Vibrationally excited H_2 mutes the He I triplet line at 1.08 μm on small exoplanets

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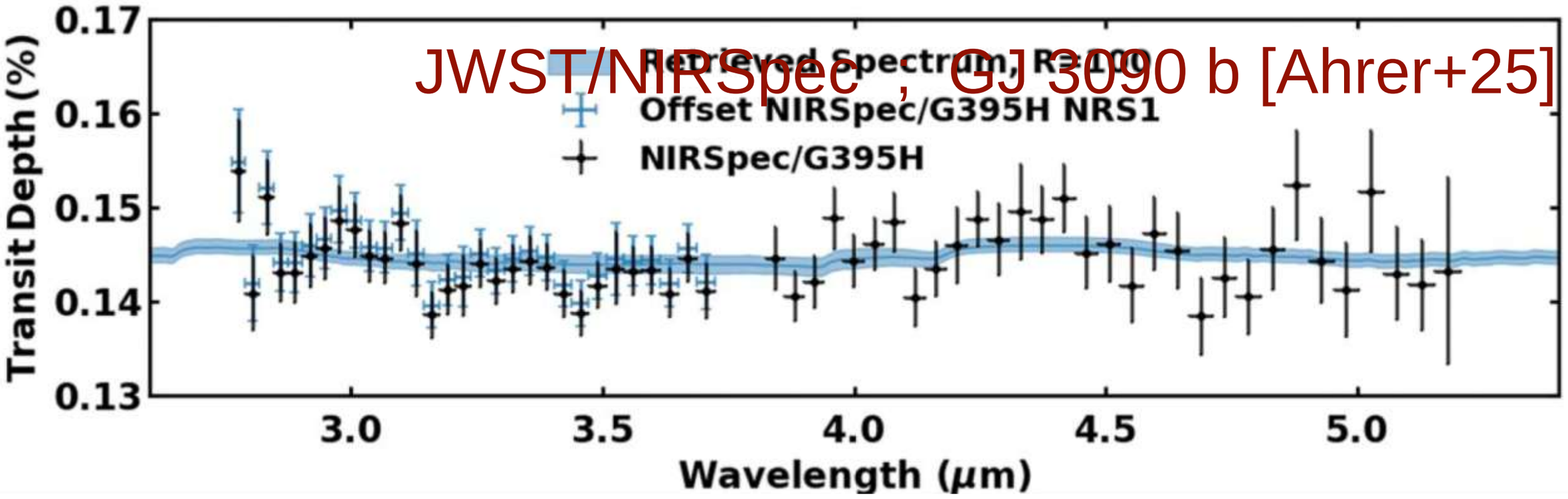
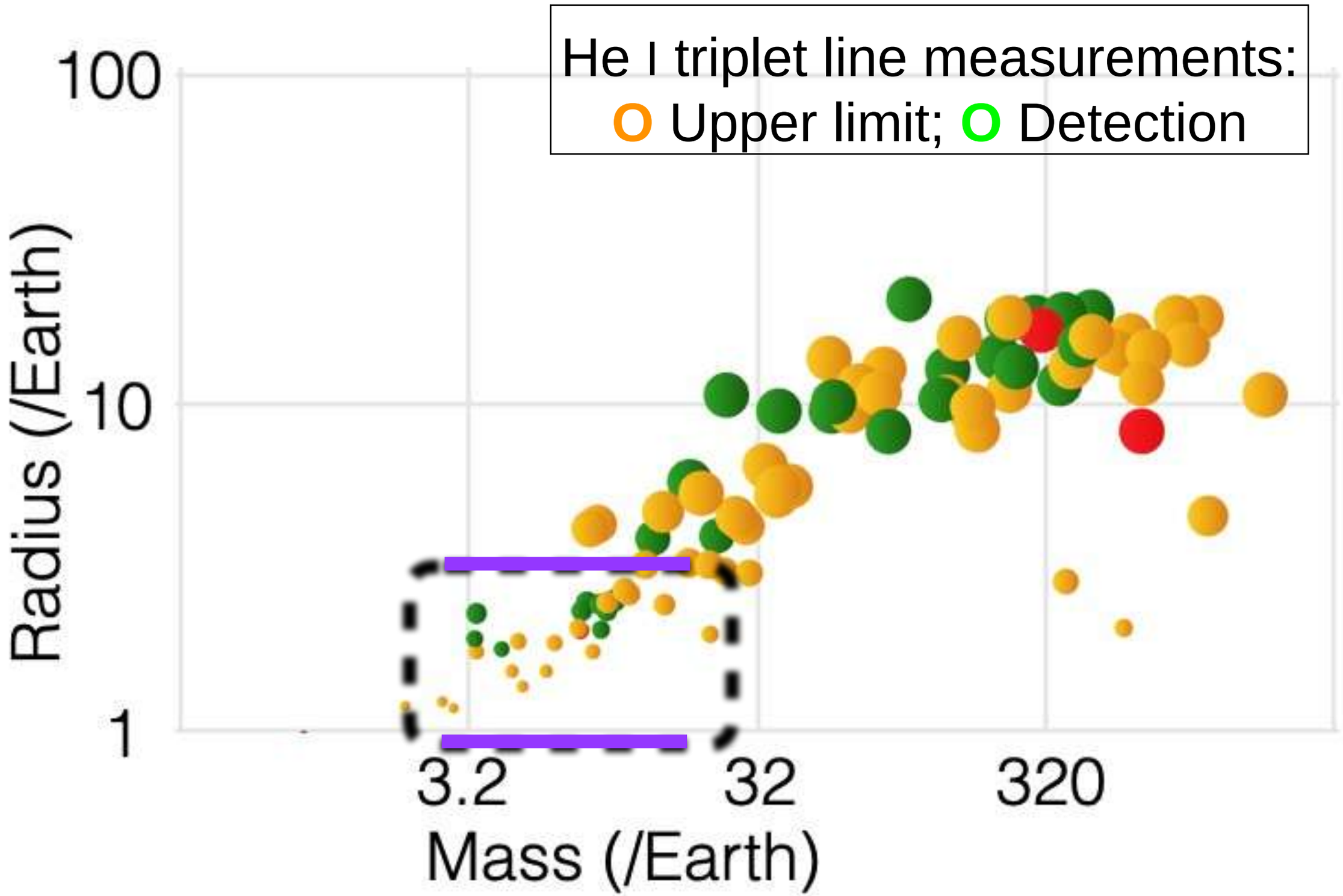
Sub-Neptunes are very interesting because…

