Circumstellar gas generated by the extreme mass loss of planets

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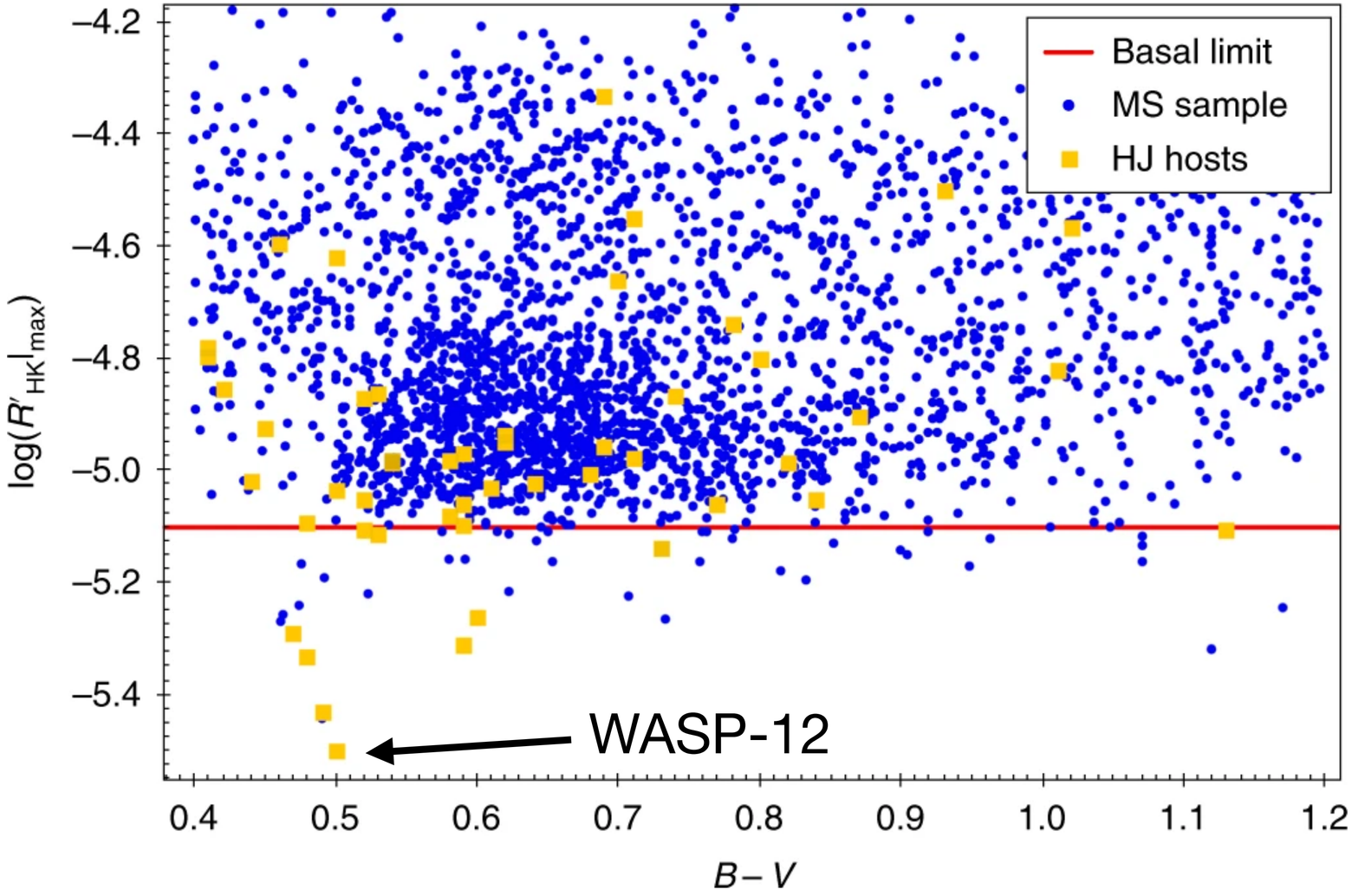
Stars hosting hot Jupiters are more likely to exhibit low activity in Ca II H & K lines



Haswell et al. (2020)

