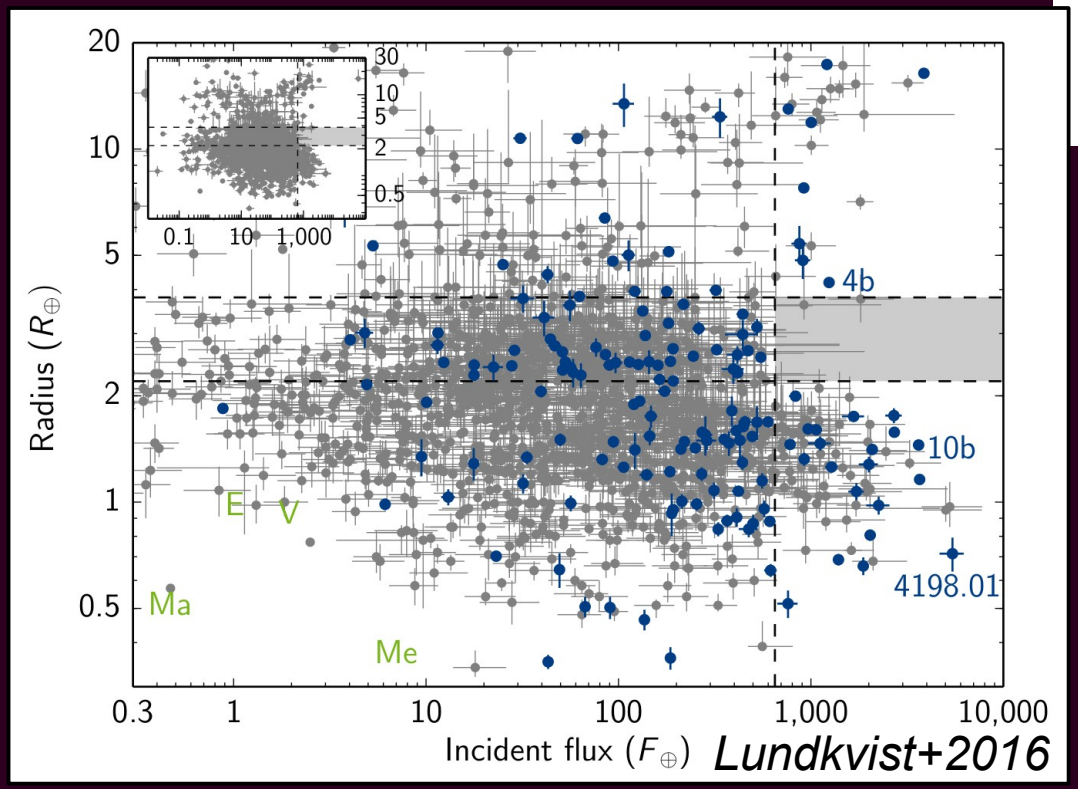
– effects of stellar wind

– transit asymmetries → presence of comet-like tails or bow-shocks

Extended atmospheres and escape