But they also like to keep their secrets away…



With (happily) some exceptions,

e.g. the **He I triplet line at 1.08 μm**

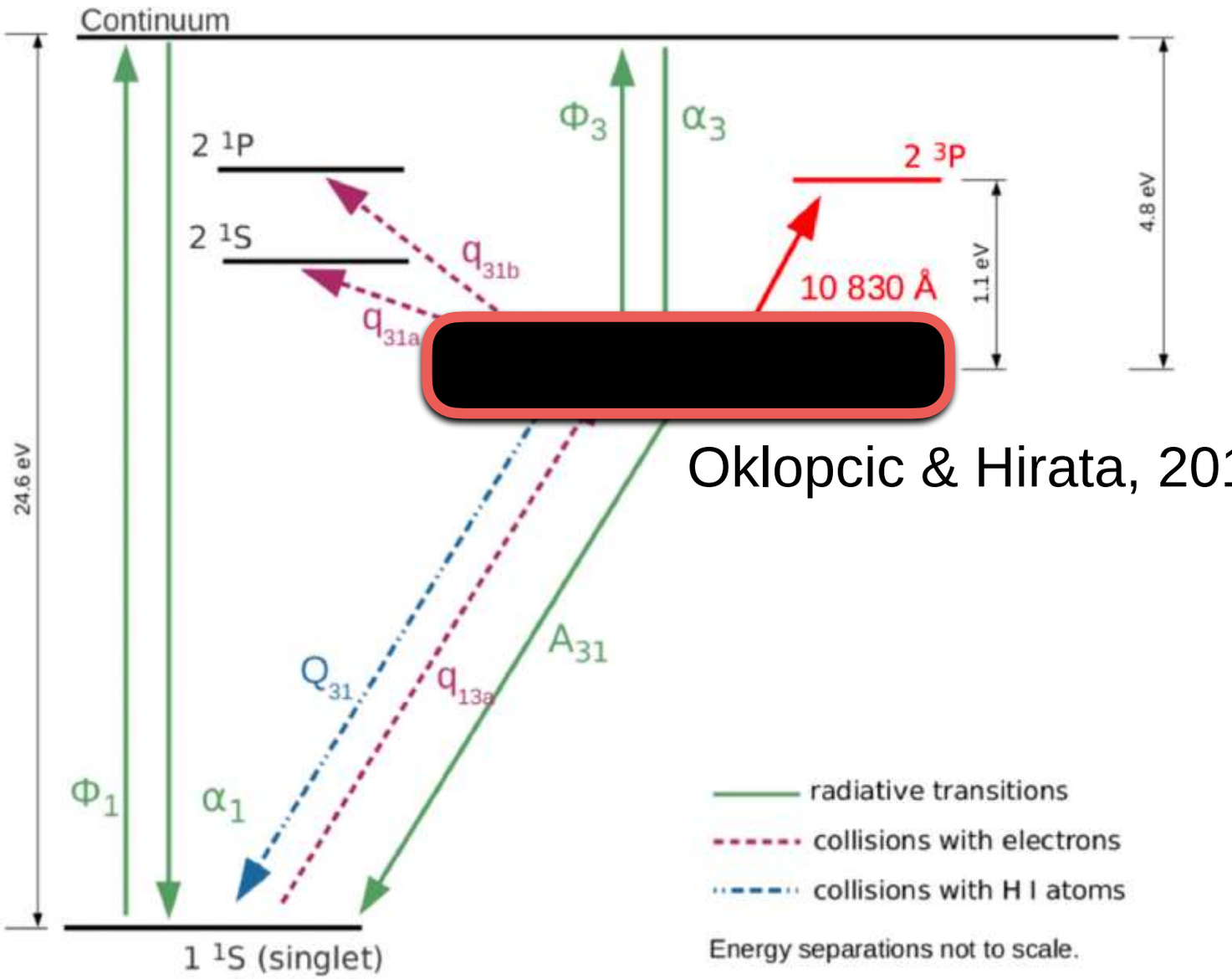


Formation of the He I triplet line at 1.08 μm

$He^+ + e^-$

Classical view:

low-density atomic H gas



Oklopcic & Hirata, 2018

Some questions to myself. Effect of:

#1) Photoelectrons [GM25].

#2) Molecularity of the gas [GM+25].

