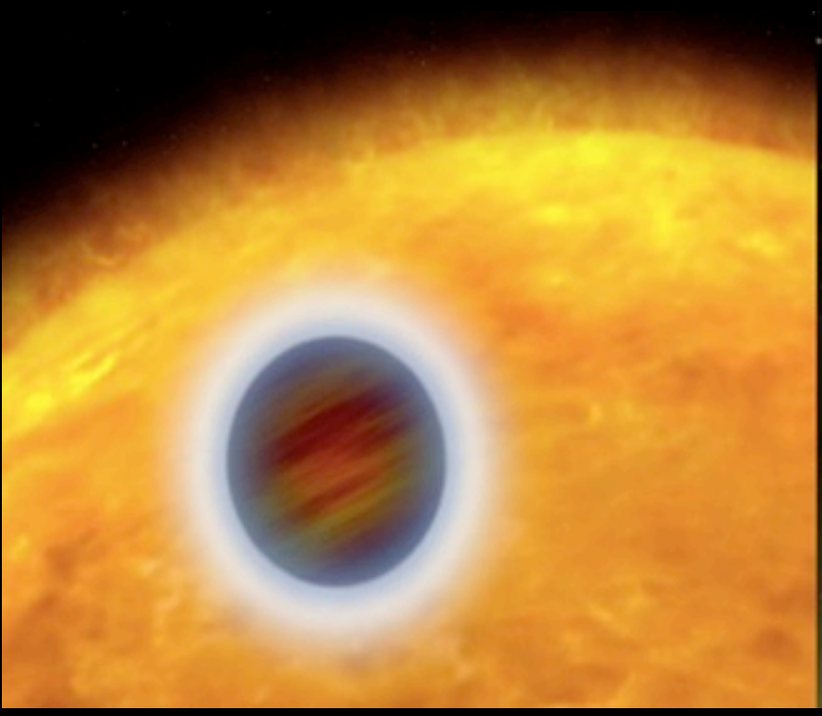
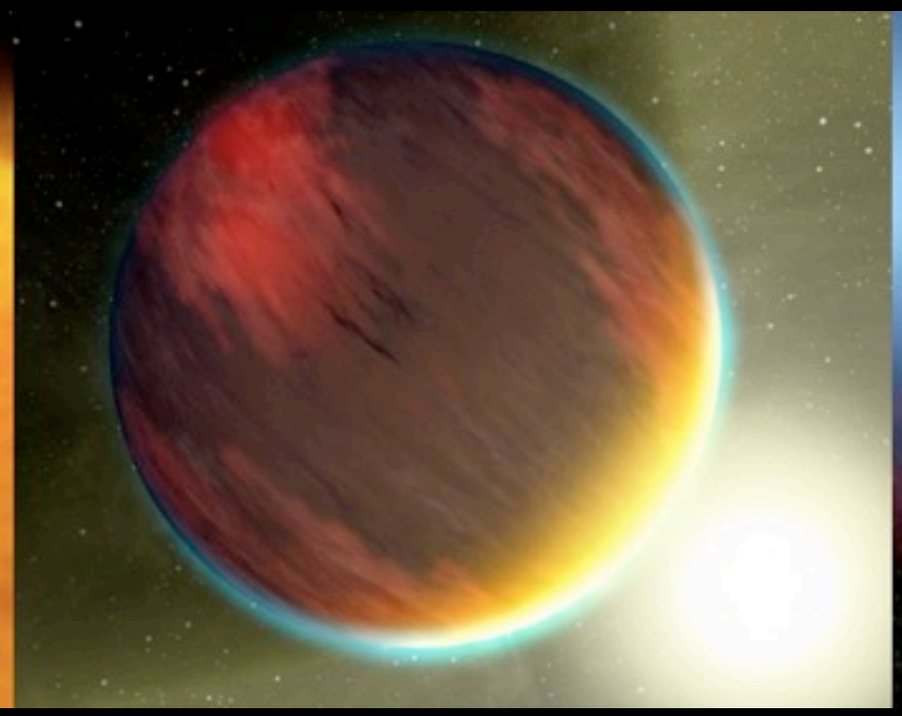
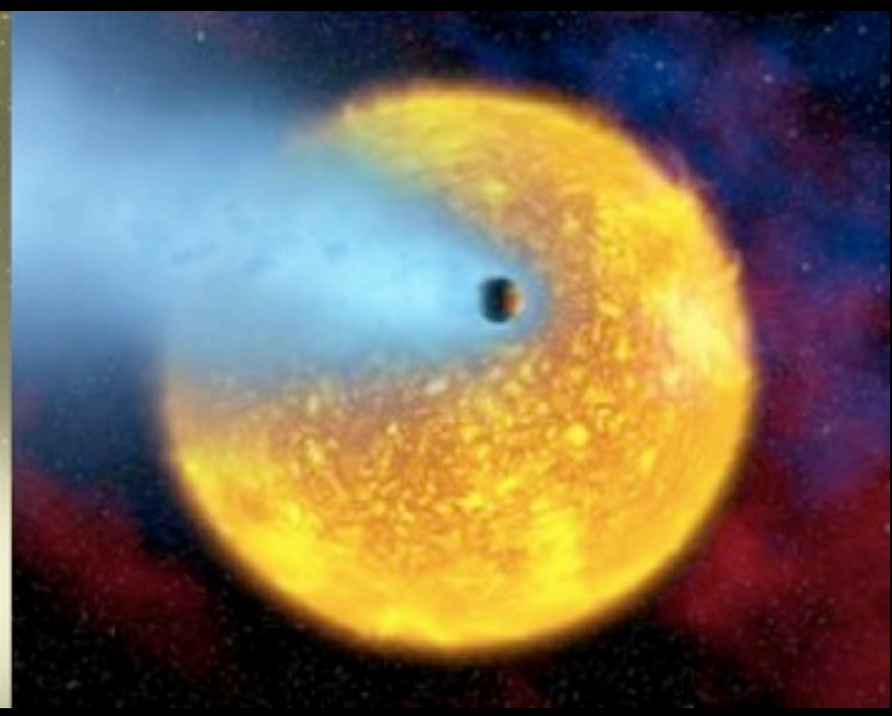
Characterizing Hot Jupiter Atmospheres with Large Ground-Based Telescopes