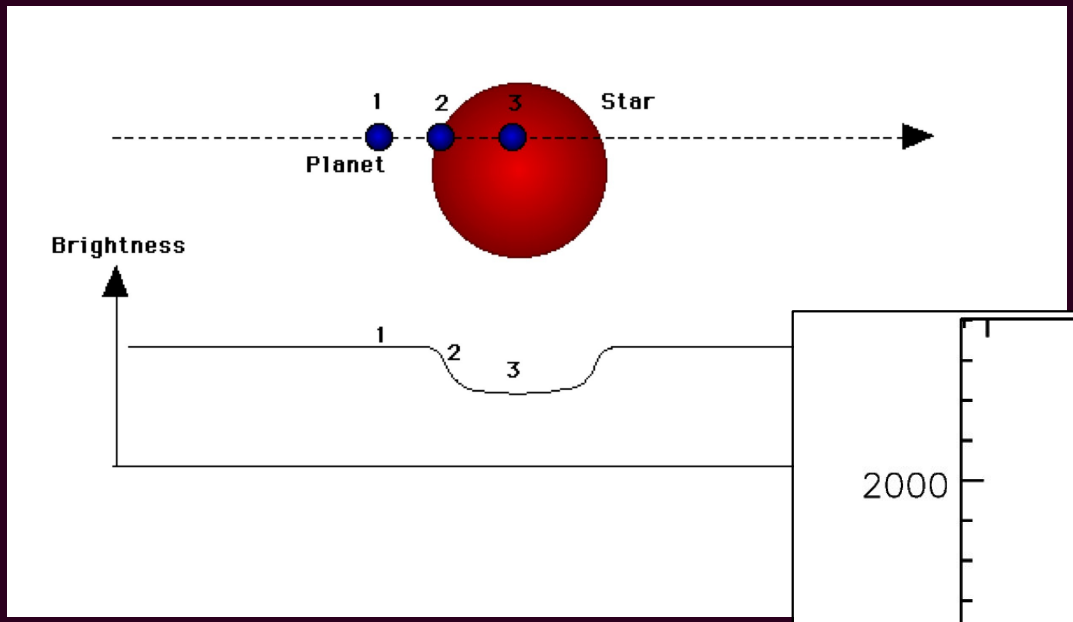


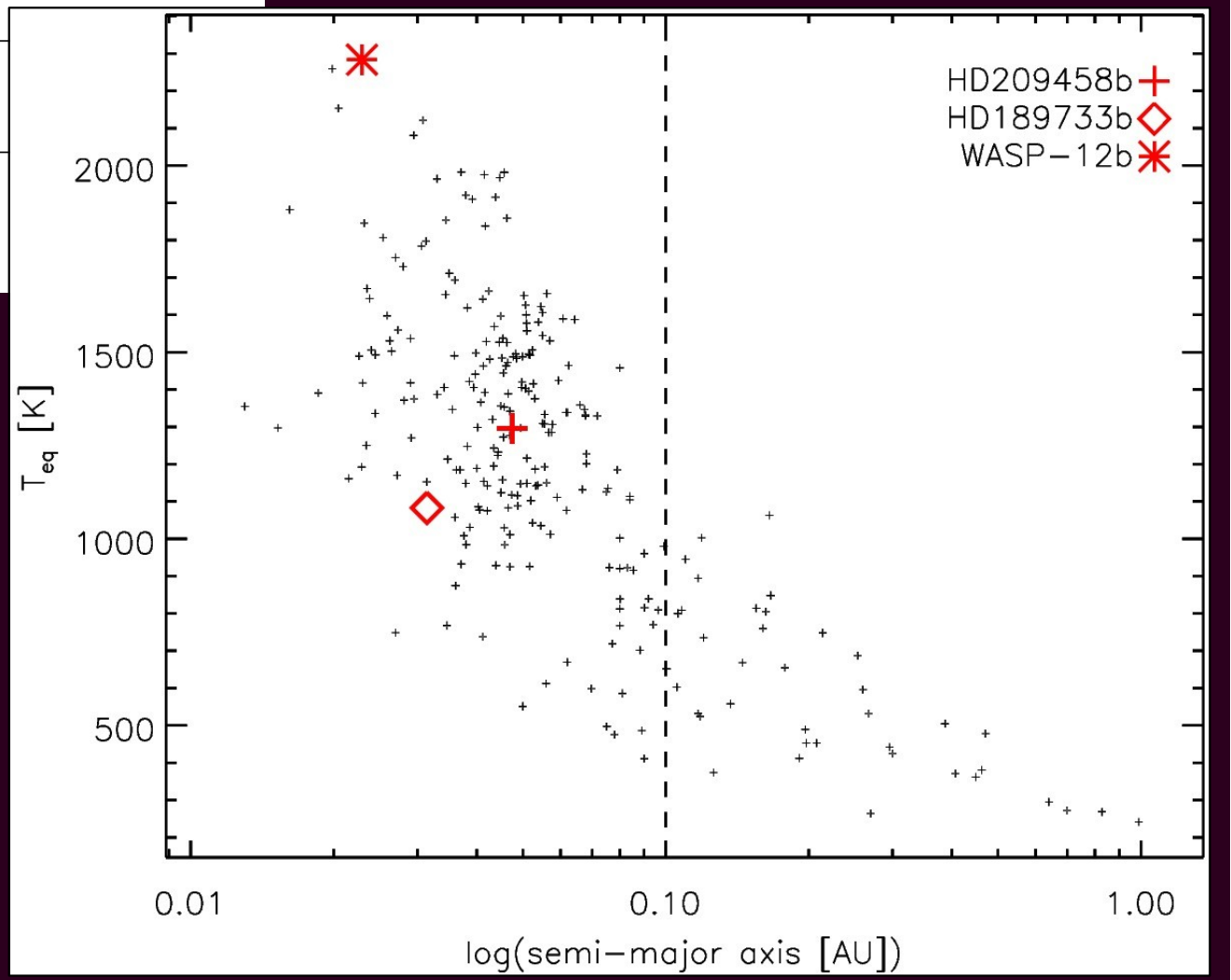




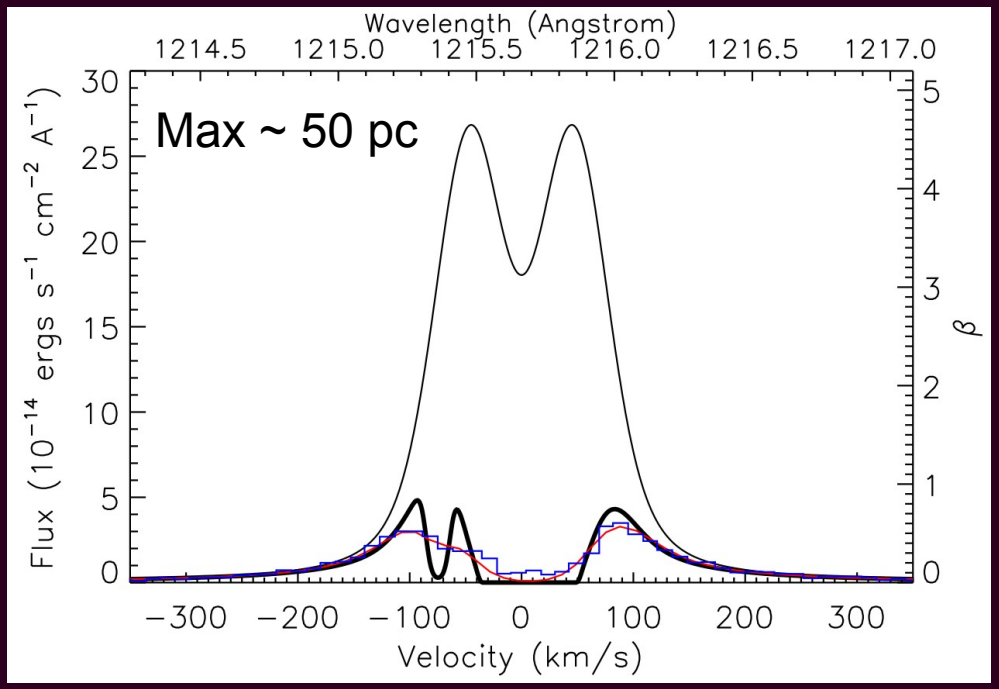
- Planet evolution
- Planet formation
- Planet habitability