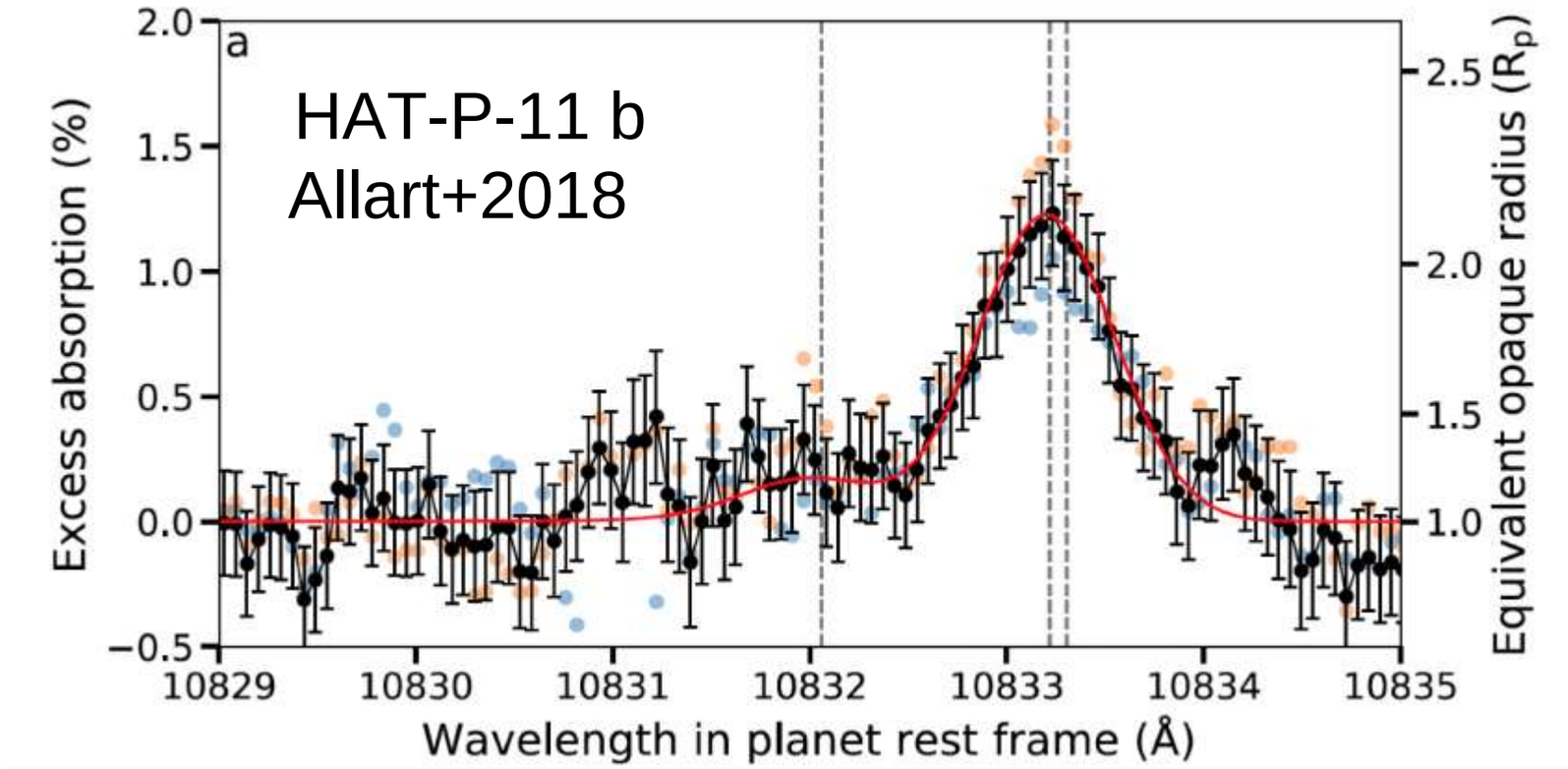
He

#3) Metal chemistry [GM, *in prep.*].

#4) Radiative transfer in the lines.

“Molecularity”