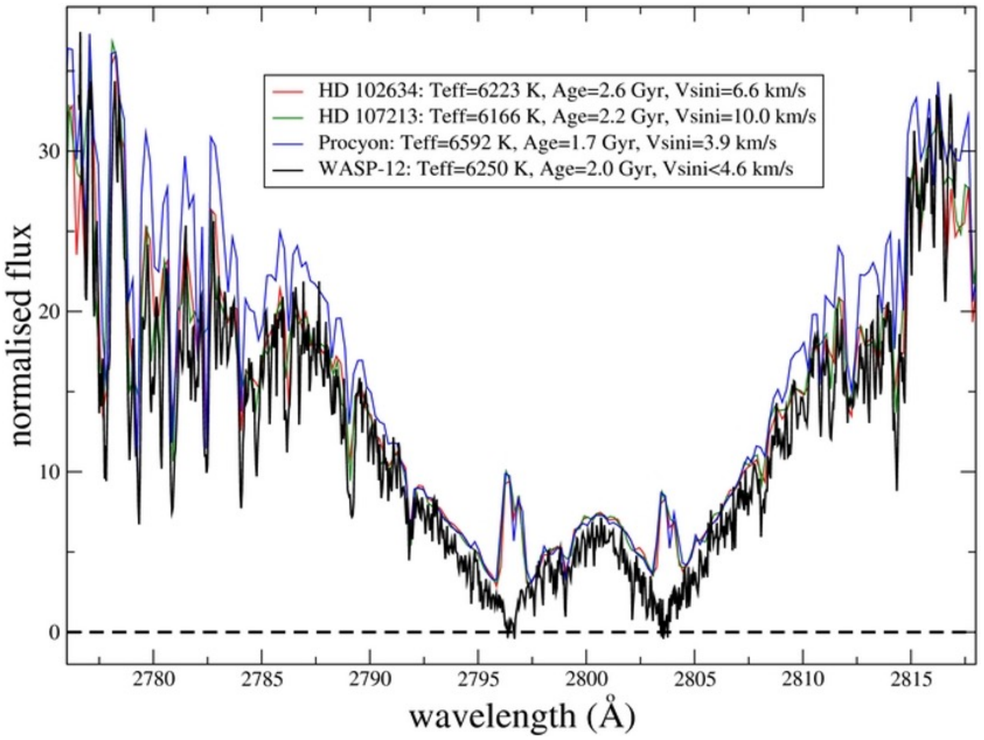
Selection effects?

Can close-in giant planets inhibit the magnetic activity of stars?

Can extreme mass loss from the planet lead to circumstellar gas that obscures the Ca II H & K line?

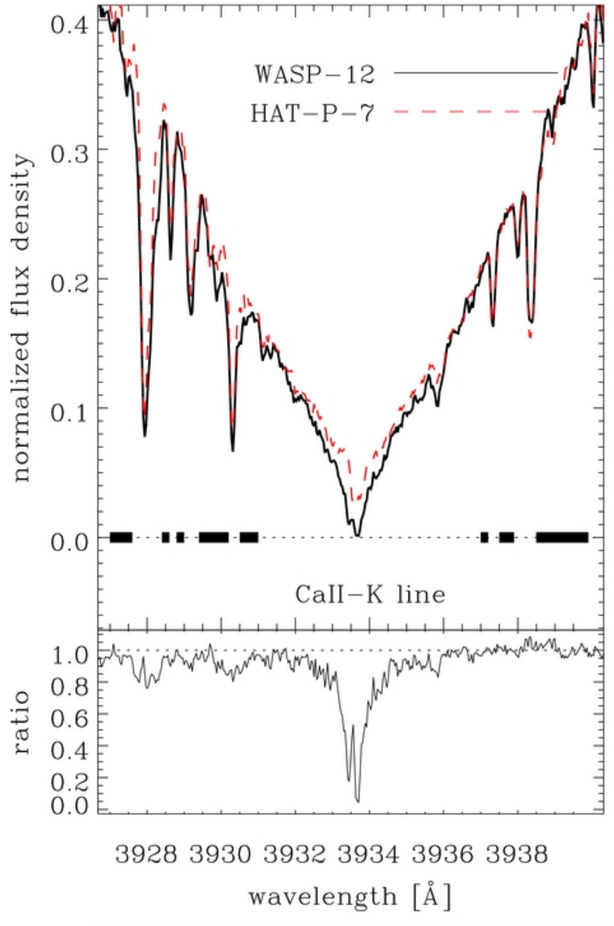
WASP 12 hosts a giant planet ~1.5 M_J on a ~1 day orbit (~3 stellar radii!)

Mg II h & k lines



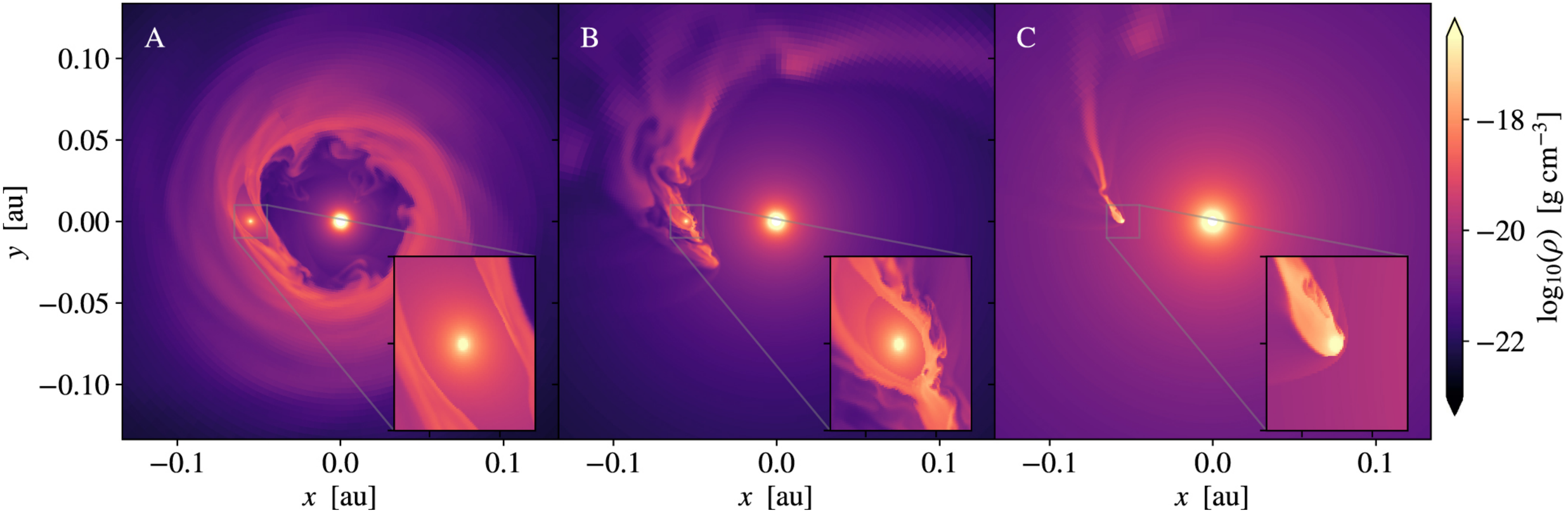
Haswell et al. (2012)