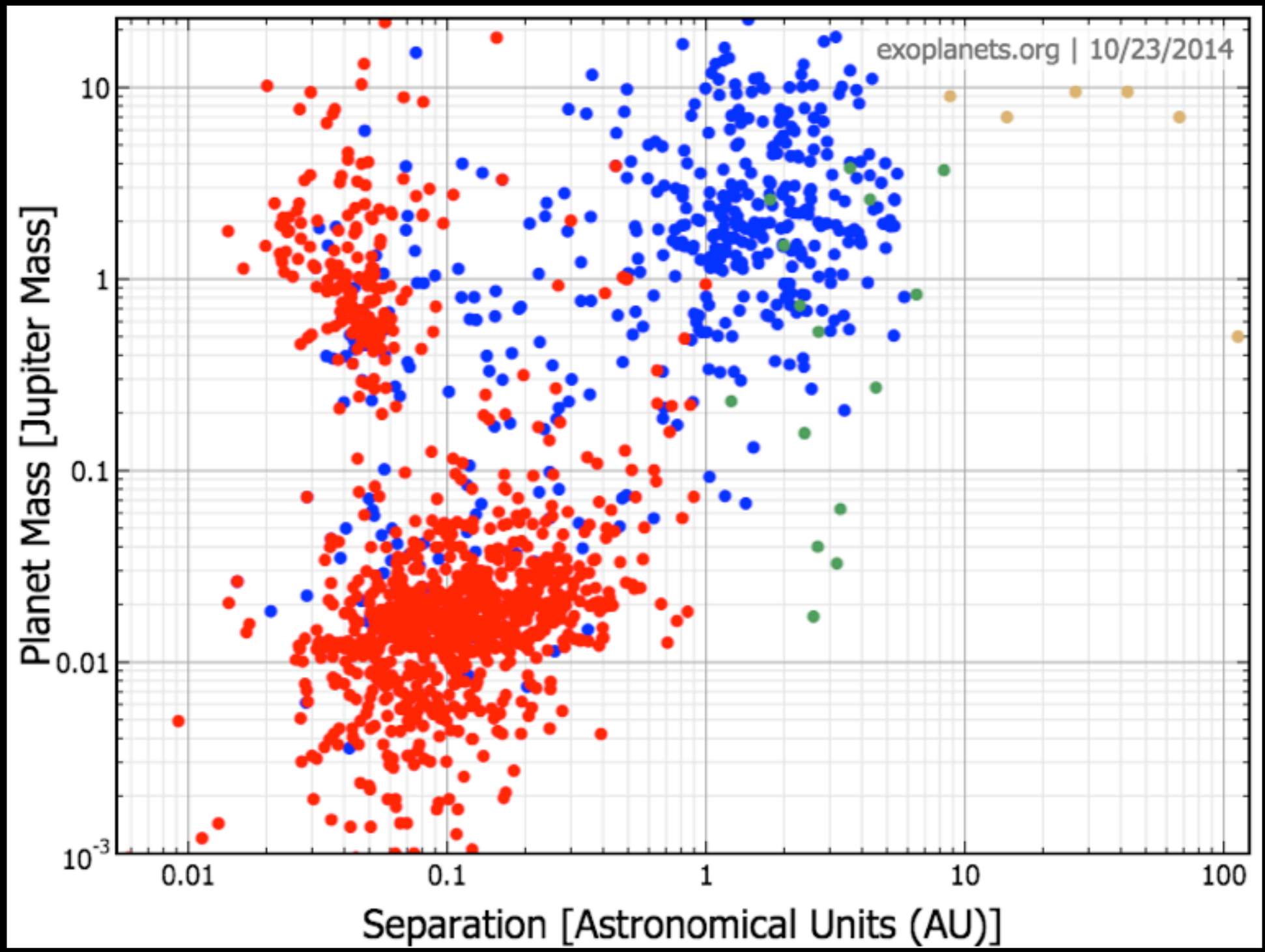




Knicole D. Colón

Lehigh University

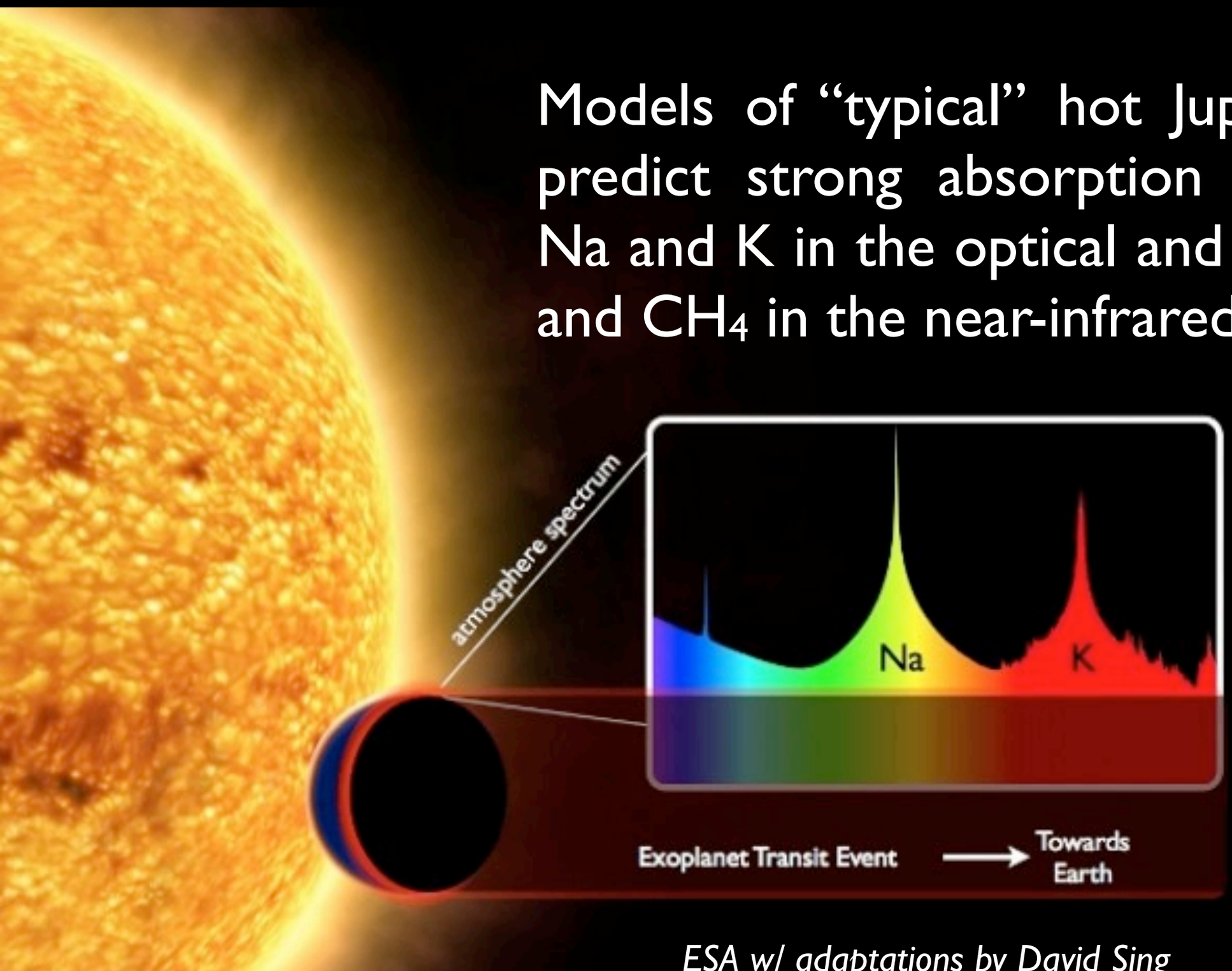
BDEXOCON - October 2014

Current State of Exoplanet Affairs



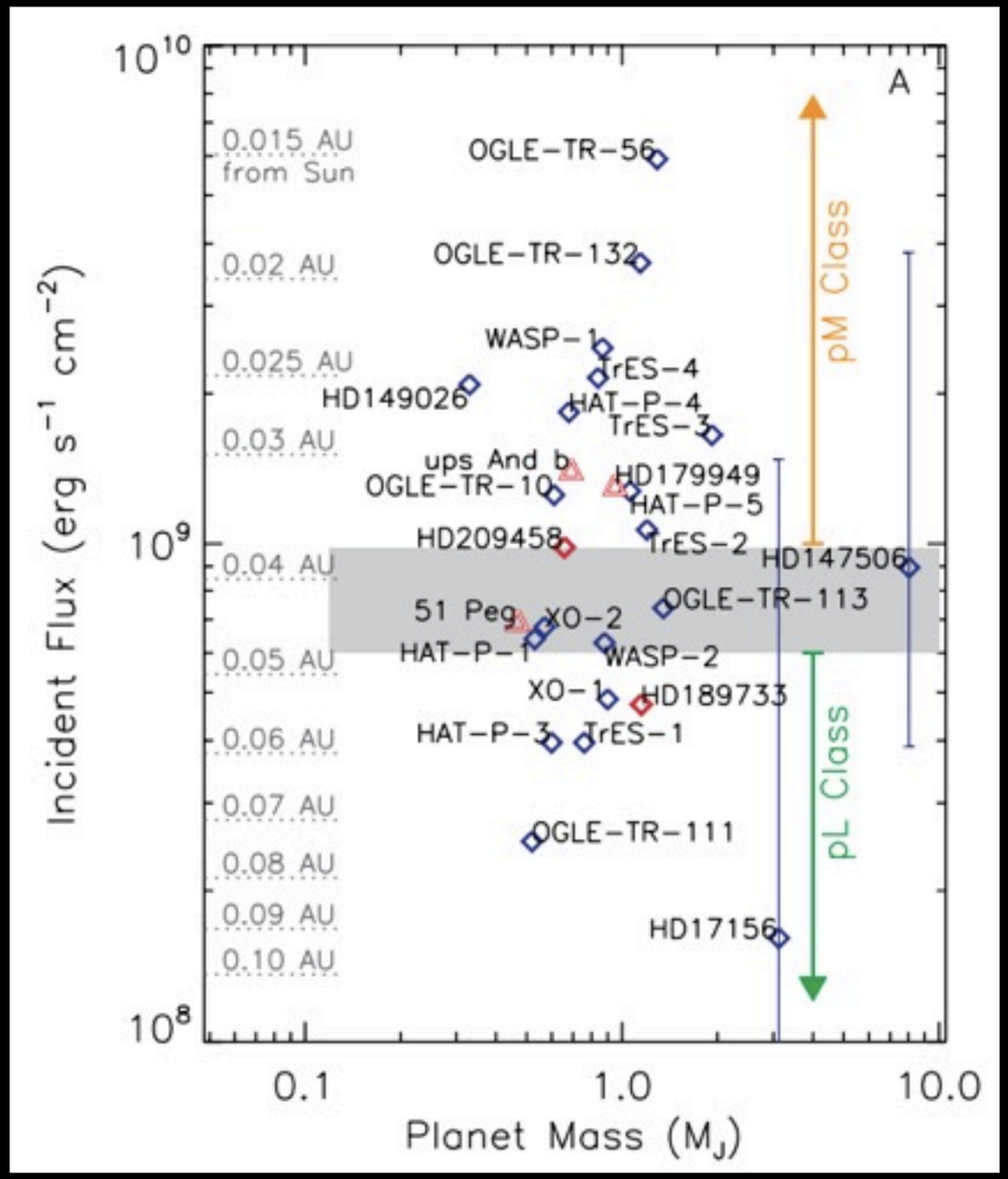
Hot Jupiter Atmospheres

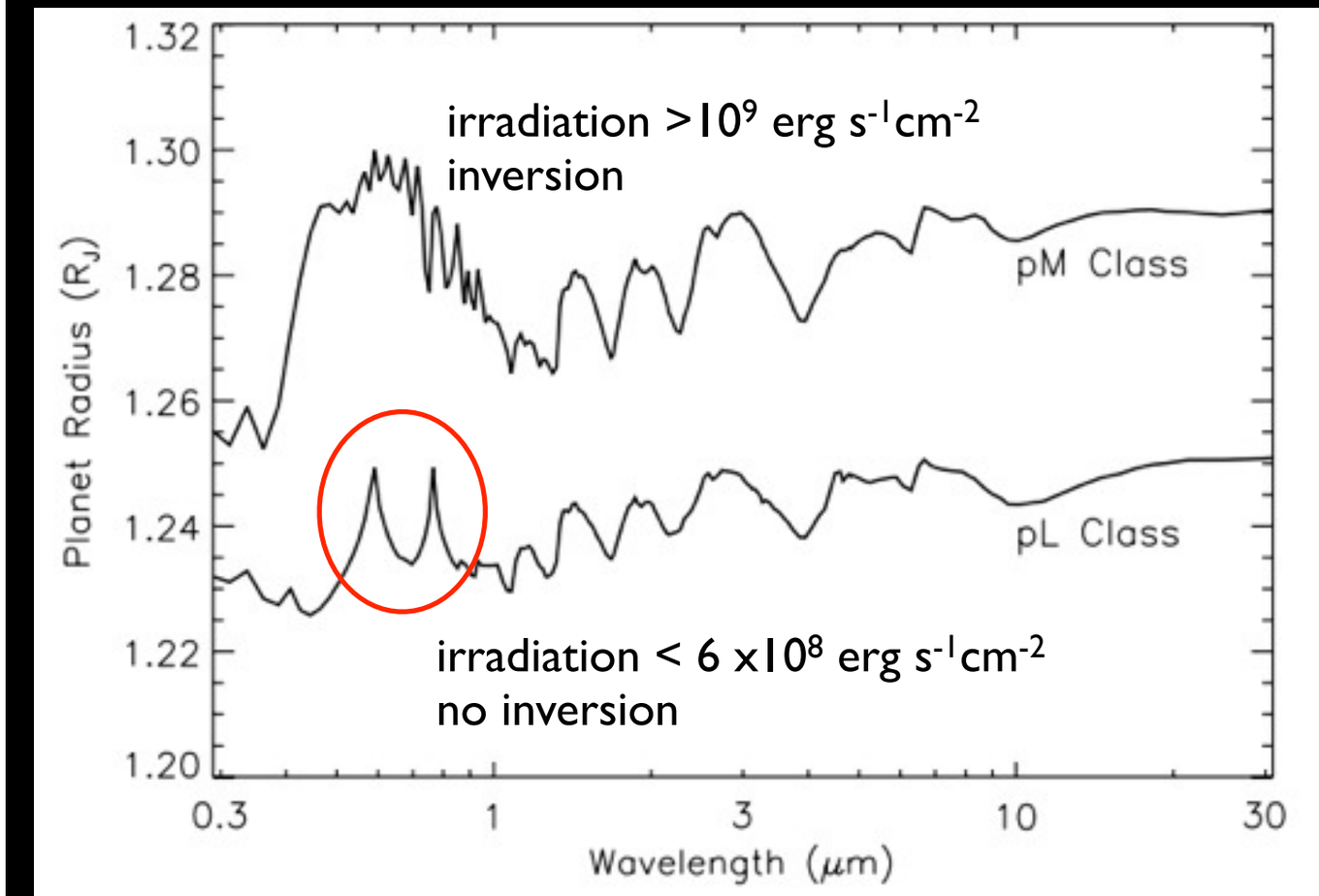
Models of "typical" hot Jupiters predict strong absorption from Na and K in the optical and H_2O and CH_4 in the near-infrared



