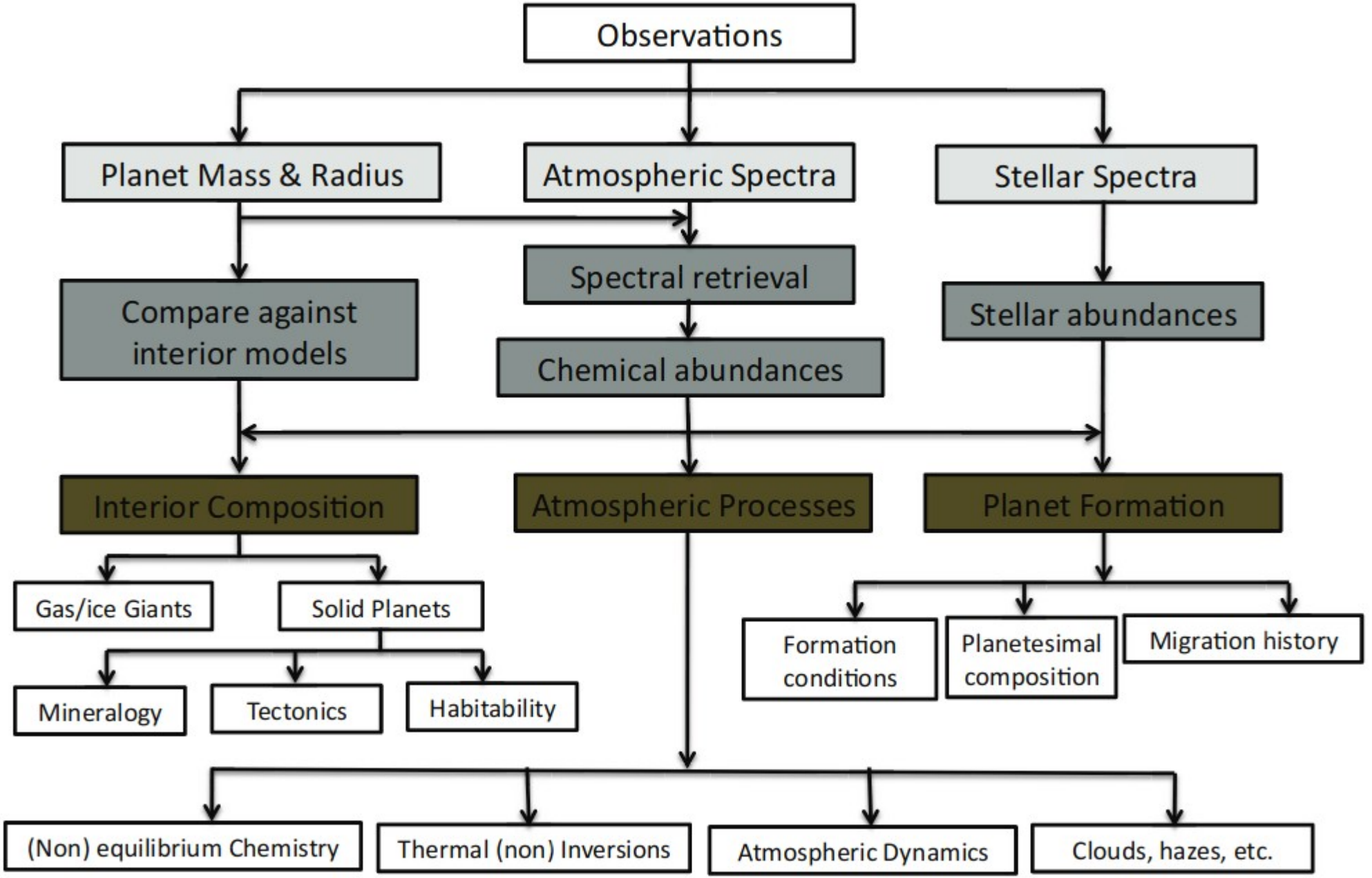
Exoplanet characterization

Exoplanet characterization



Madhusudan et al. 2013