Ca II K line



Fossati et al. (2013)

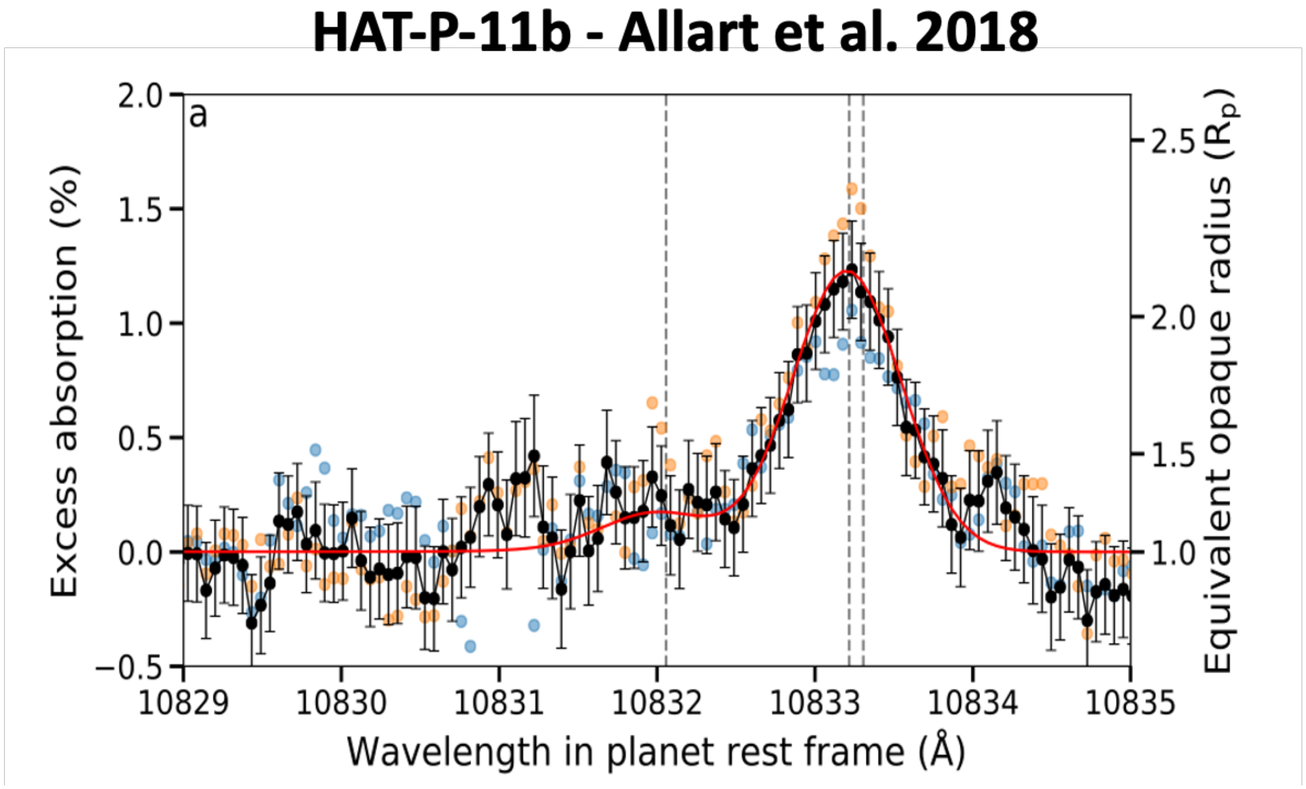
Increasing stellar wind strength

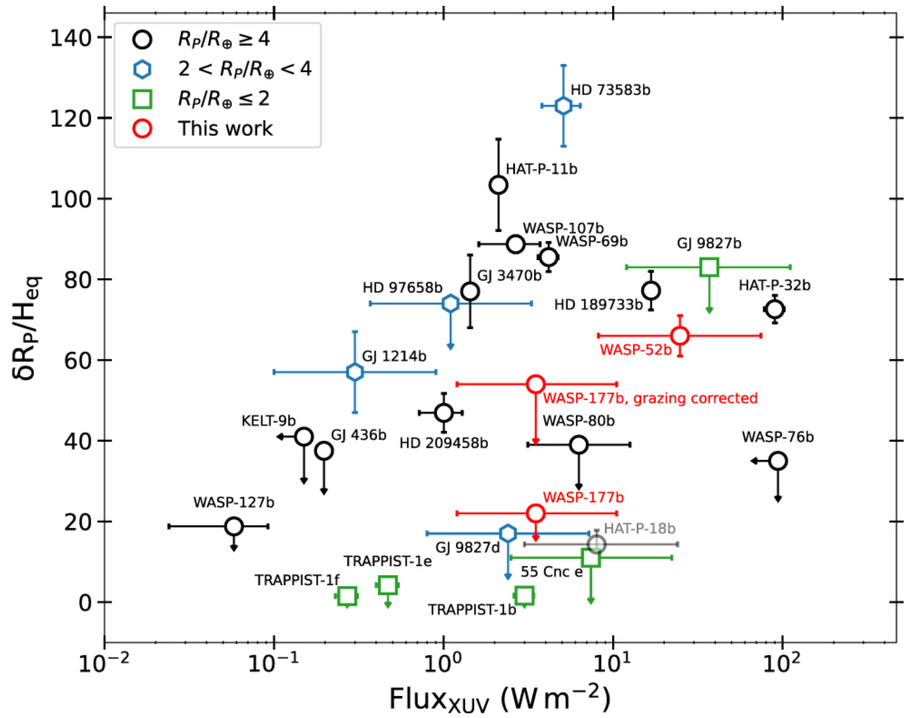