The line traces the upper atmosphere, up to a few R_p.



Bulk gas may or may not have transitioned from H_2 into H.

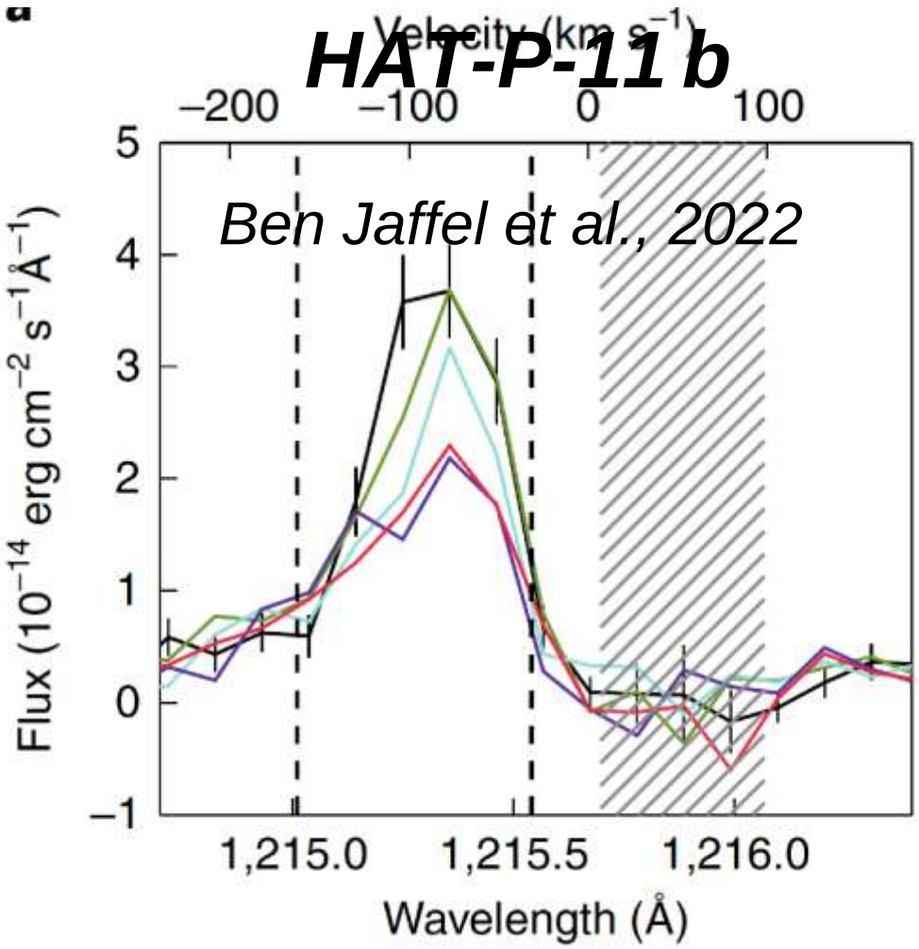
Is that important at all?