ESA w/ adaptations by David Sing

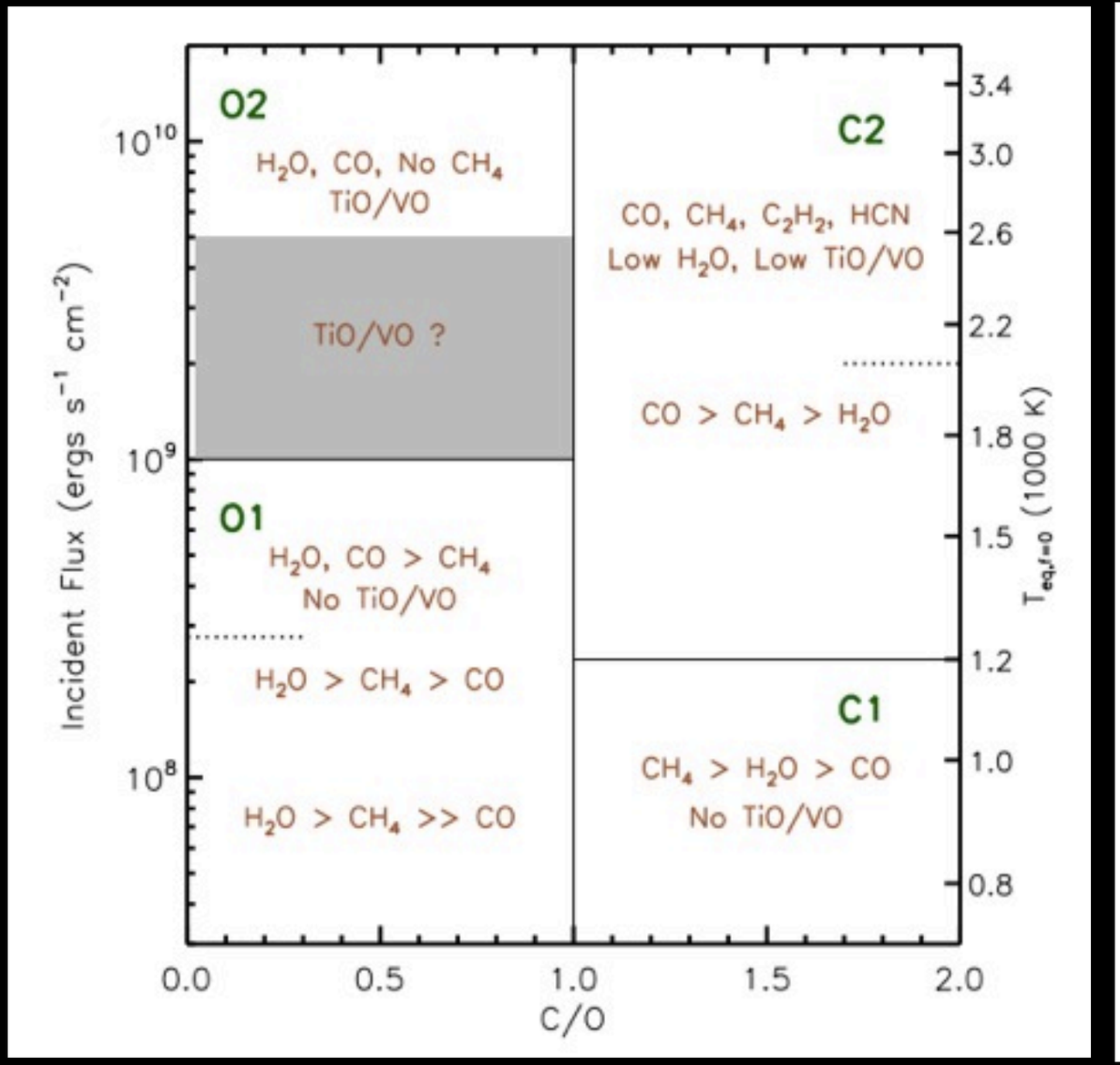
Two Classes of Hot Jupiters?

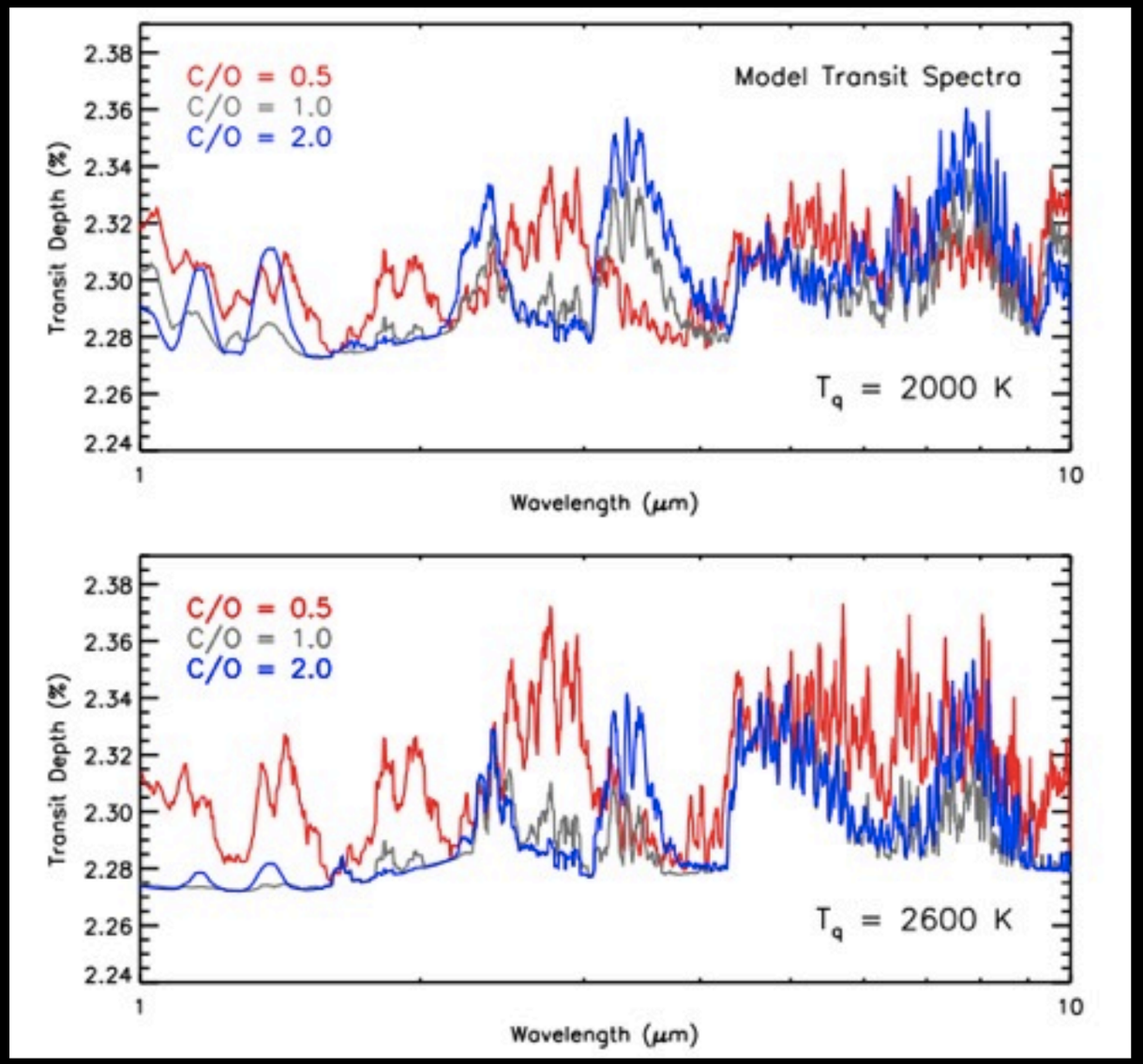




Fortney et al. 2008

Four Classes of Hot Jupiters?