MacLeod et al. (2023)

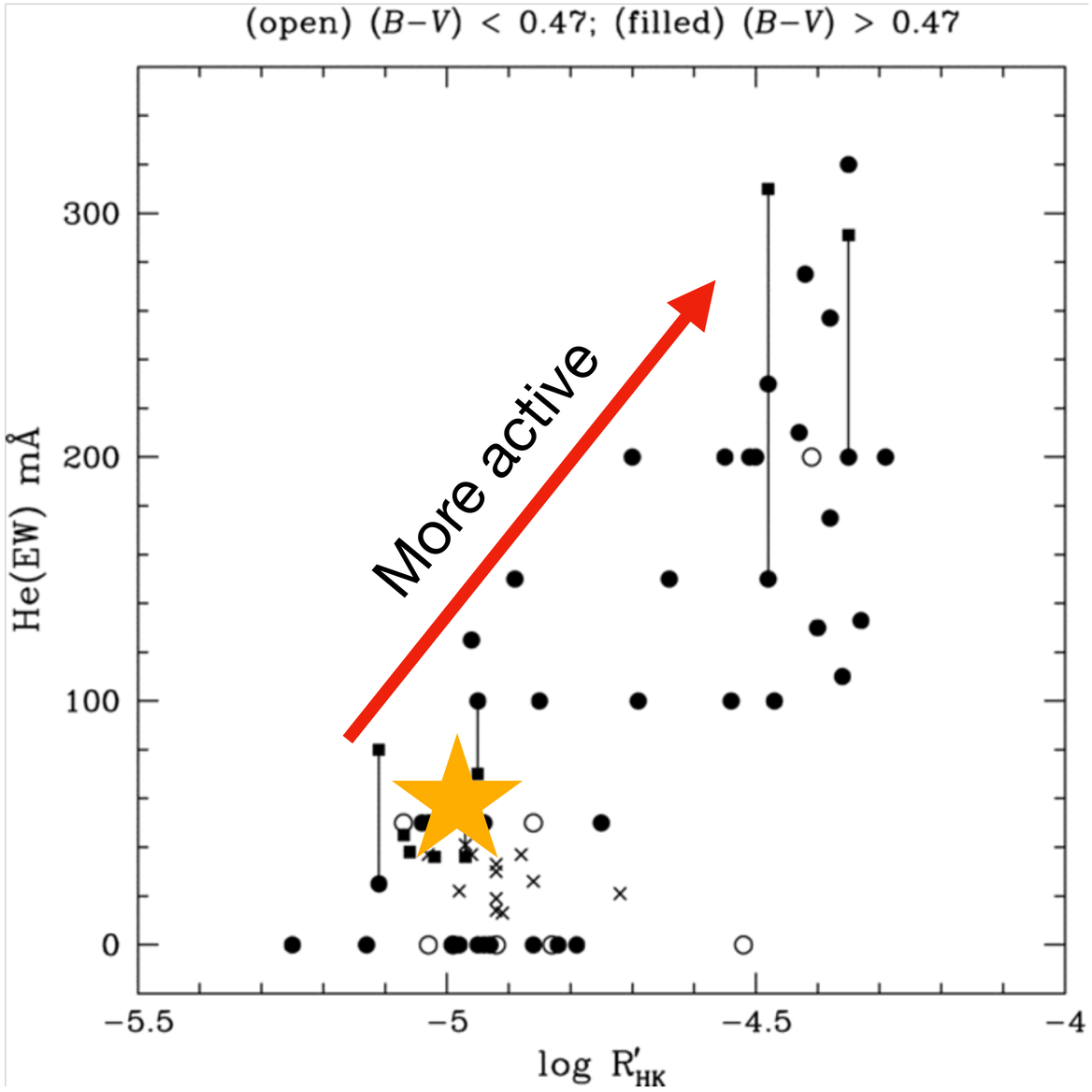
If there is significant amounts circumstellar gas, surely it should be observable in other lines?