Exoplanet characterization

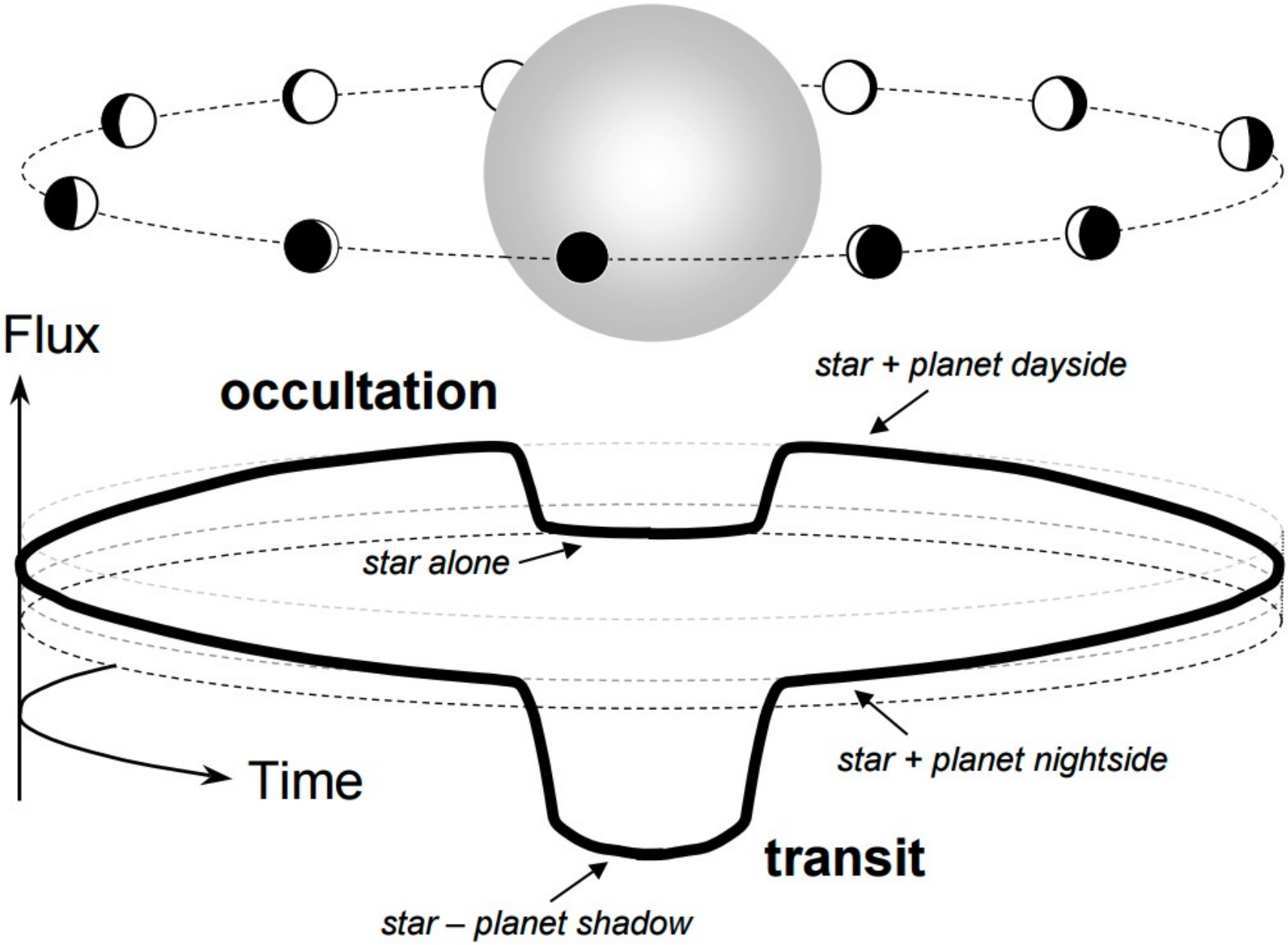


image credit Josh Winn