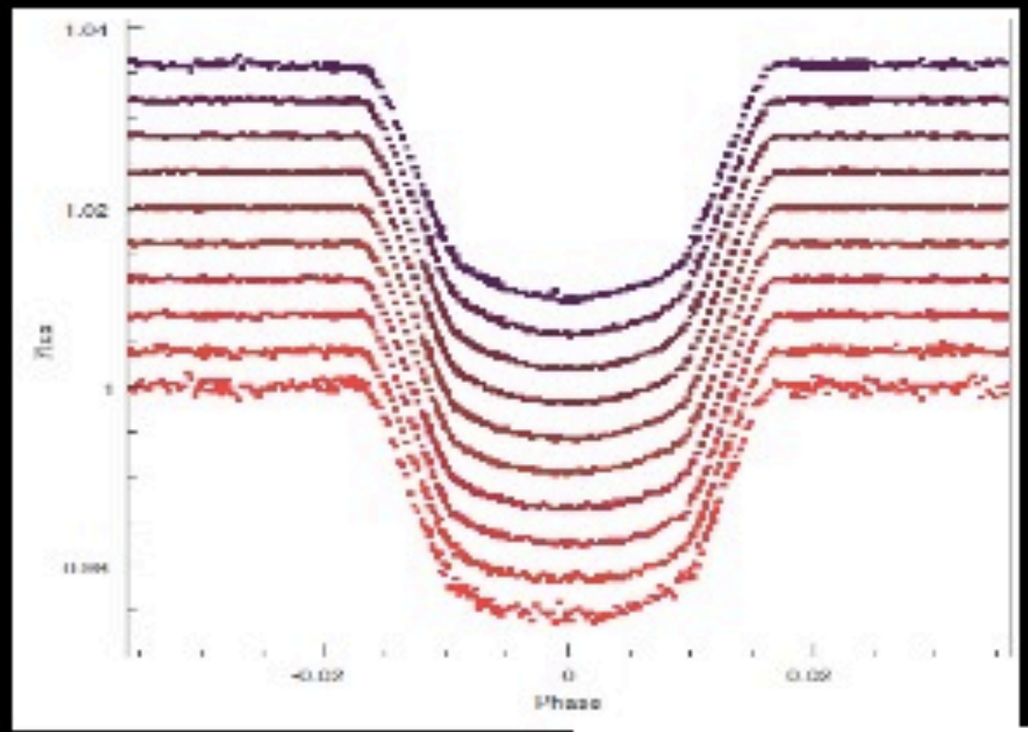
Madhusudhan 2012

Some Recent Transmission Results

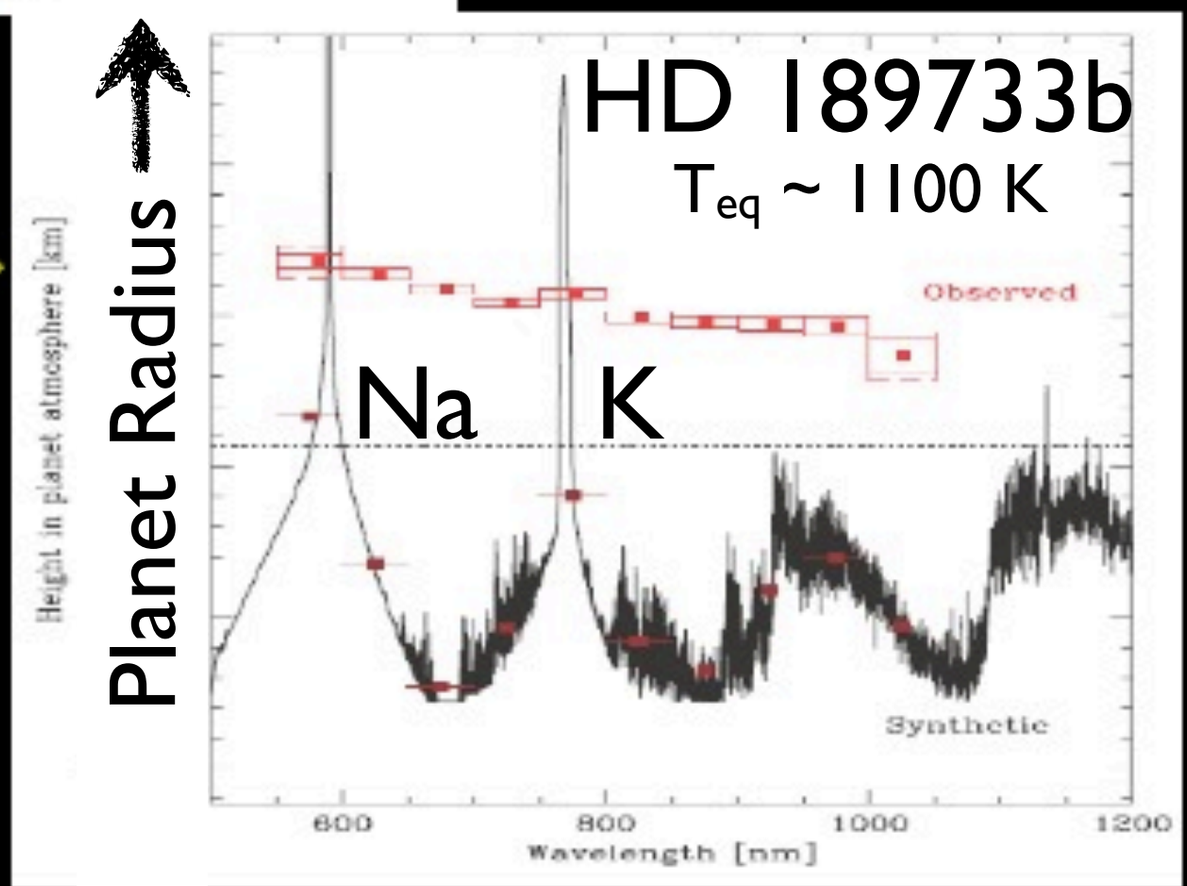
HD209458b
- Na
- C II
- H_2O, H I, H_2, TiO/VO
- CO
- H I, O I, Si III
- H_2O

HD189733b
- Na
- haze
- CO, H I
- H_2O, CH_4
- H_2O

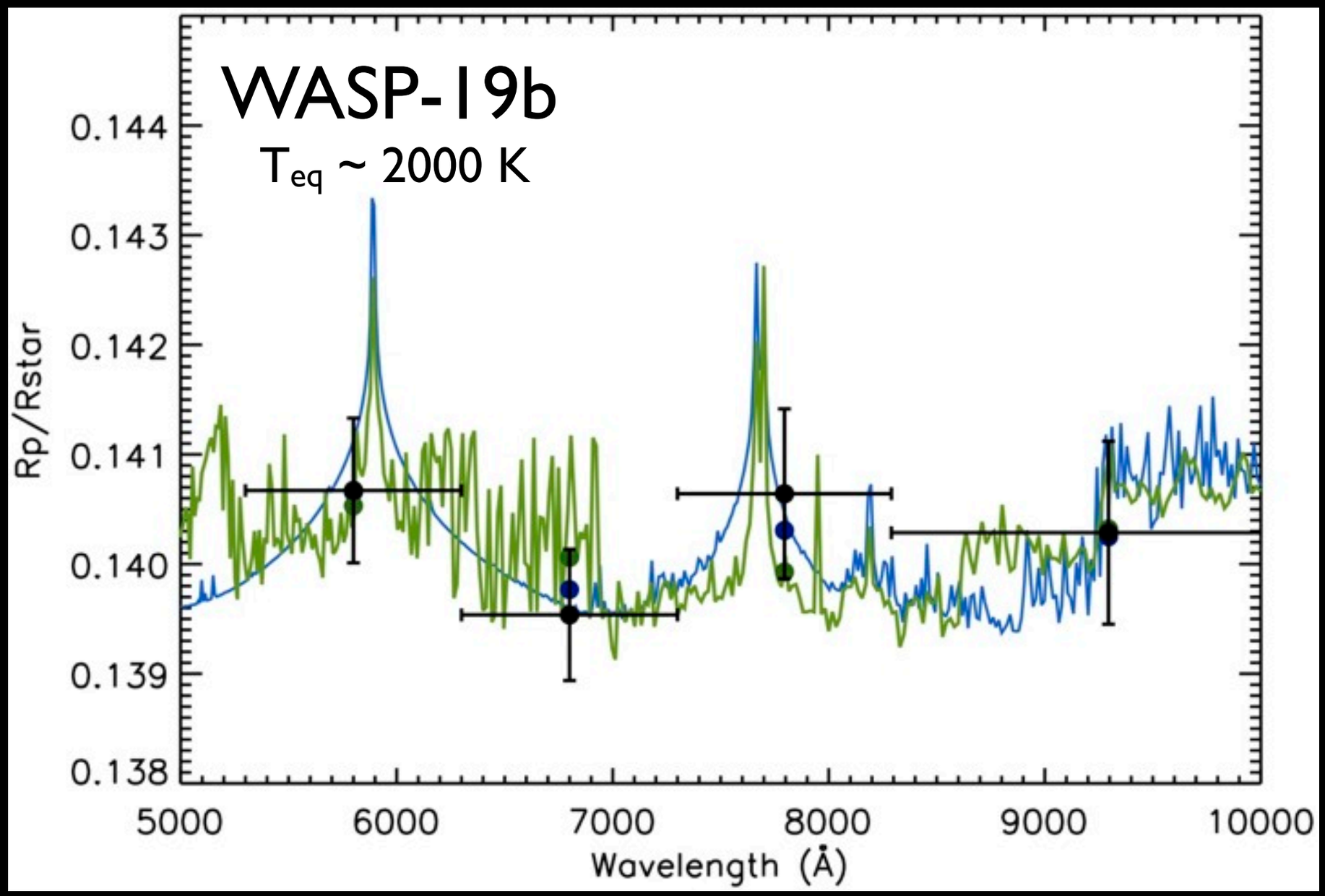
XO-1b: H_2O, CH_4, CO_2
Wasp-12b: Mg II, Metals
XO-2b: K
HD80606b: K
Wasp-17b: Na



Pont et al. 2008



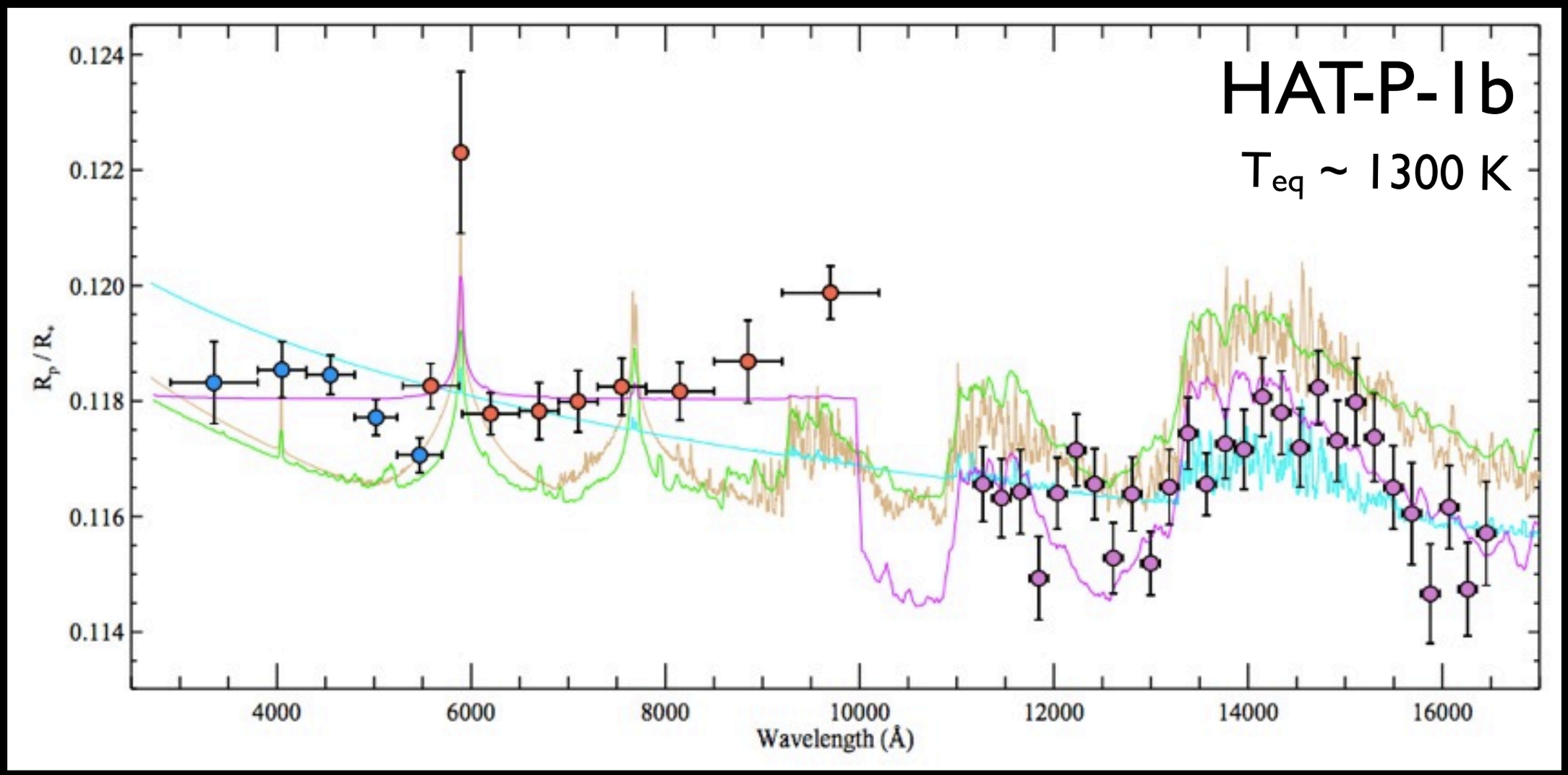
Some studies find hot Jupiters have high altitude clouds or hazes that obscure possible potassium absorption



HST - Huitson et al. 2013

Some studies find hot Jupiters have some extra absorbers *or* an under-abundance of potassium compared to sodium