The helium 10830 Å line is a good tracer of escaping gas



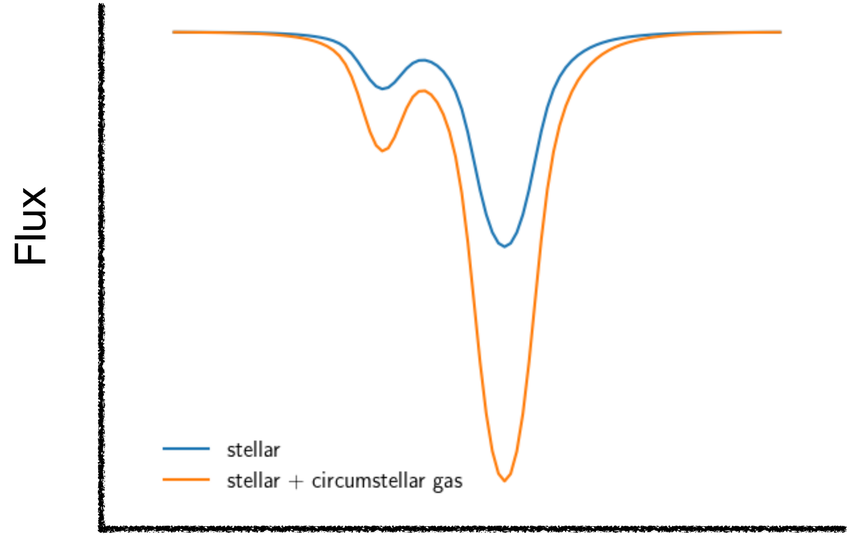


Kirk et al. (2022)

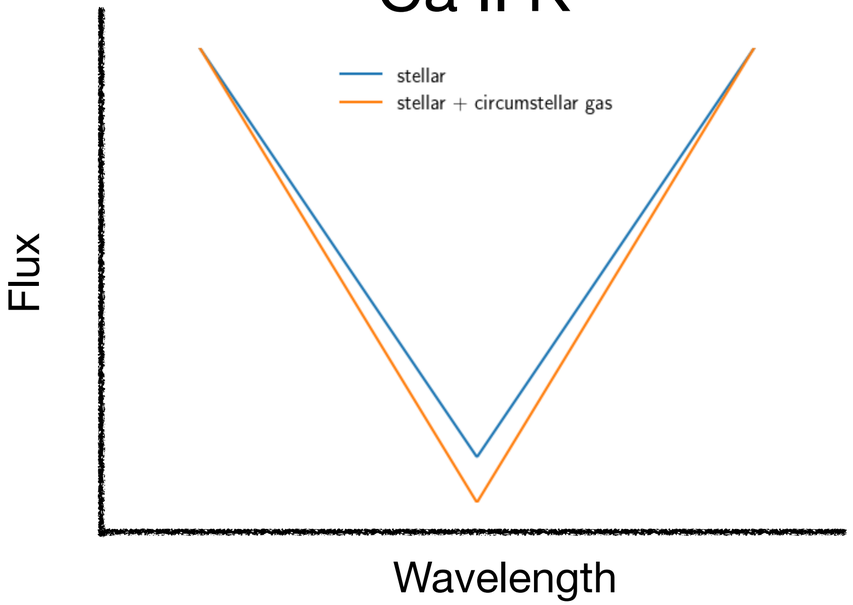


Smith et al. (2016)