Built a molecular network [GM, A&A, 2025]

Explored warm Neptunes HAT-P-11 b, GJ 3470 b, GJ 436 b [GM+2025, A&AL]

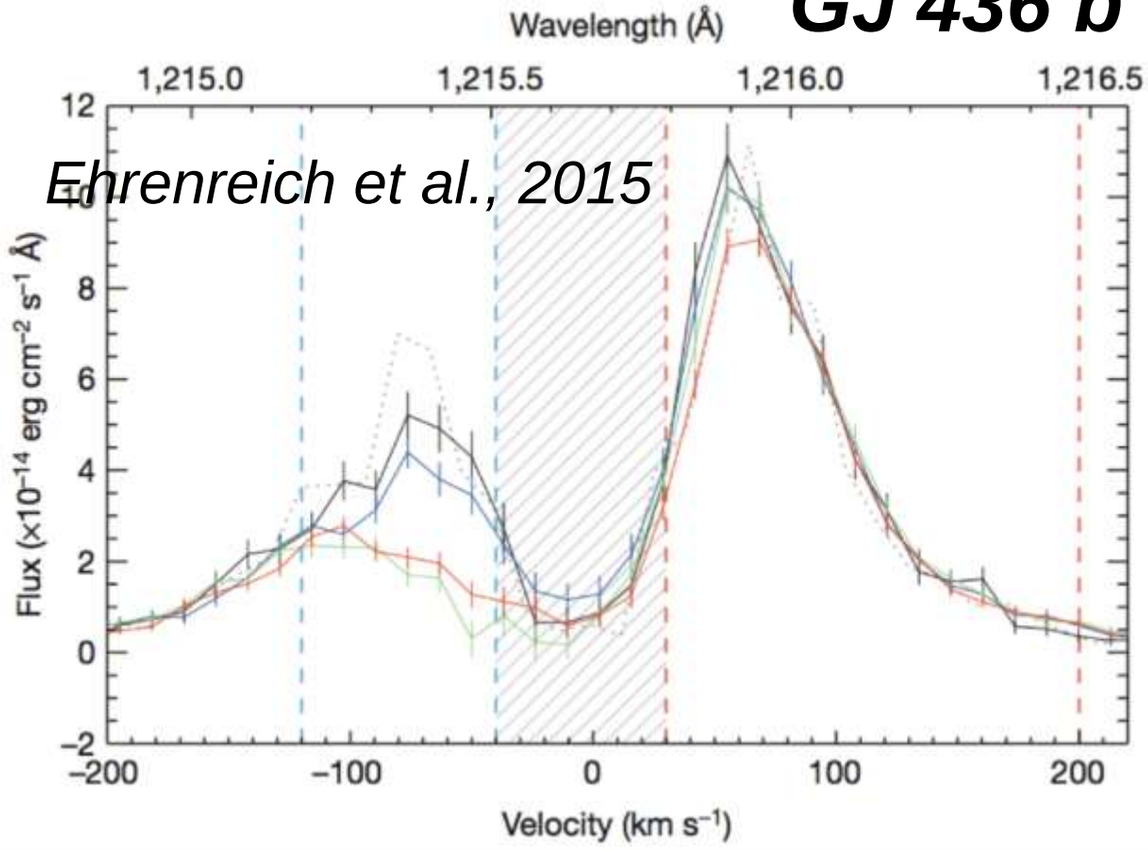
Ly-α

HAT-P-11 b

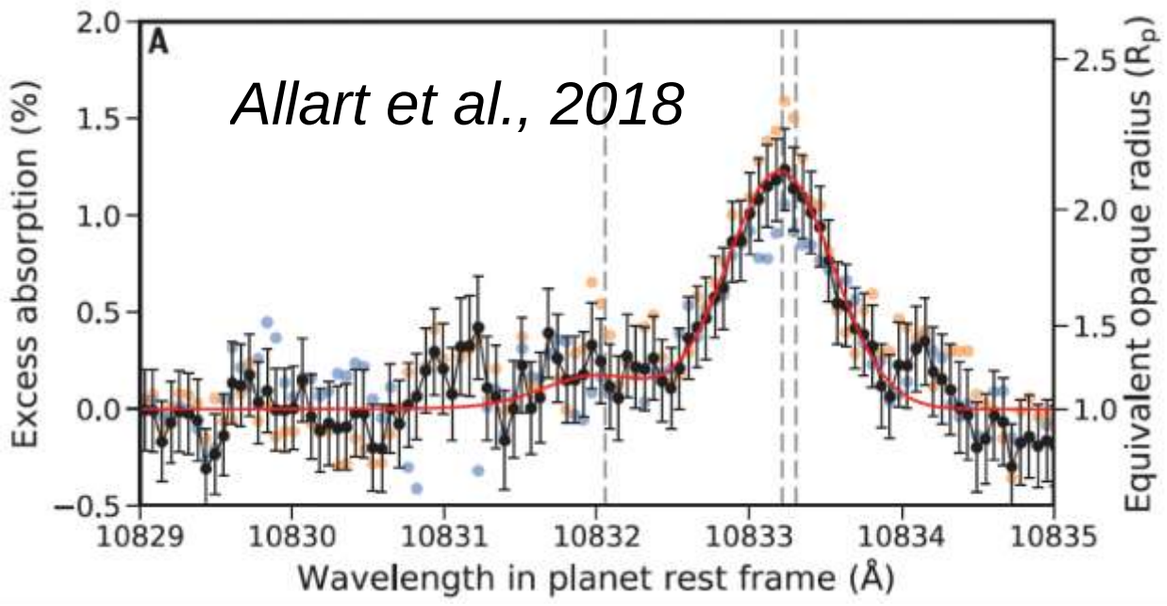


Ben Jaffel et al., 2022