Earth atmosphere

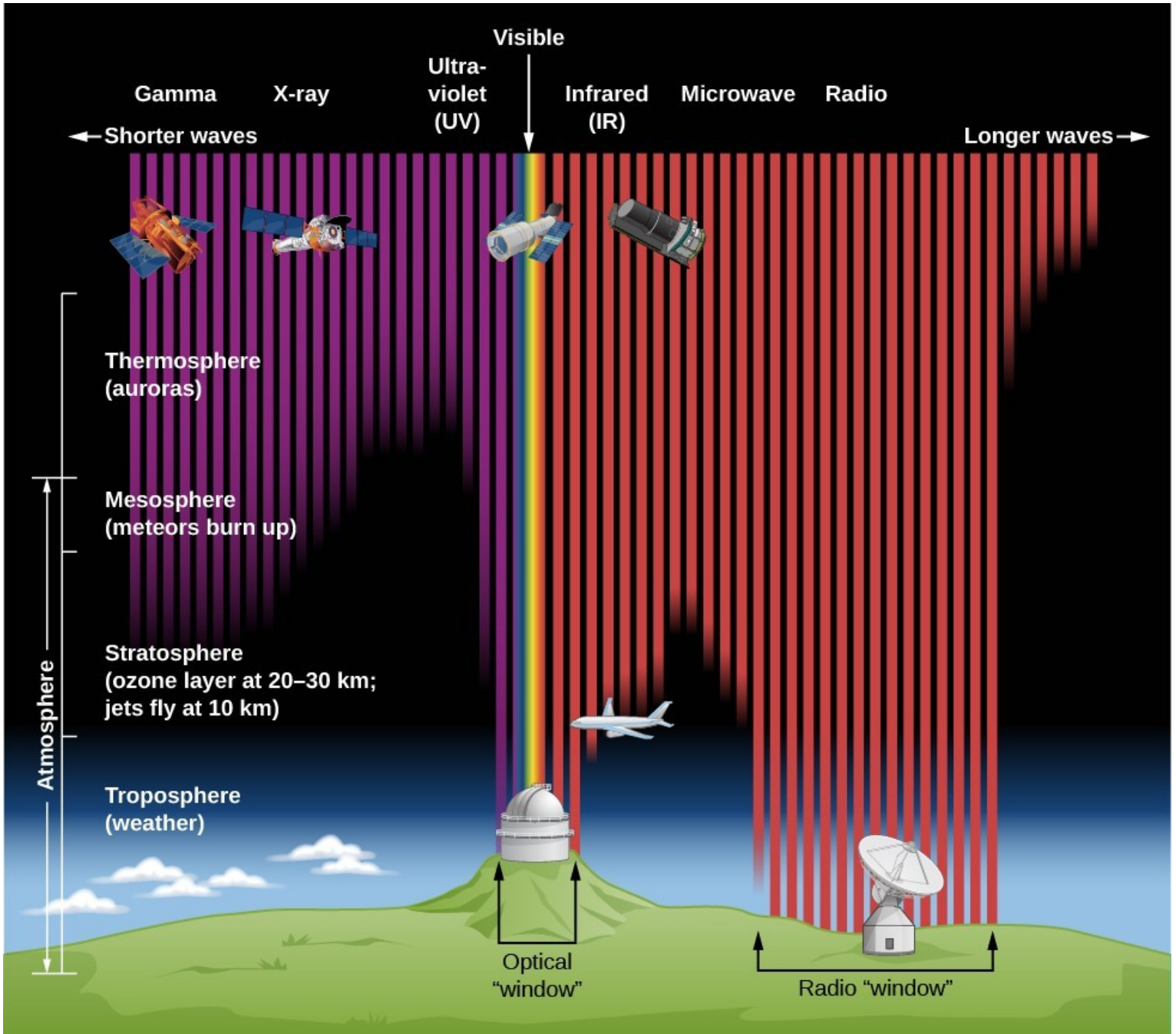


image credit STScI

Atmospheres: spectrophotometry