Hot Jupiter systems

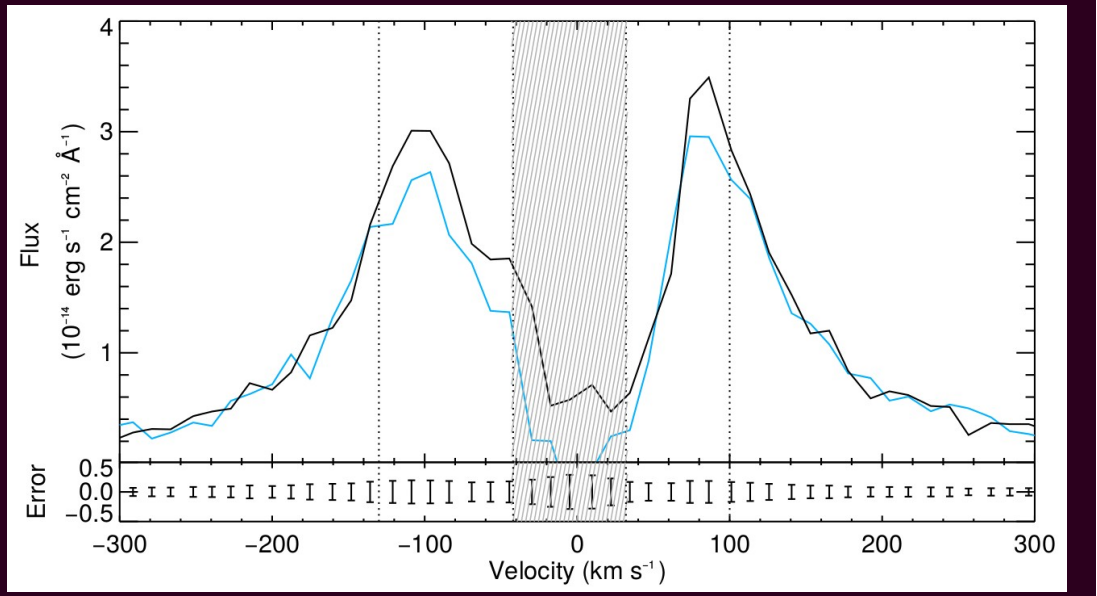


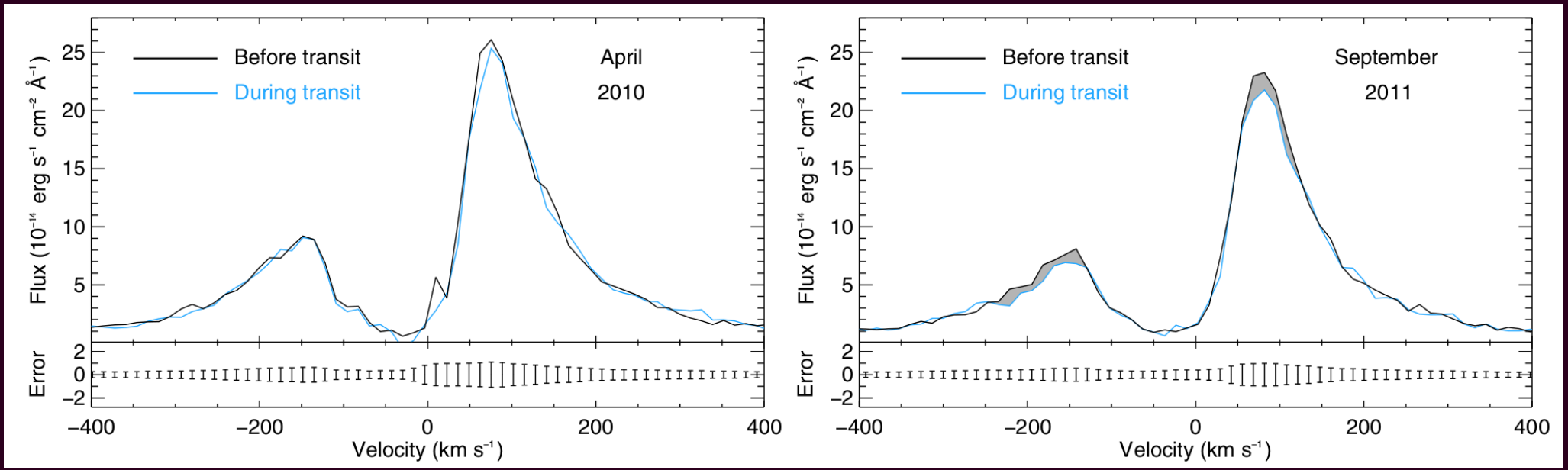


Hot Jupiter systems – Ly-α



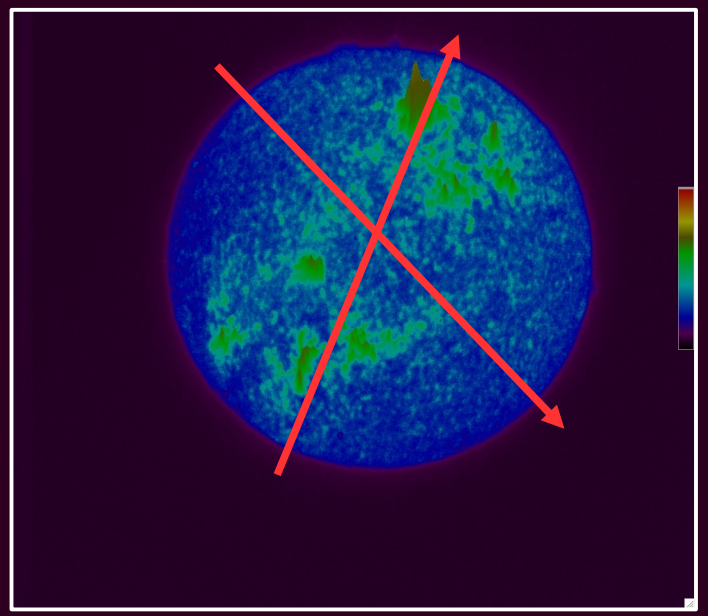
HD209458b – *Bourrier+2013*



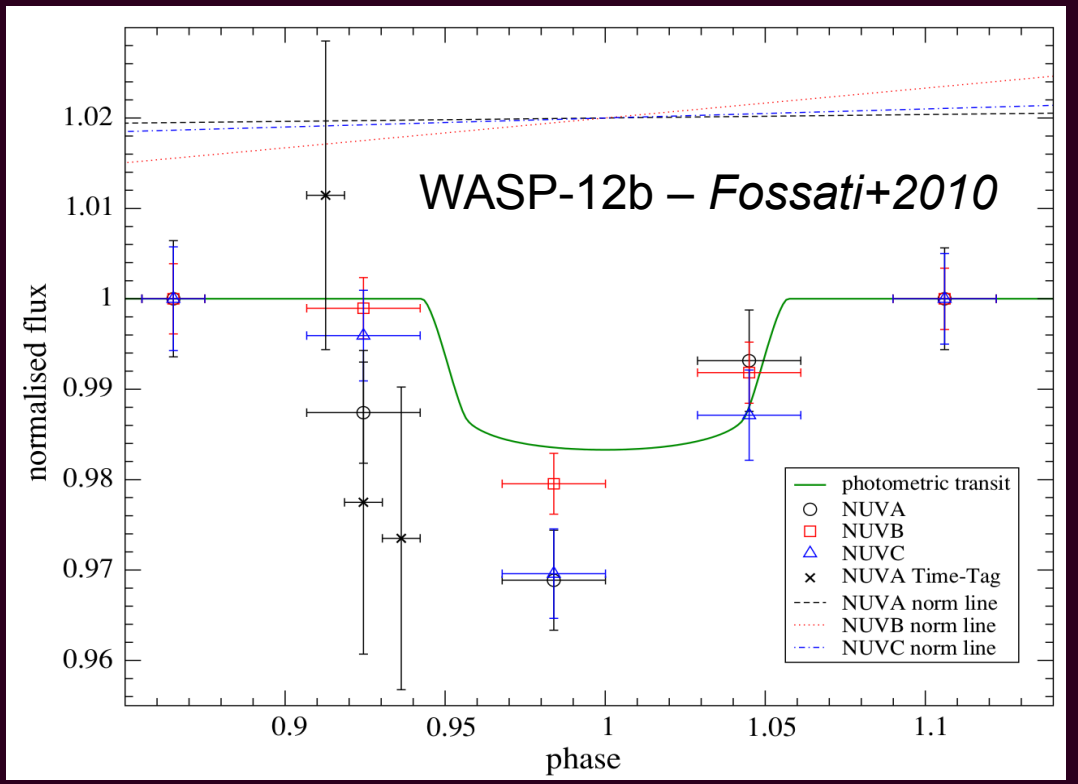