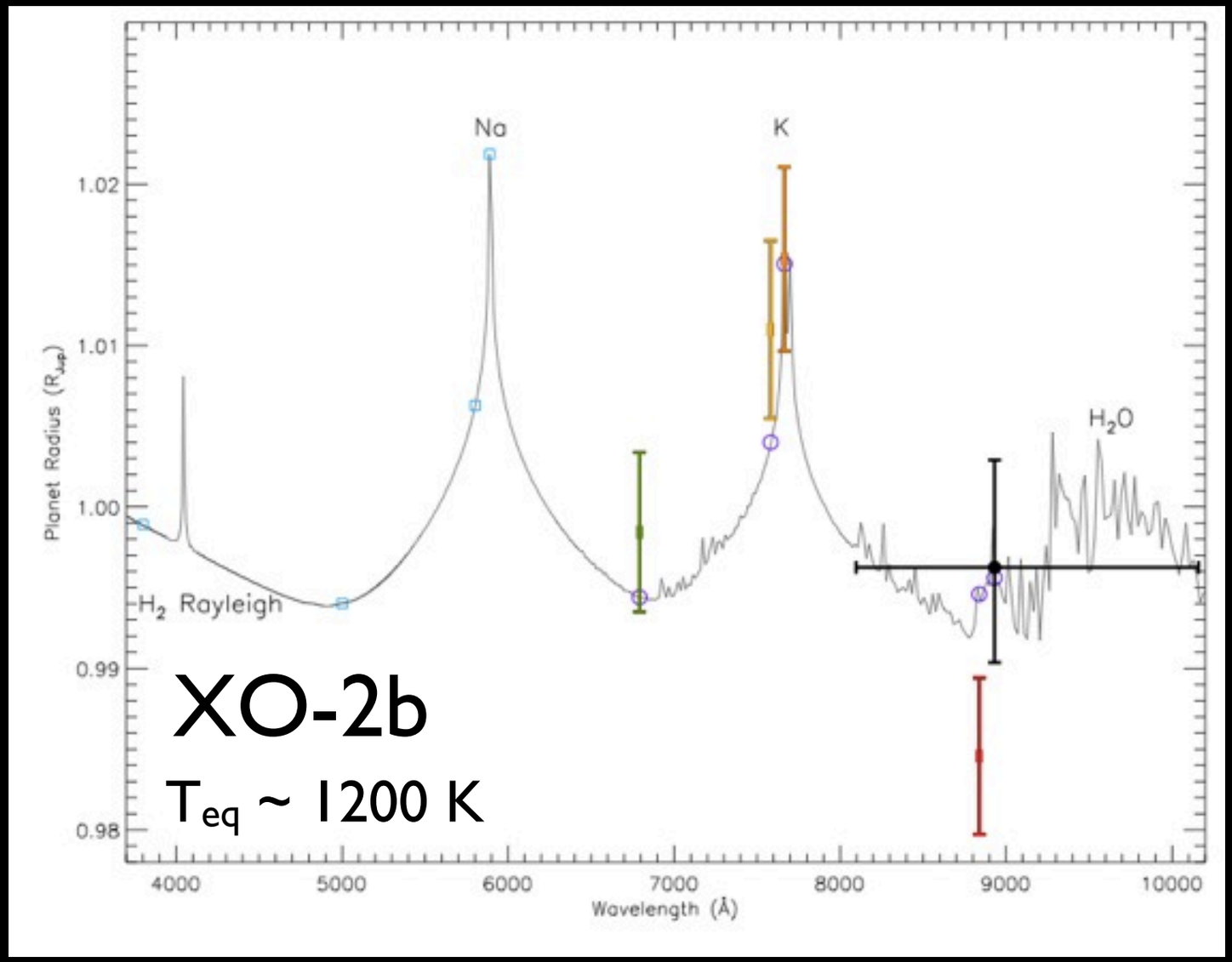
Planet Radius



Wavelength (Angstroms)

HST - Nikolov et al. 2014

Some studies find hot Jupiters have significant potassium absorption



Wavelength (Angstroms)

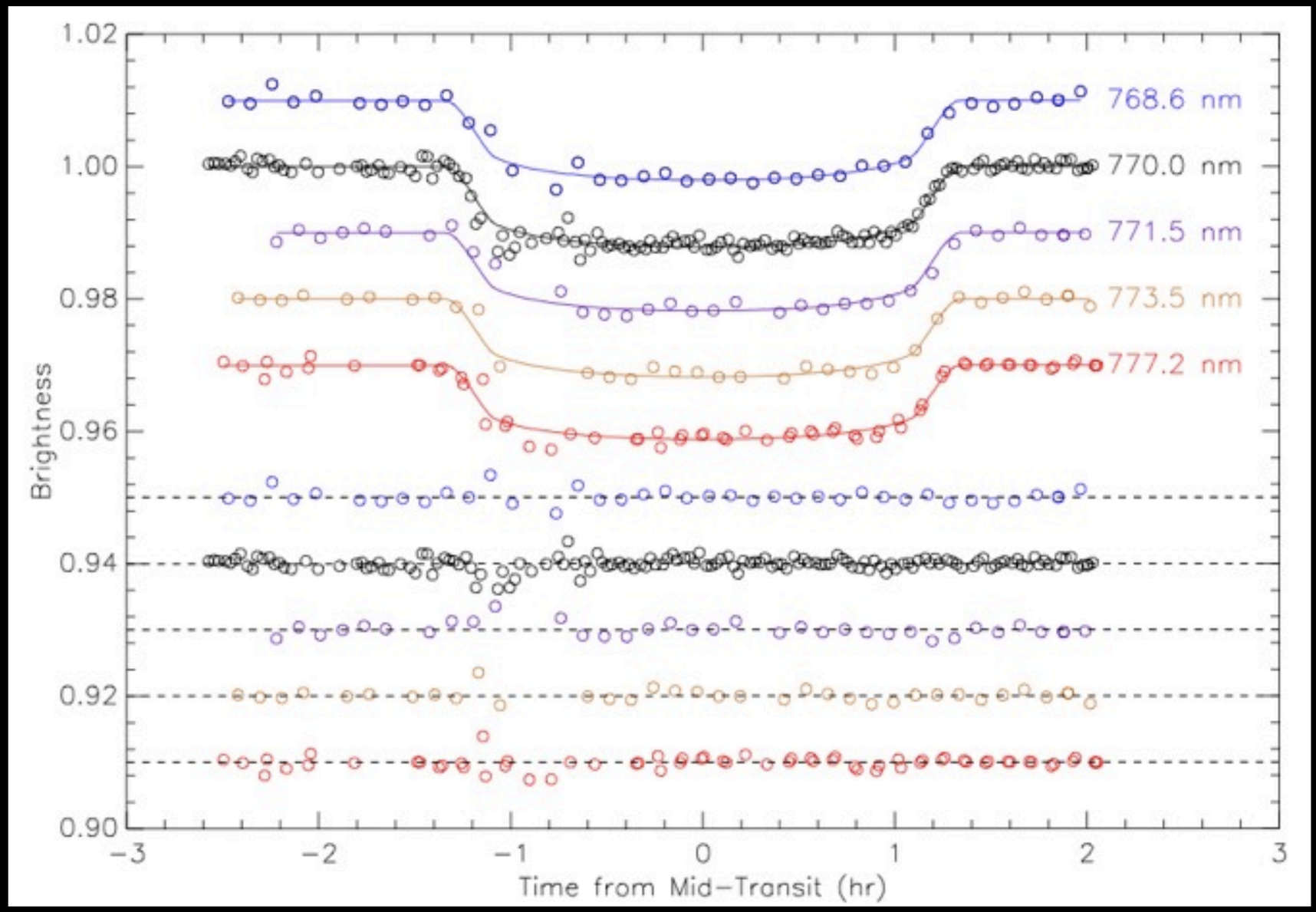
GTC - Sing et al. 2011

Optical Spectra with OSIRIS on GTC

- 10.4-meter Gran Telescopio Canarias (GTC)
- Optical System for Imaging and low Resolution Integrated Spectroscopy (OSIRIS): instrument with a unique tunable filter imaging mode allowing for use of custom narrow bandpasses

XO-2b Transit Light Curves

T_{eq} ~ 1200 K

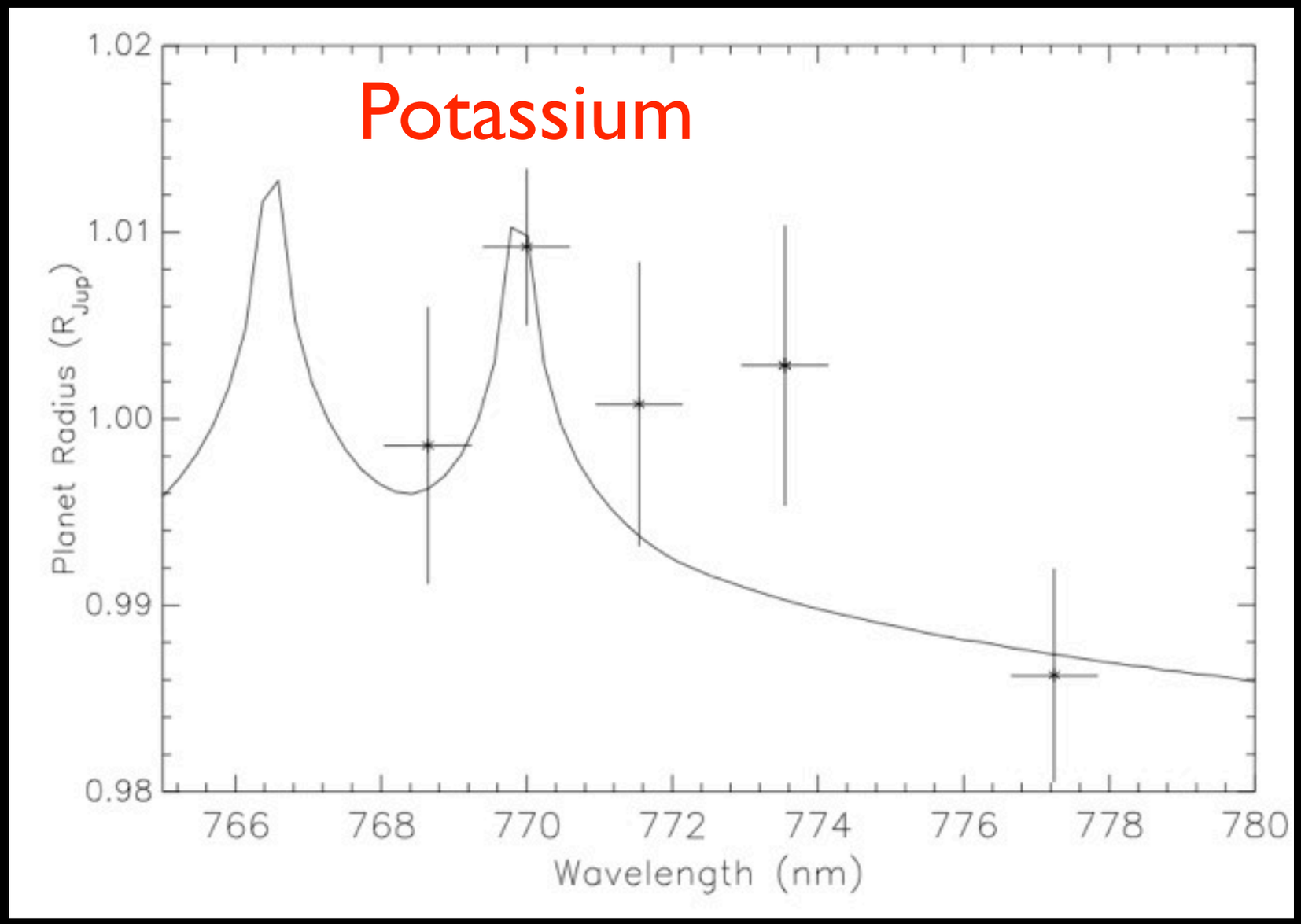


Time from Mid-Transit (hr)