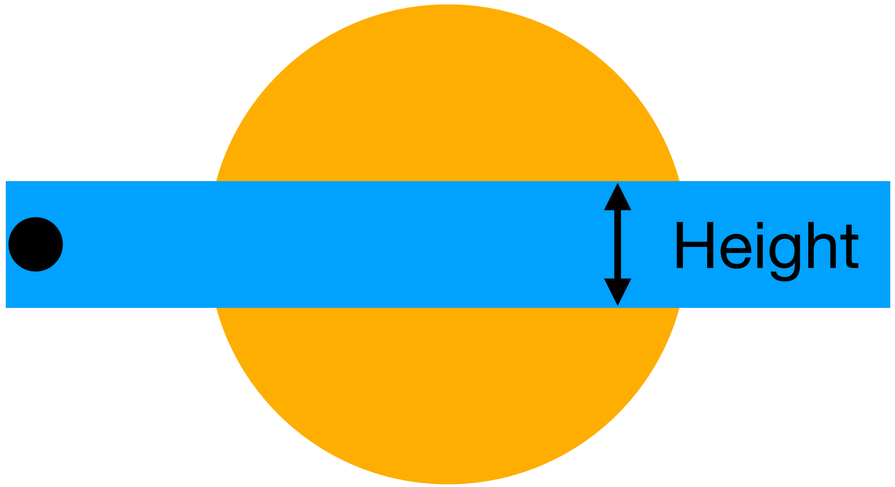
He 10830 Å

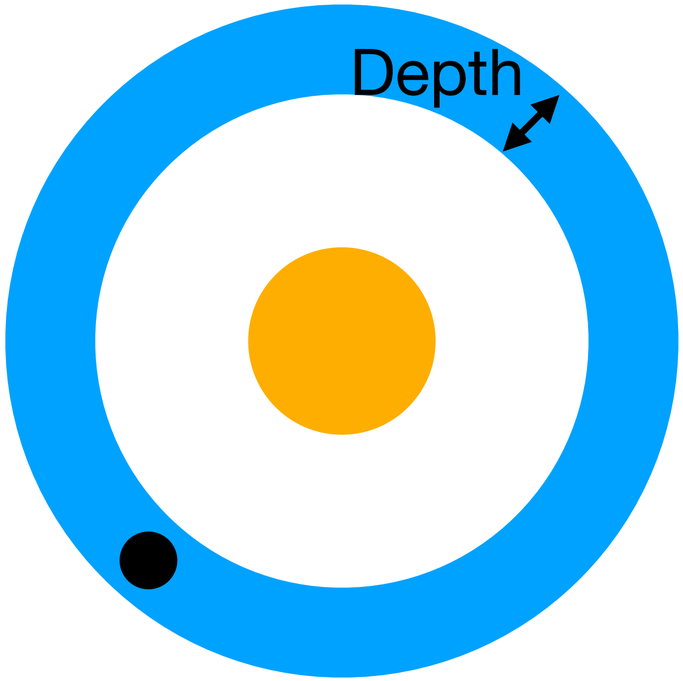


Ca II K



A simple model of the circumstellar gas





Assumptions:

-Constant height, depth

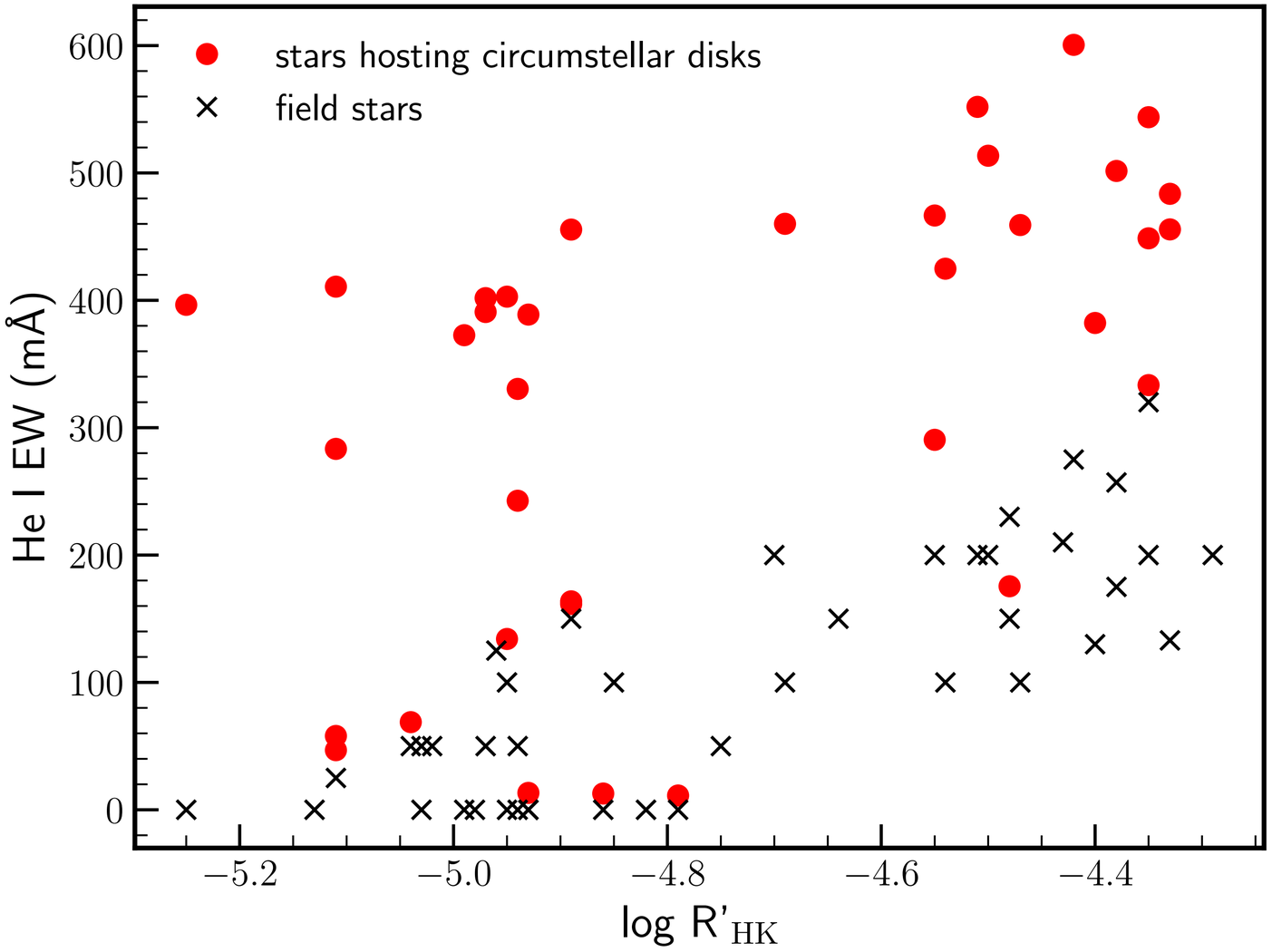
-The gas is on Keplerian orbits (i.e slow radial evolution)