HD189733b – *Lecavelier+2012*

Hot Jupiter systems – near-UV



Less dependent on specific/local stellar characteristics and higher flux



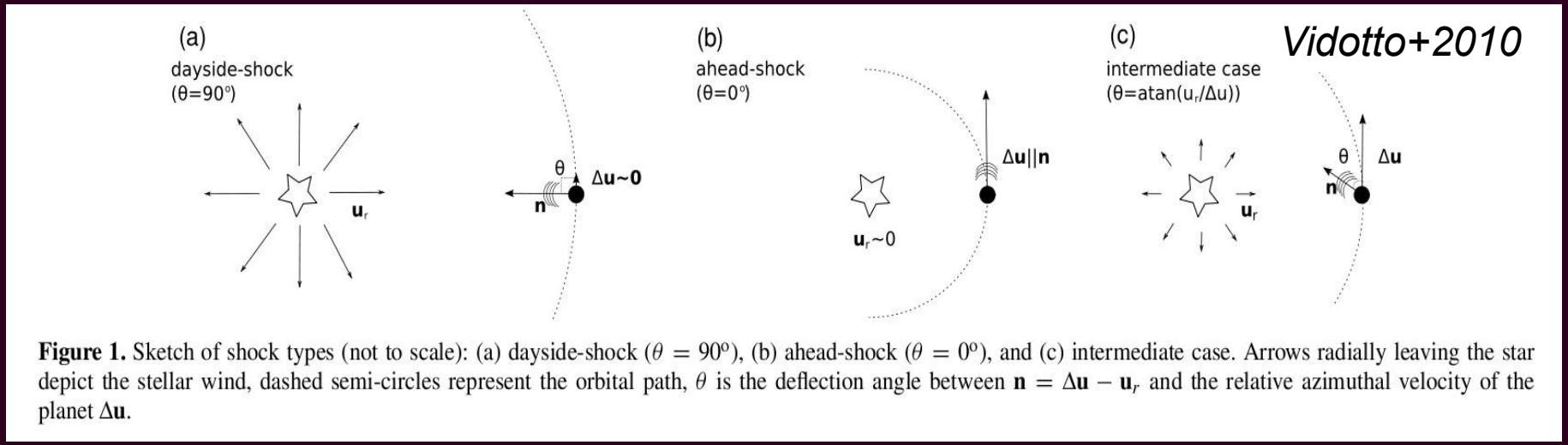
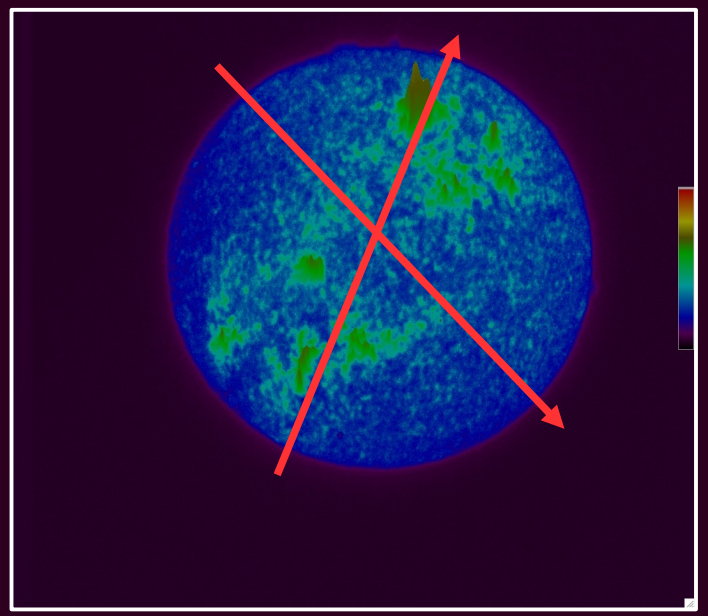
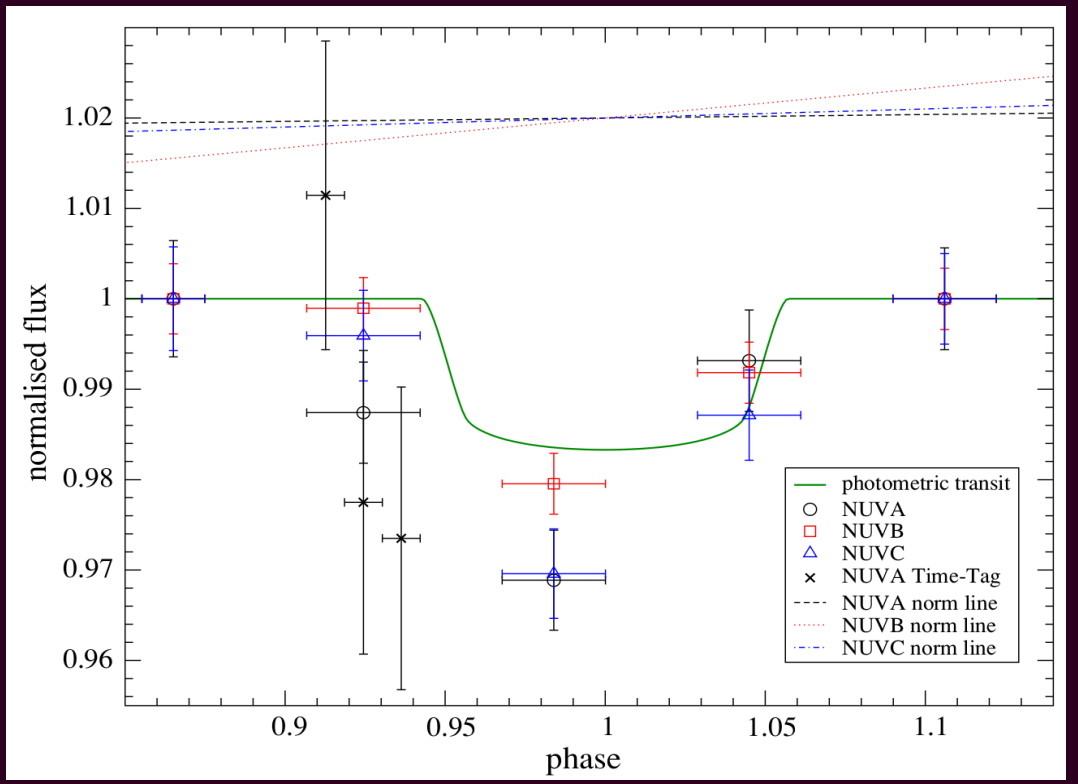