Colón et al., in prep

XO-2b Transmission Spectrum

T_{eq} ~ 1200 K



Planet Radius (R_{Jup})

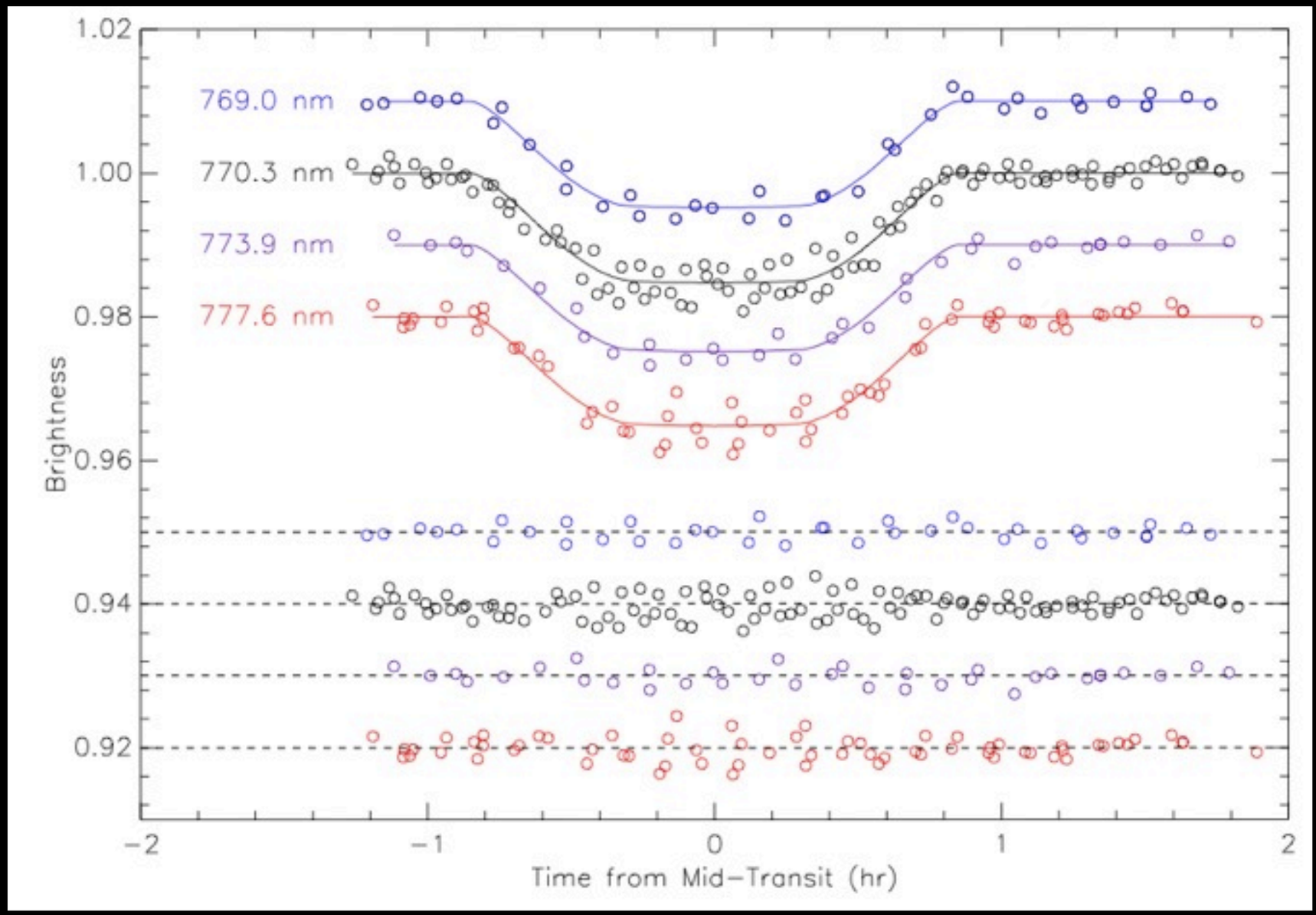
Wavelength (nm)

We tentatively confirm the detection of K absorption by Sing et al. (2011)

Colón et al., in prep

TrES-2b Transit Light Curves

T_{eq} ~ 1500 K

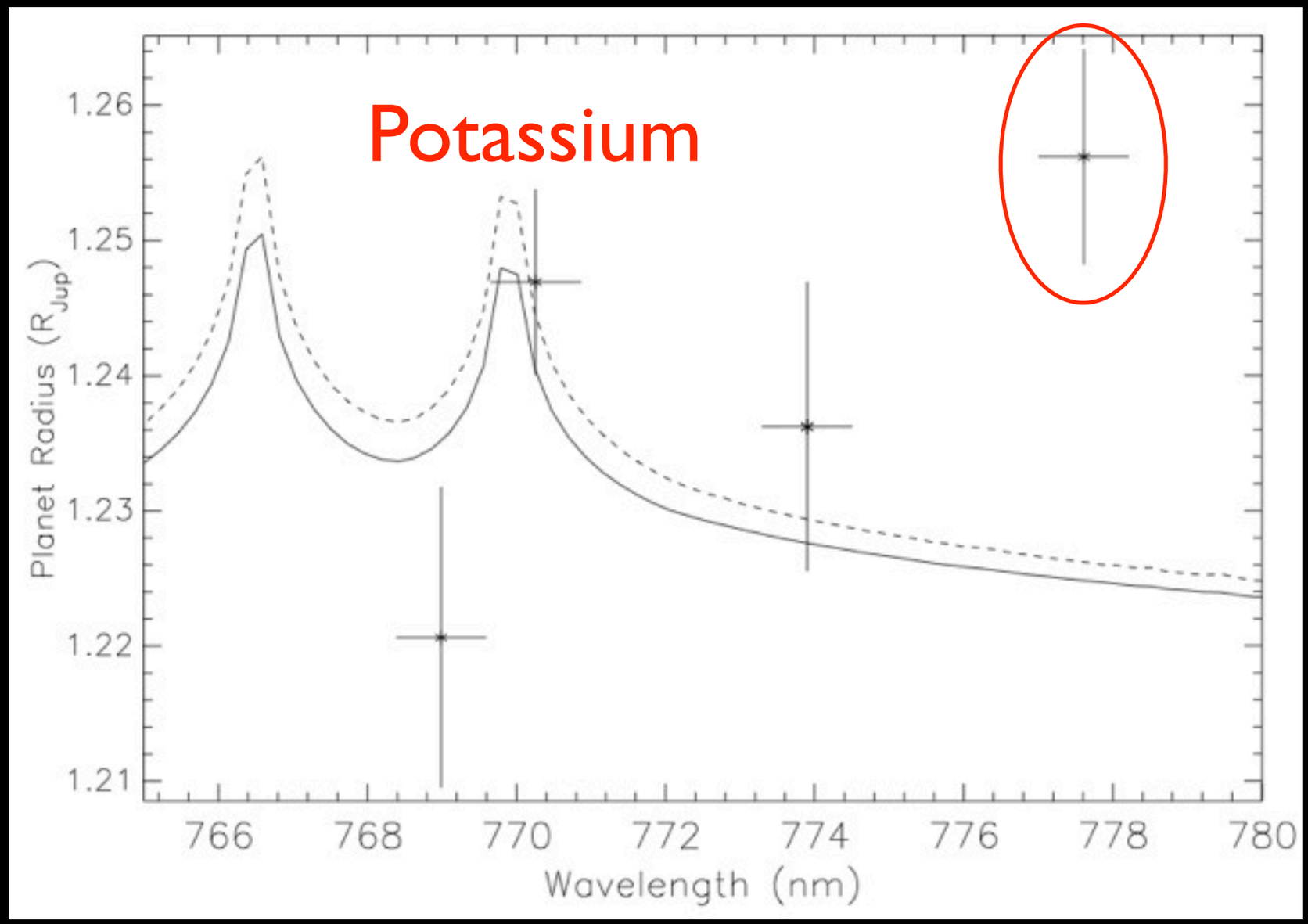


Time from Mid-Transit (hr)

Colón et al., in prep

TrES-2b Transmission Spectrum

T_{eq} ~ 1500 K



Planet Radius (R_{Jup})

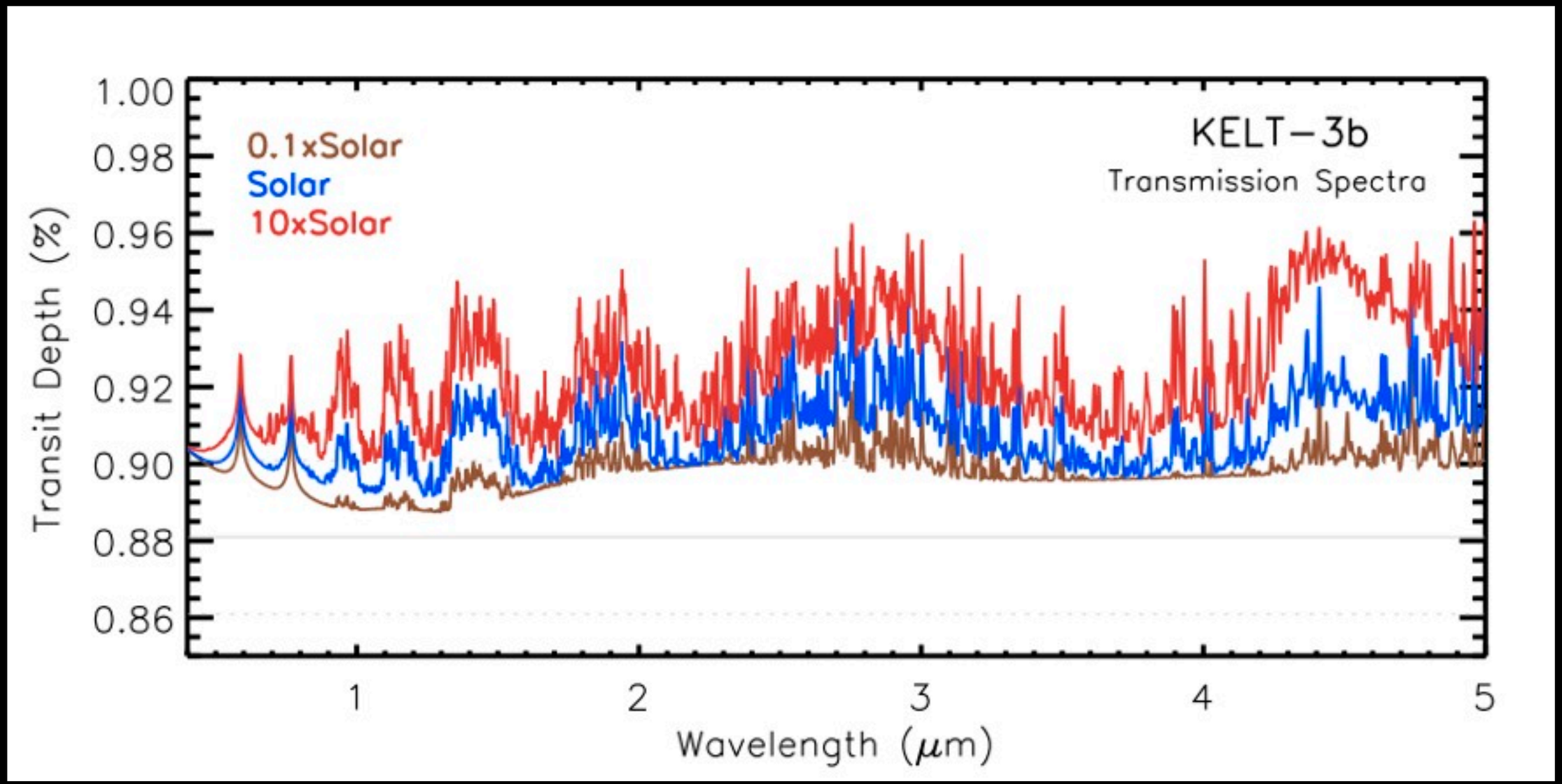
Wavelength (nm)