-The gas is optically thin to EUV radiation

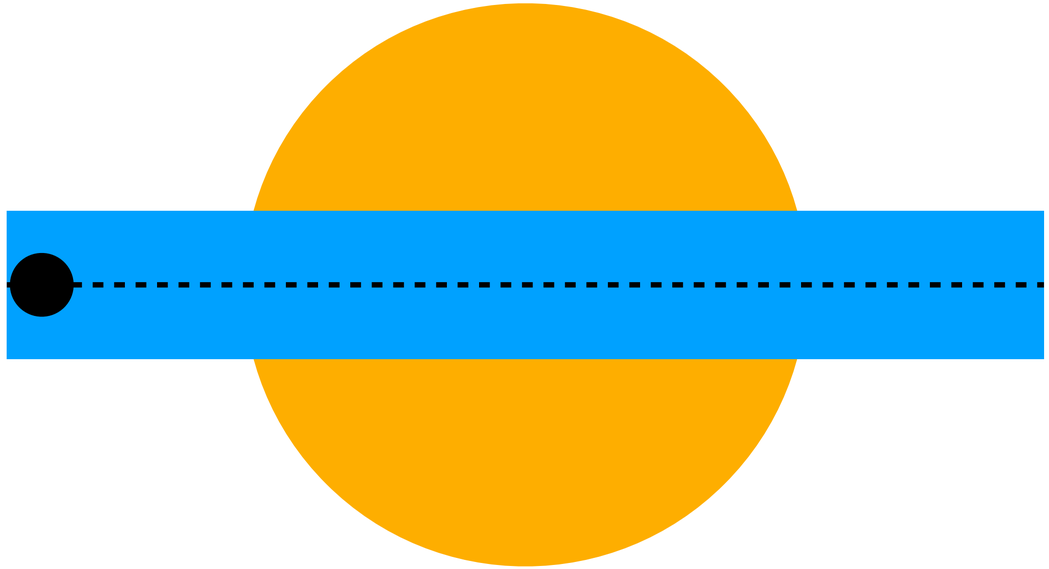
-The gas is in photoionization-recombination equilibrium

-The helium line is in statistical equilibrium

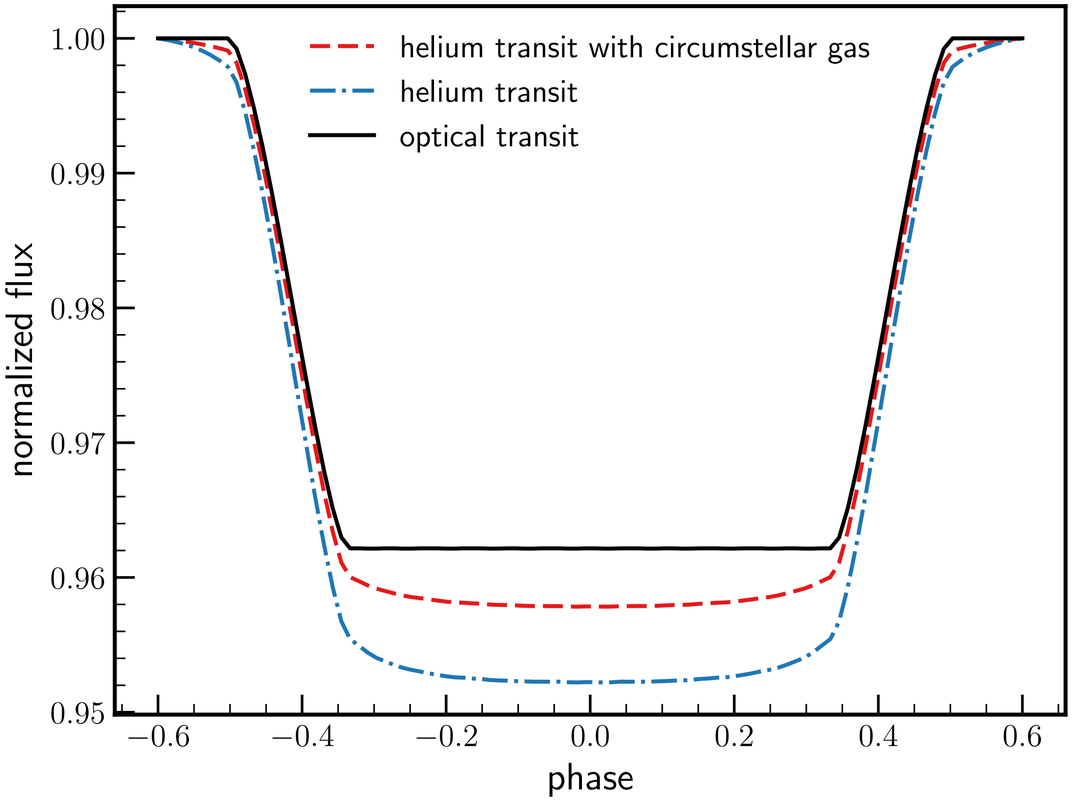
What would we expect from a population of stars hosting circumstellar gas?