Figure 1. Sketch of shock types (not to scale): (a) dayside-shock ($\theta = 90^o$), (b) ahead-shock ($\theta = 0^o$), and (c) intermediate case. Arrows radially leaving the star depict the stellar wind, dashed semi-circles represent the orbital path, θ is the deflection angle between $\mathbf{n} = \Delta\mathbf{u} - \mathbf{u}_r$ and the relative azimuthal velocity of the planet $\Delta\mathbf{u}$.

Possibility to detect/measure exoplanetary magnetic fields

Hot Jupiter systems – near-UV





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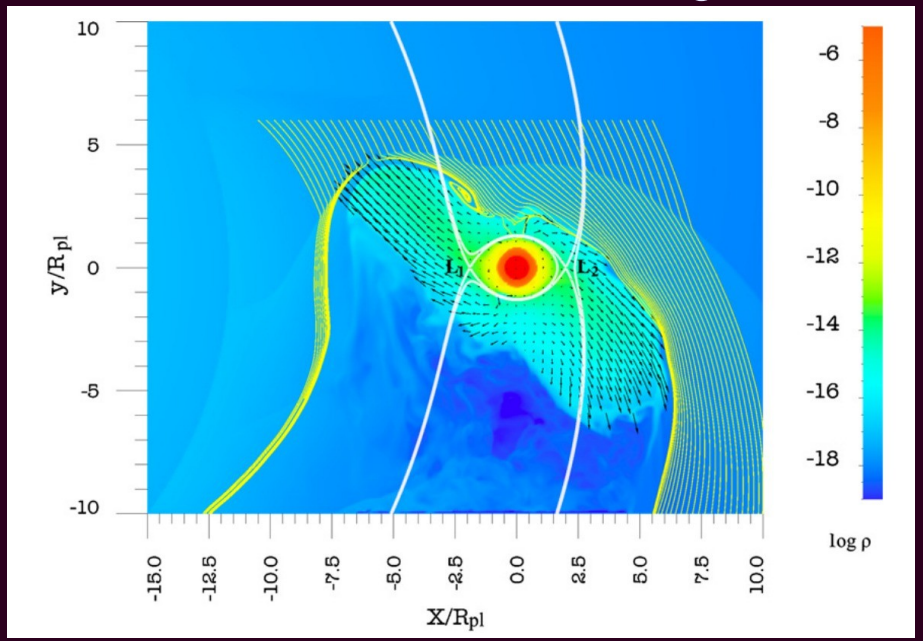
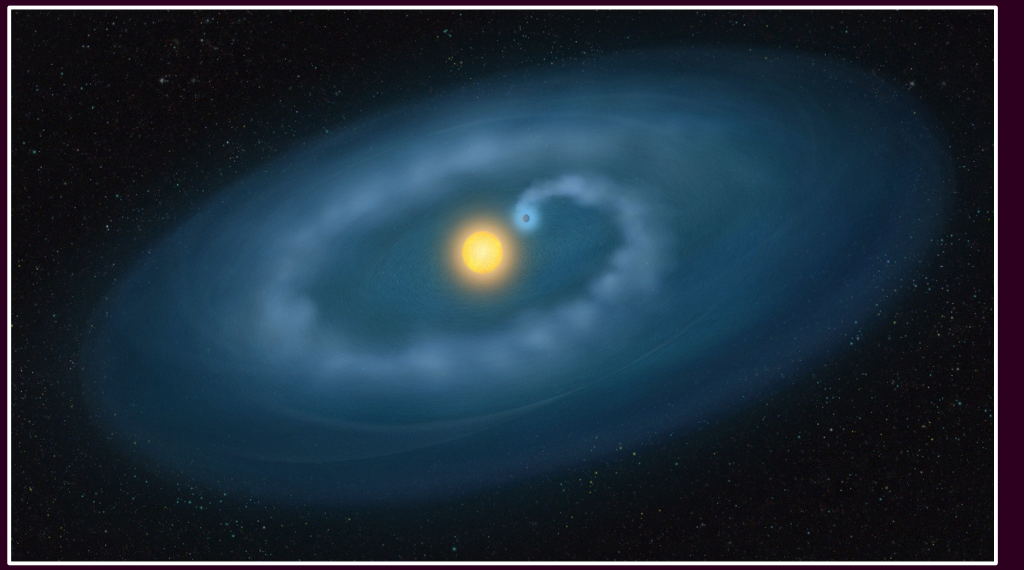
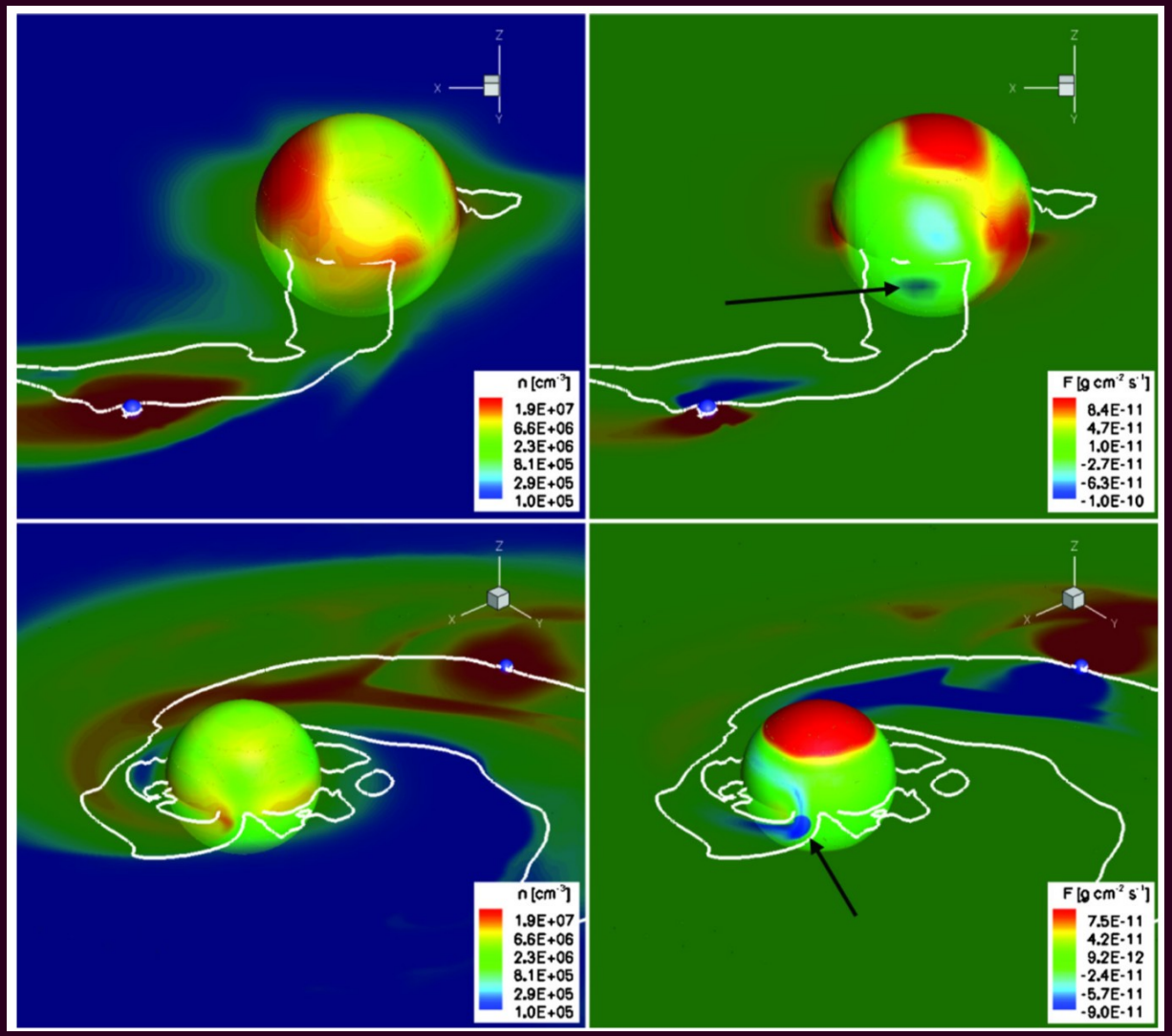
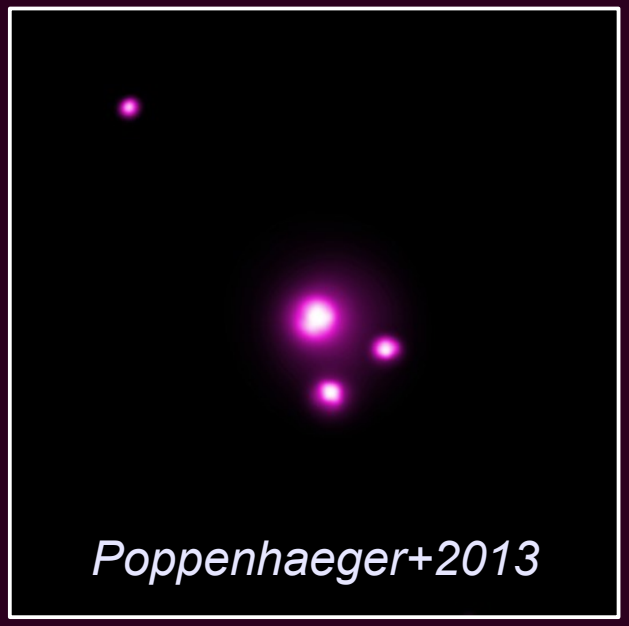