First tentative detection of K absorption in this planet

Colón et al., in prep

Future Work

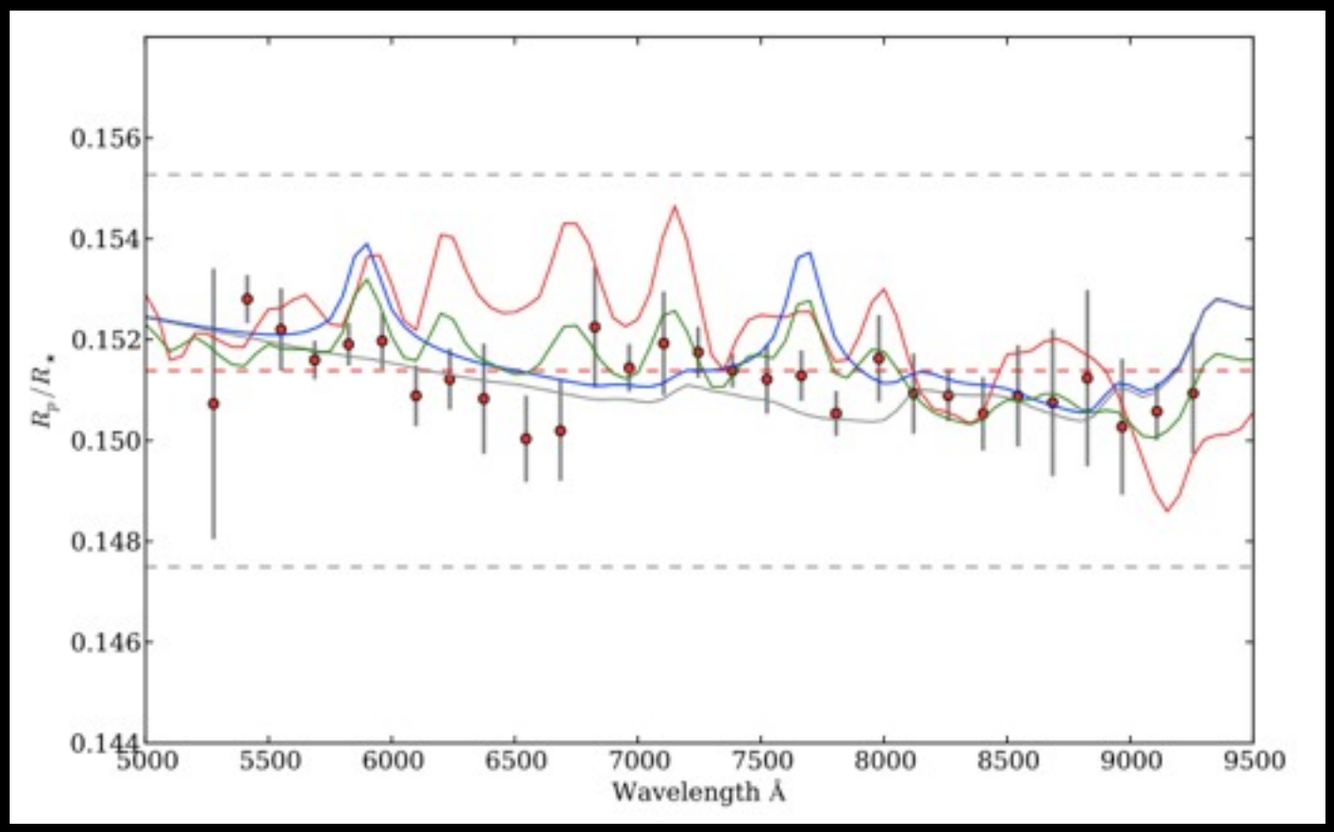
Characterize the "typical" hot Jupiter KELT-3b (T_{eq} ~ 1800 K and V ~ 9.8)