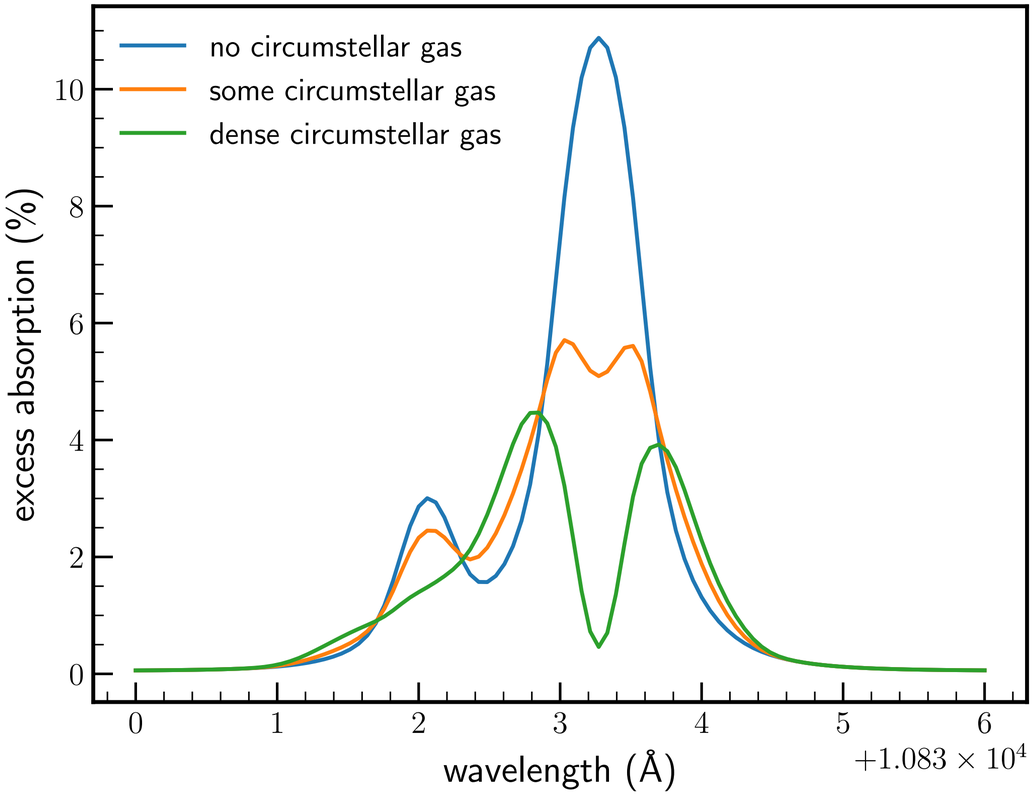
How does circumstellar gas affect the observed transit of the planet



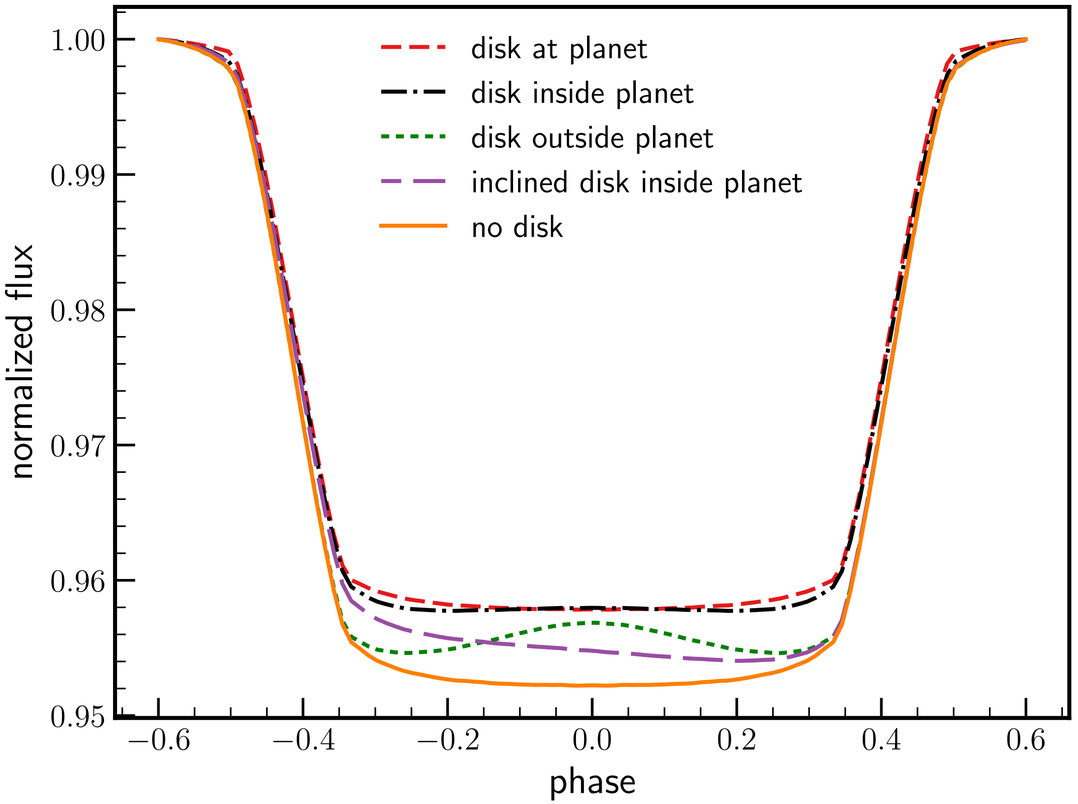
Acts like a giant spot!



It also affects the spectrum



Moving the planet/gas leads to interesting looking transits



Summary

Stars hosting close-in giant planets appear to exhibit low activity in the Ca II H & K lines

Complementary observations of both the Ca II H & K and the He 10830 Å lines of the star can indicate whether the star is likely to host circumstellar gas

The presence of circumstellar gas will pollute the He 10830 Å transmission spectrum

If detected, the presence of circumstellar gas can tell us much about the mass loss/evolution of hot Jupiters and stellar winds