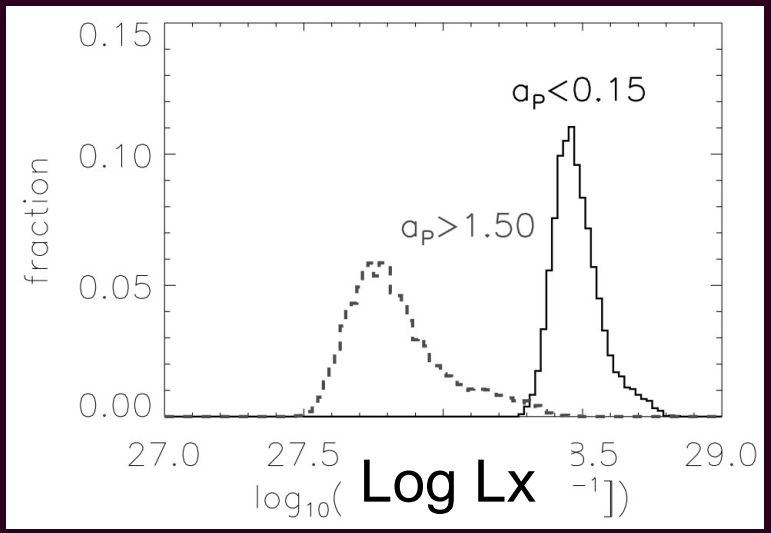
Star-Planet interaction

Cohen+2011



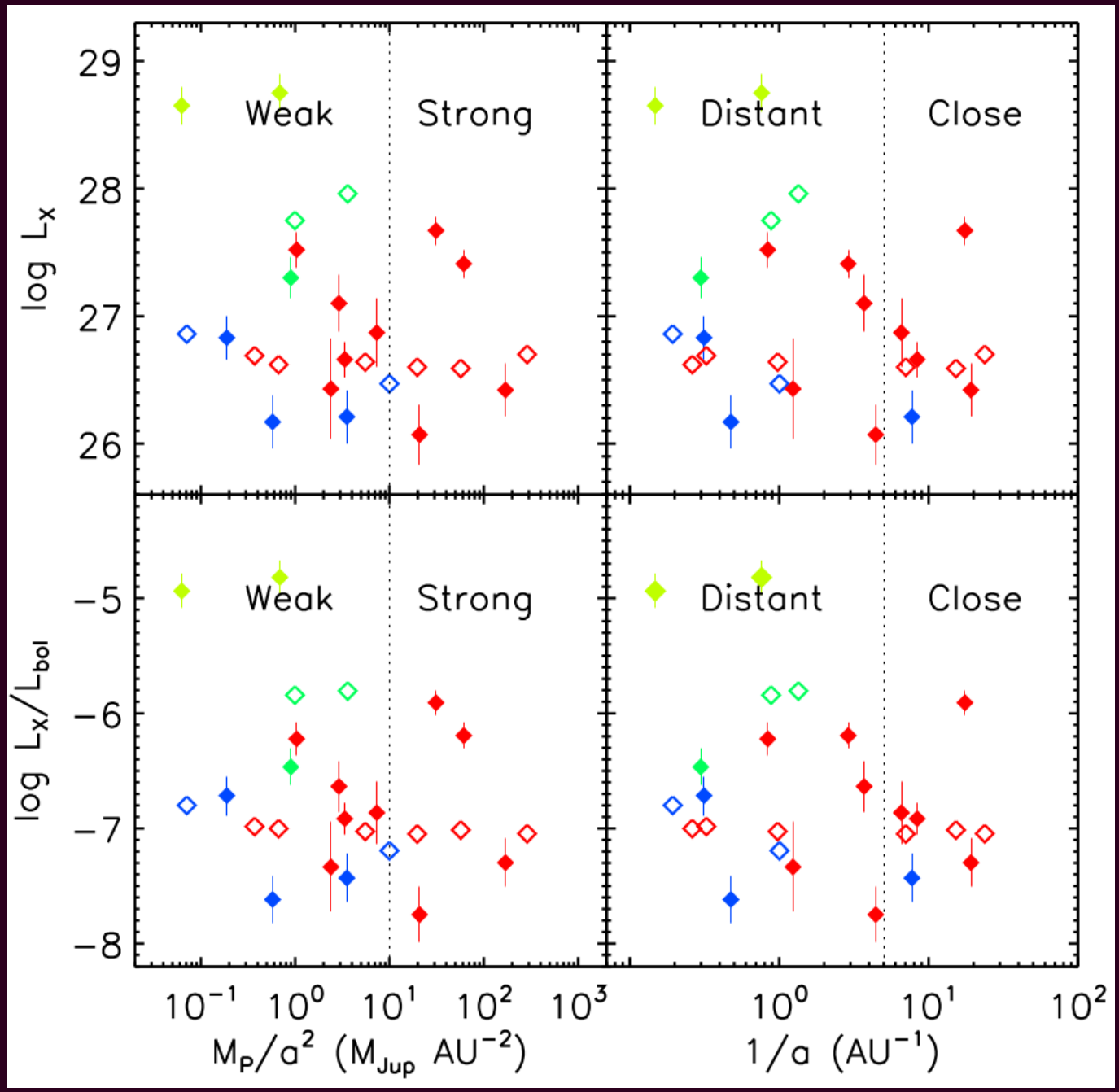


Kashyap+2008



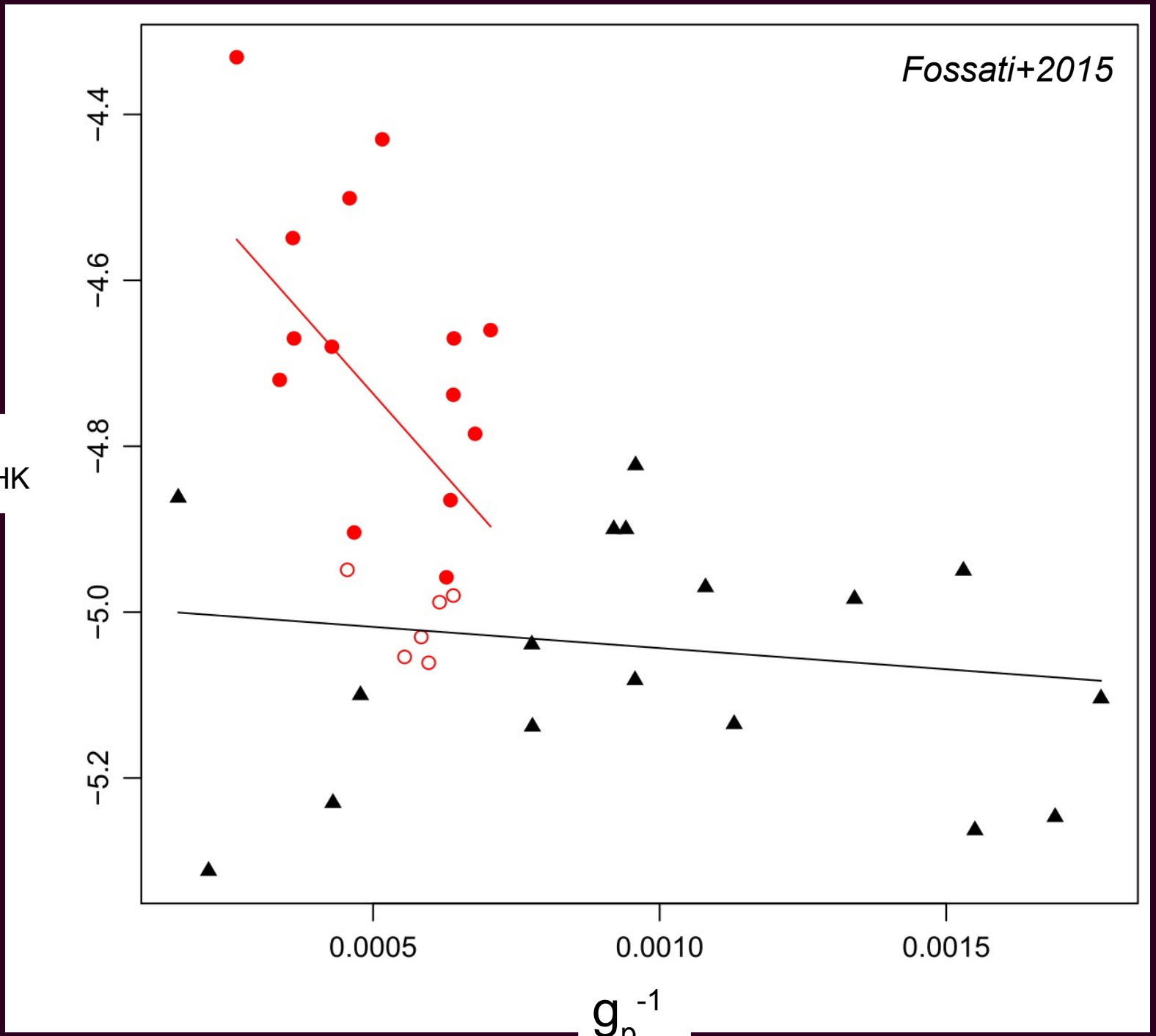
Magnetic vs tidal interaction

Star-Planet interaction

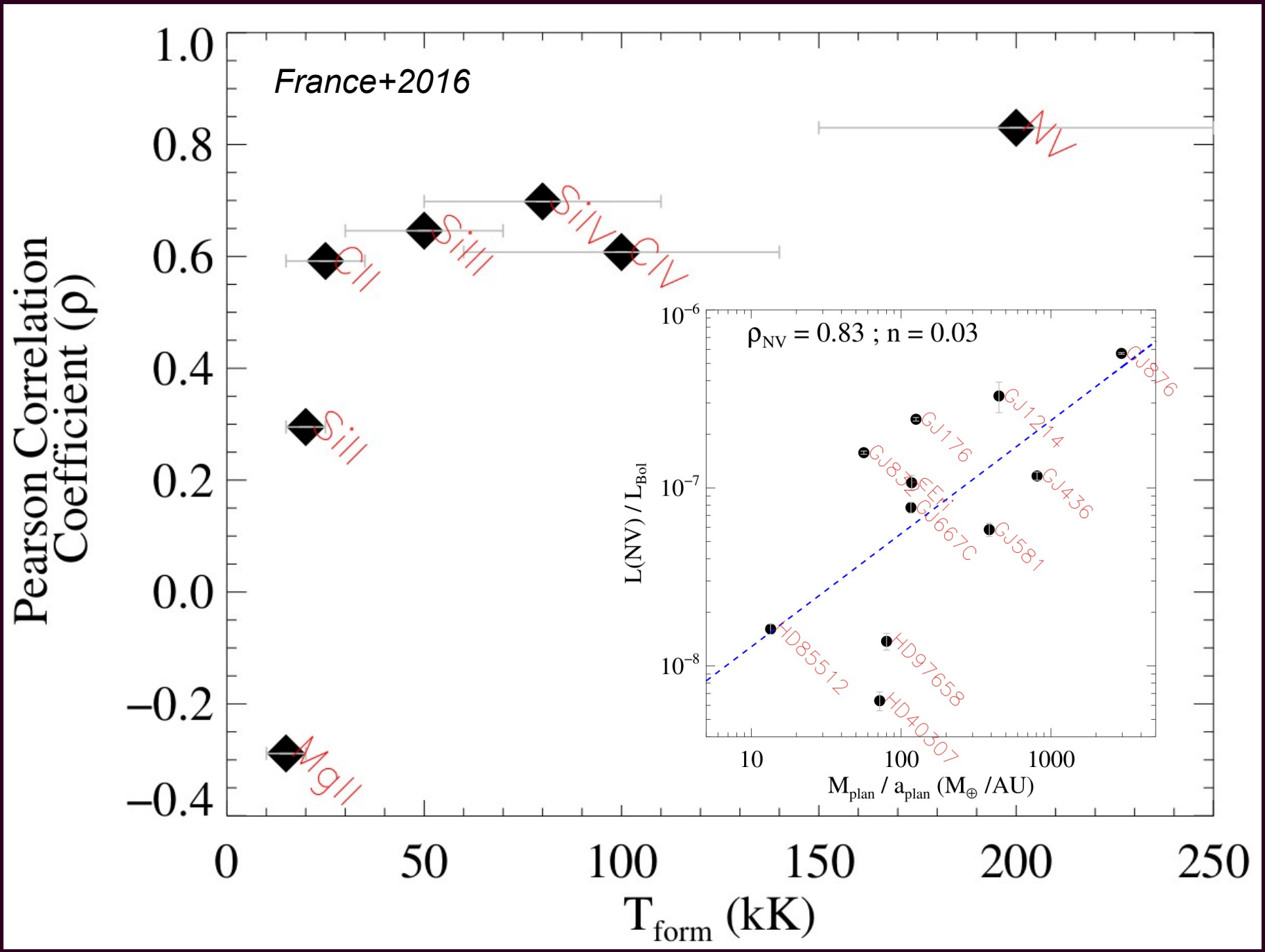


Miller+2015

Star-Planet interaction



Star-Planet interaction



Conclusion

– Large collecting area

– Possibility to have long exposure times / series to allow the study of more distant planets (i.e., no Earth occultation / SAA)

– Wide UV spectral coverage (near-UV to Lyα)

– Medium (5000 – 30000; transit) and high (>50000; Lyα reconstruction / astrosphere / wind) resolution

– UV polarimetry to be combined with optical/UV high-resolution spectroscopy to study star-planet interaction