N. Madhusudhan

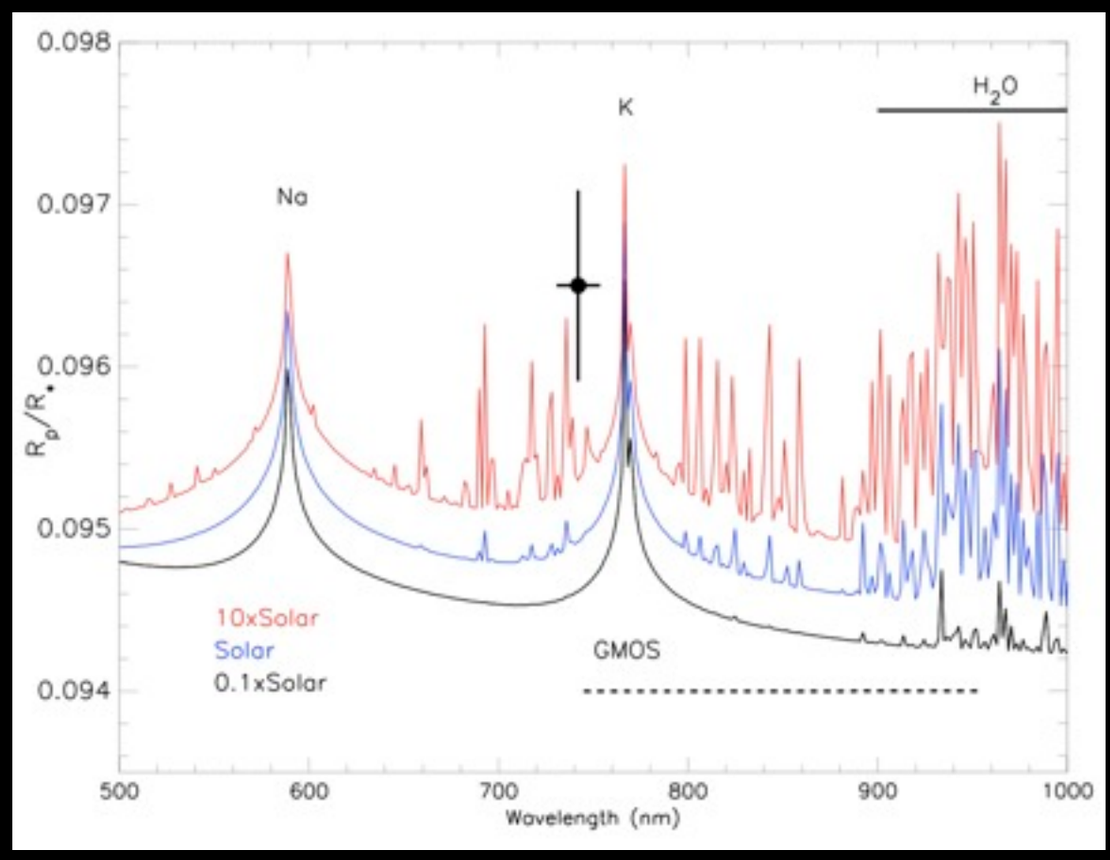
Optical Spectra with GMOS on Gemini

HAT-P-32b GMOS Spectrum



Gibson et al. 2013

KELT-3b Simulated Spectrum



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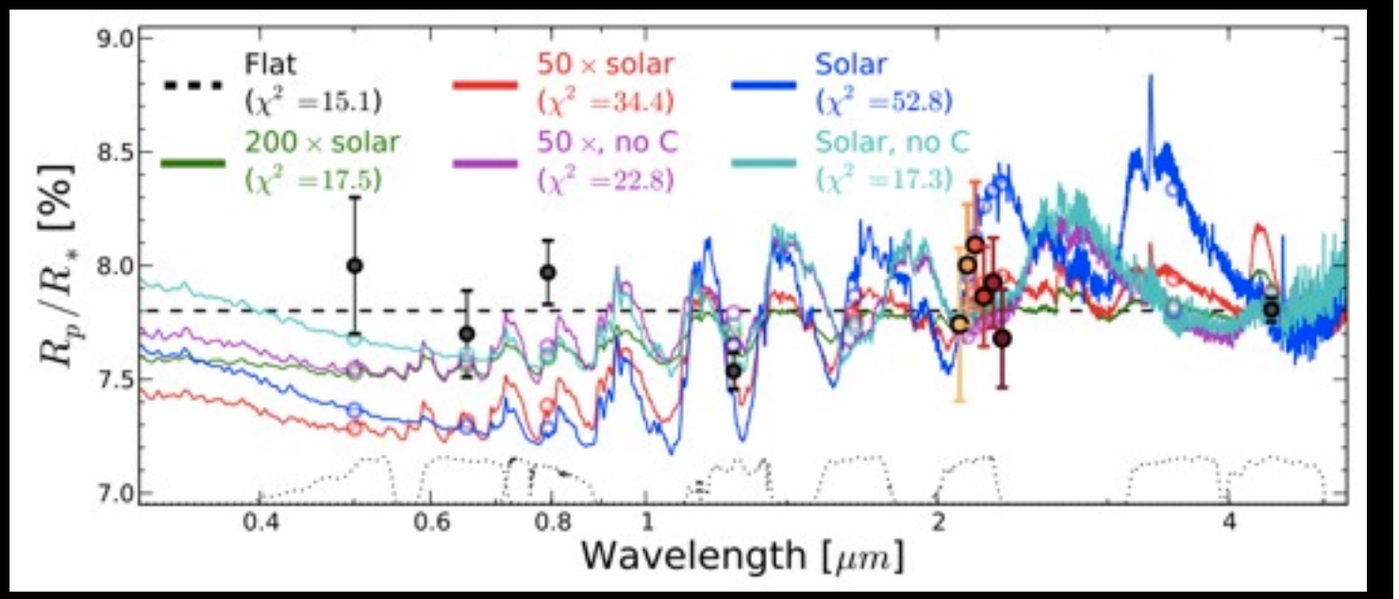
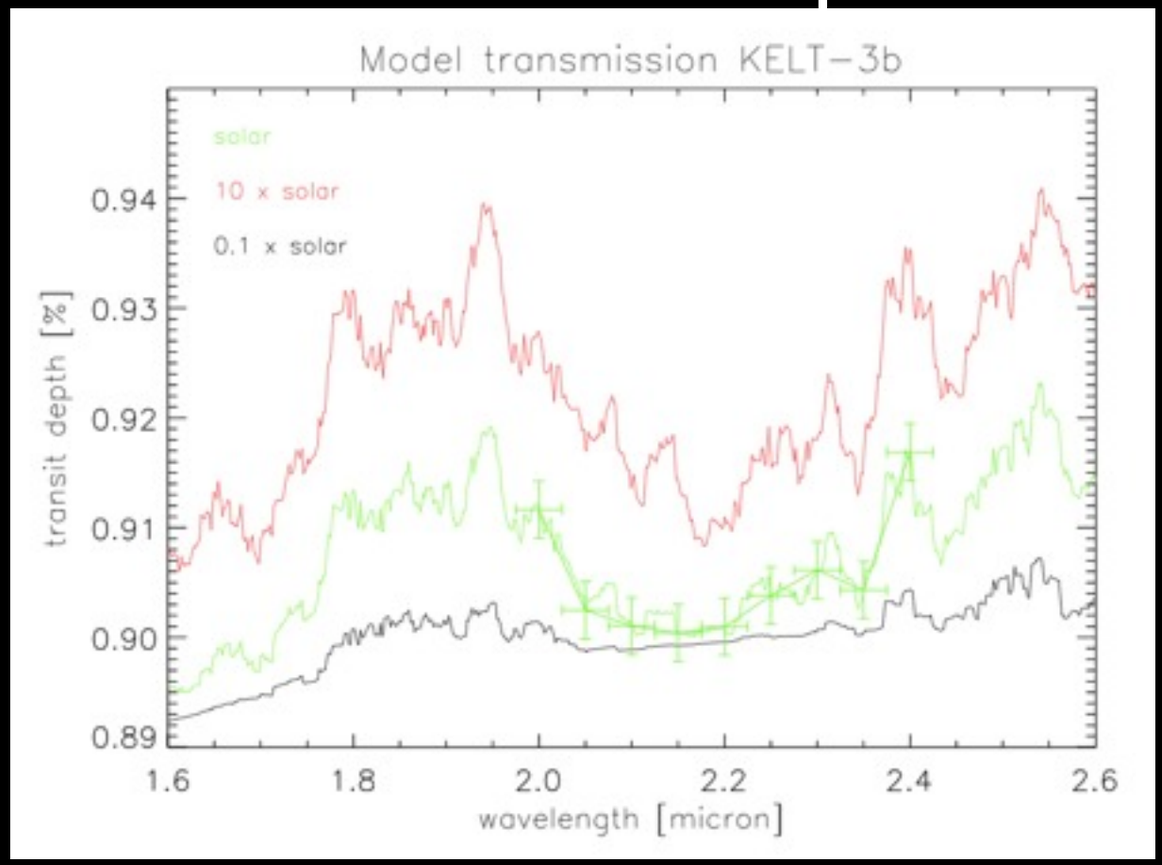
NIR Spectra with MOSFIRE on Keck

GJ 3470b MOSFIRE Spectrum



Crossfield et al. 2013

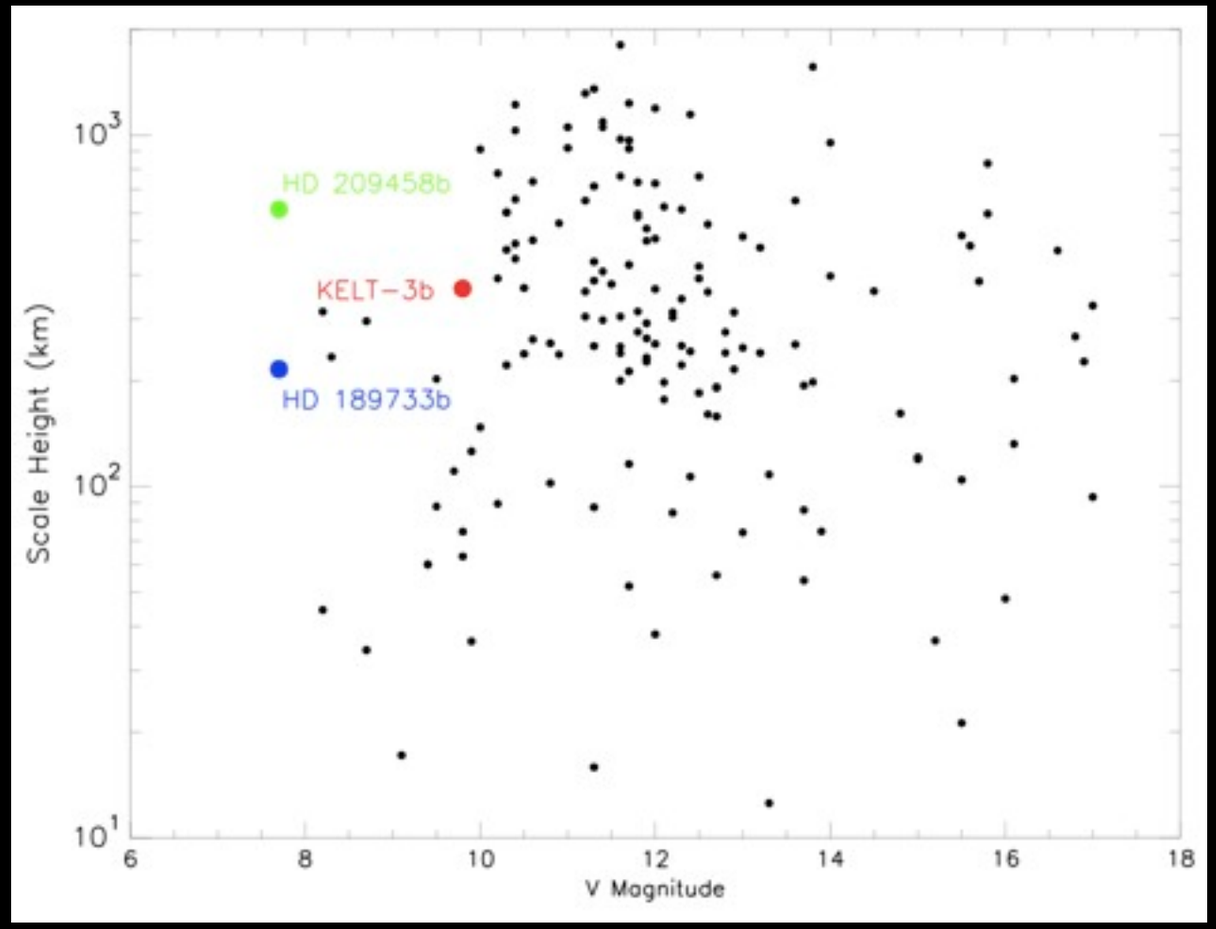
KELT-3b Simulated Spectrum

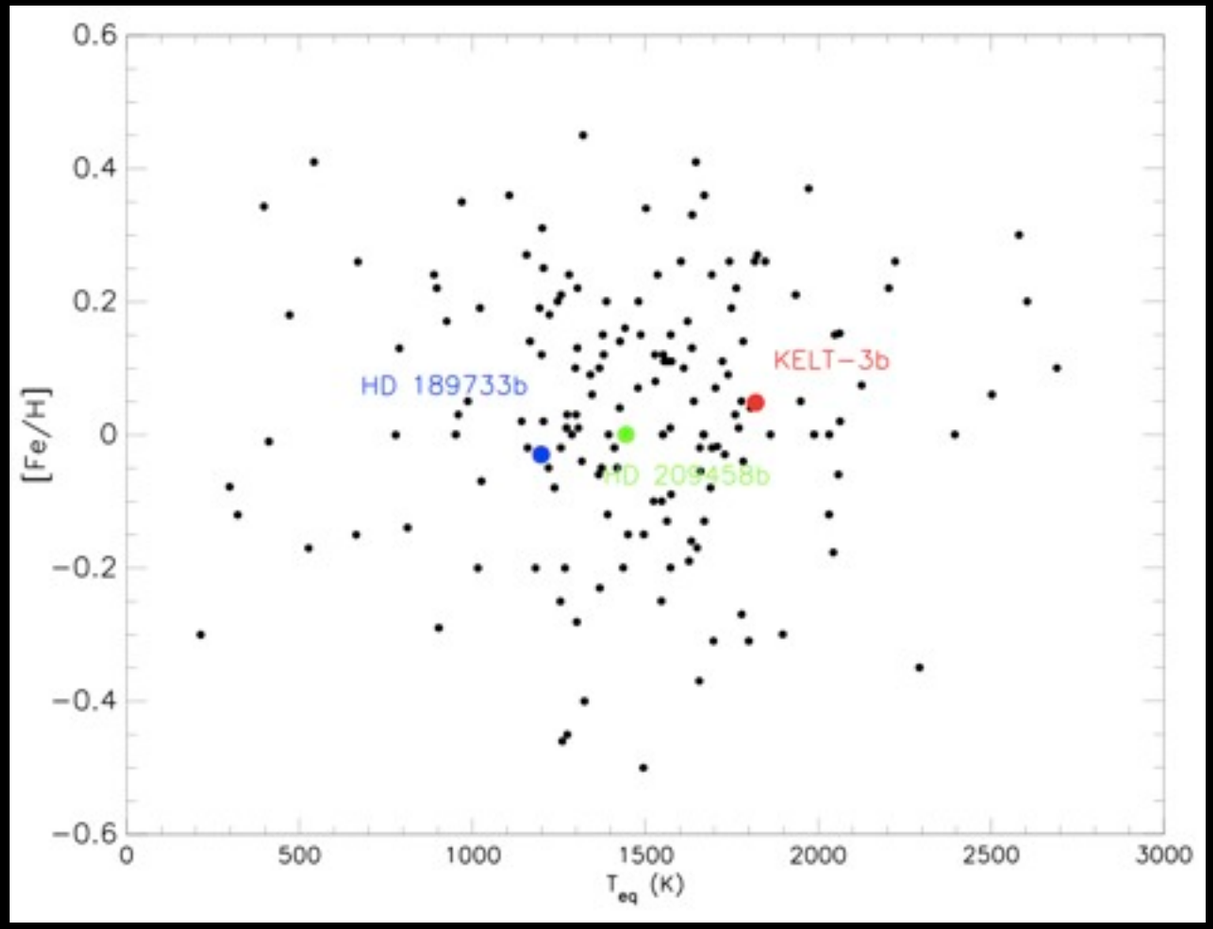


N. Madhusudhan

Future Work

Conduct a detailed comparative study with
the benchmark transiting hot Jupiters
HD 189733b (T_{eq} ~1200 K and V ~ 7.7)
HD 209458b (T_{eq} ~1500 K and V ~ 7.7)





Summary

- We have entered the realm of comparative studies of exoplanet atmospheres
- Not all planets are created equal
- Large ground-based telescopes are becoming increasingly useful for exoplanet observations thanks to new instruments/techniques