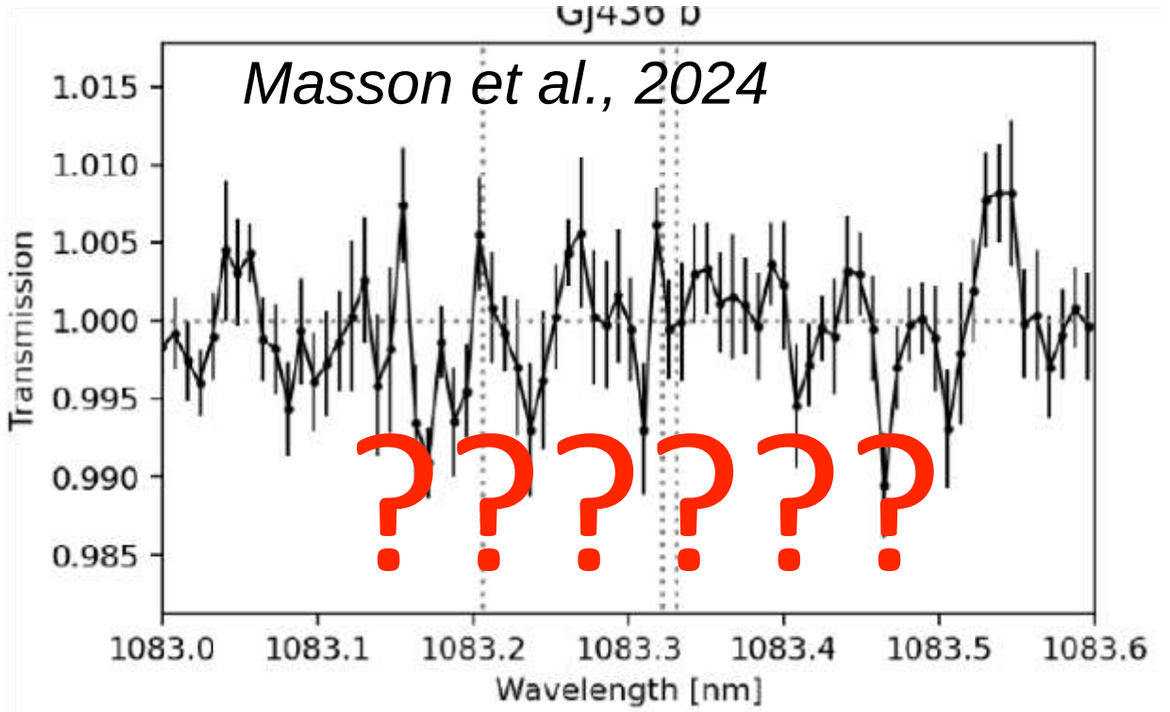
GJ 436 b



Ehrenreich et al., 2015



Allart et al., 2018

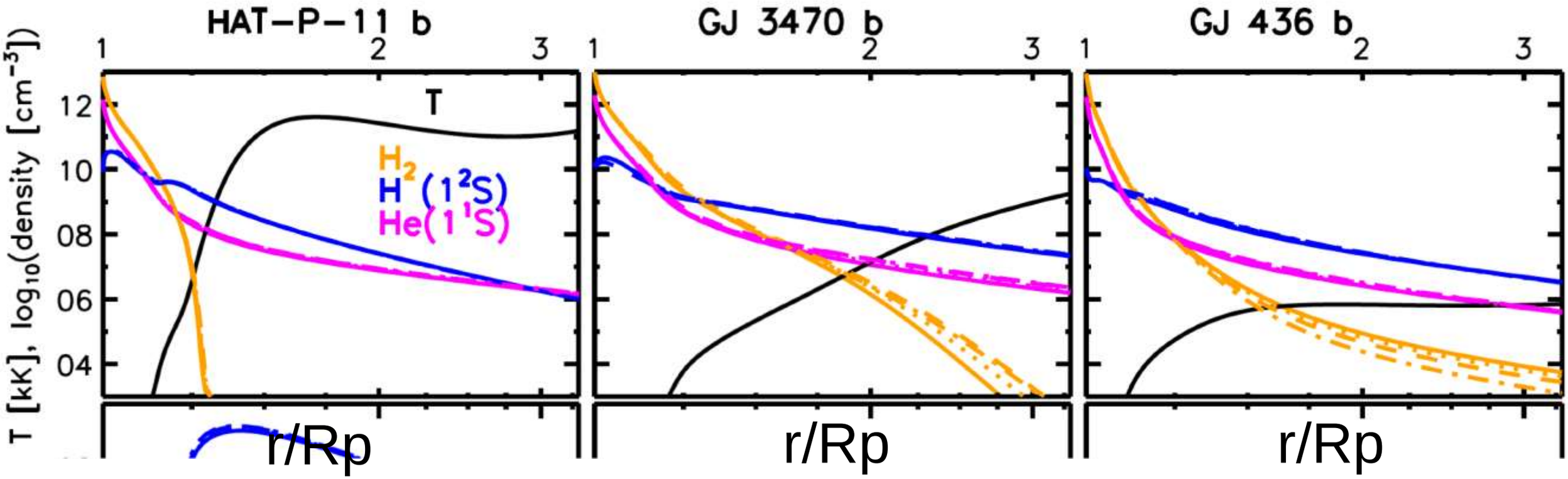


Masson et al., 2024

??????

Finding 1:

H_2 transitions into H differently at each planet



Distance	Stellar flux [erg cm^{-2}s^{-1}] over the specified bands						
	0-100 Å	0-228 Å	0-504 Å	0-912 Å	912-1200	1214-1220 Å	912-2600 Å
HAT-P-11 b	299	647	3229	11907	4644	2512	20590
GJ 3470 b	762	1044	2029	2642	461	4239	5988
GJ 436 b	53	70	127	278	70	895	1316