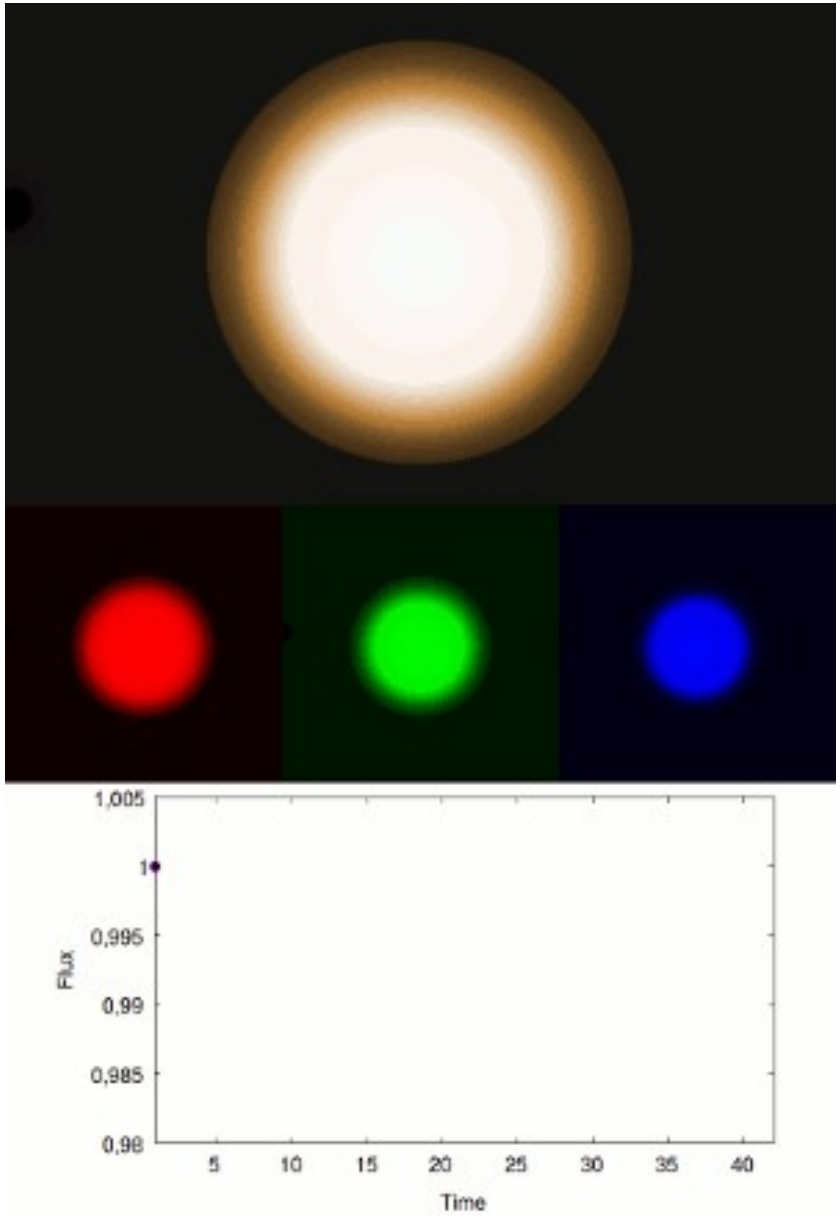
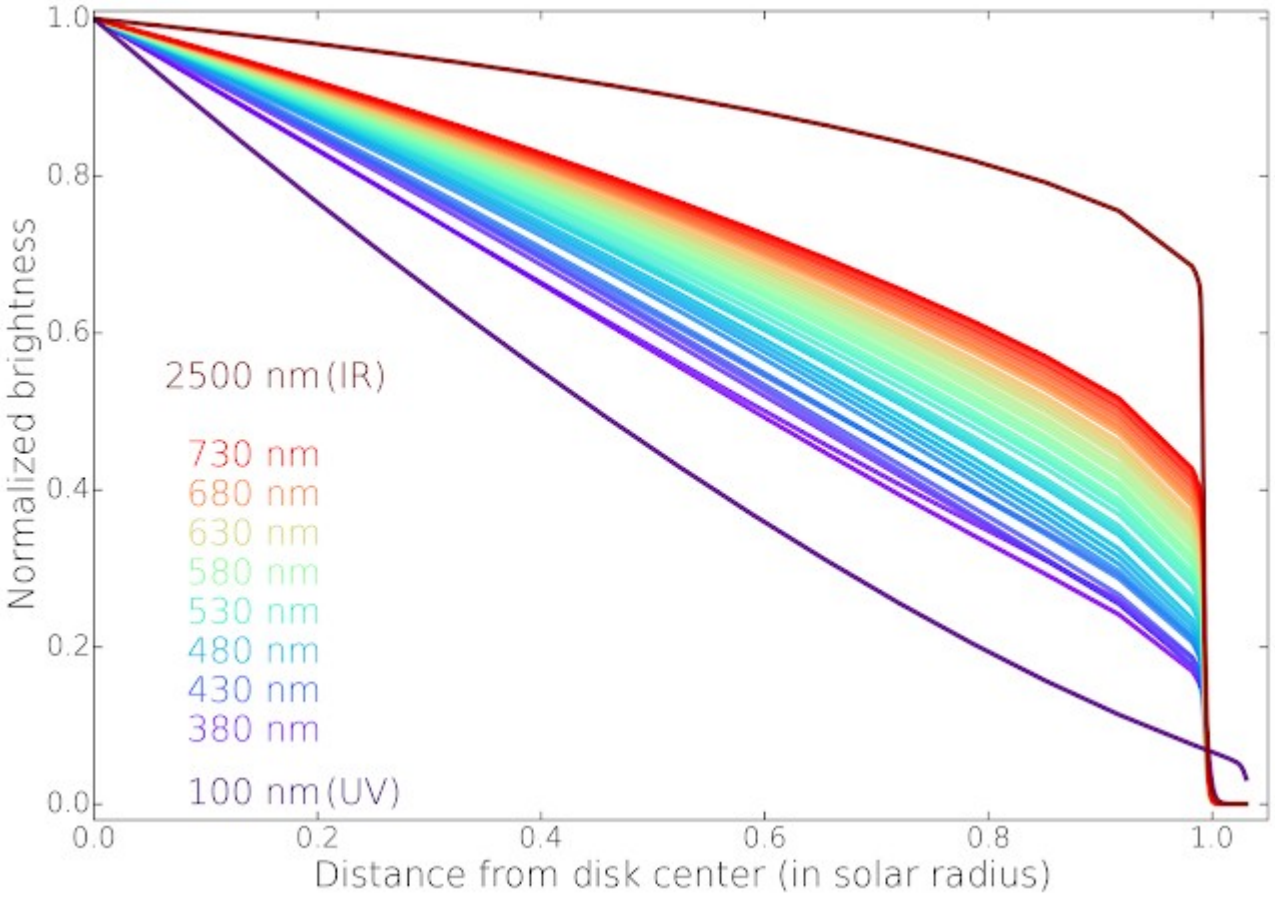


image credit Uppsala University

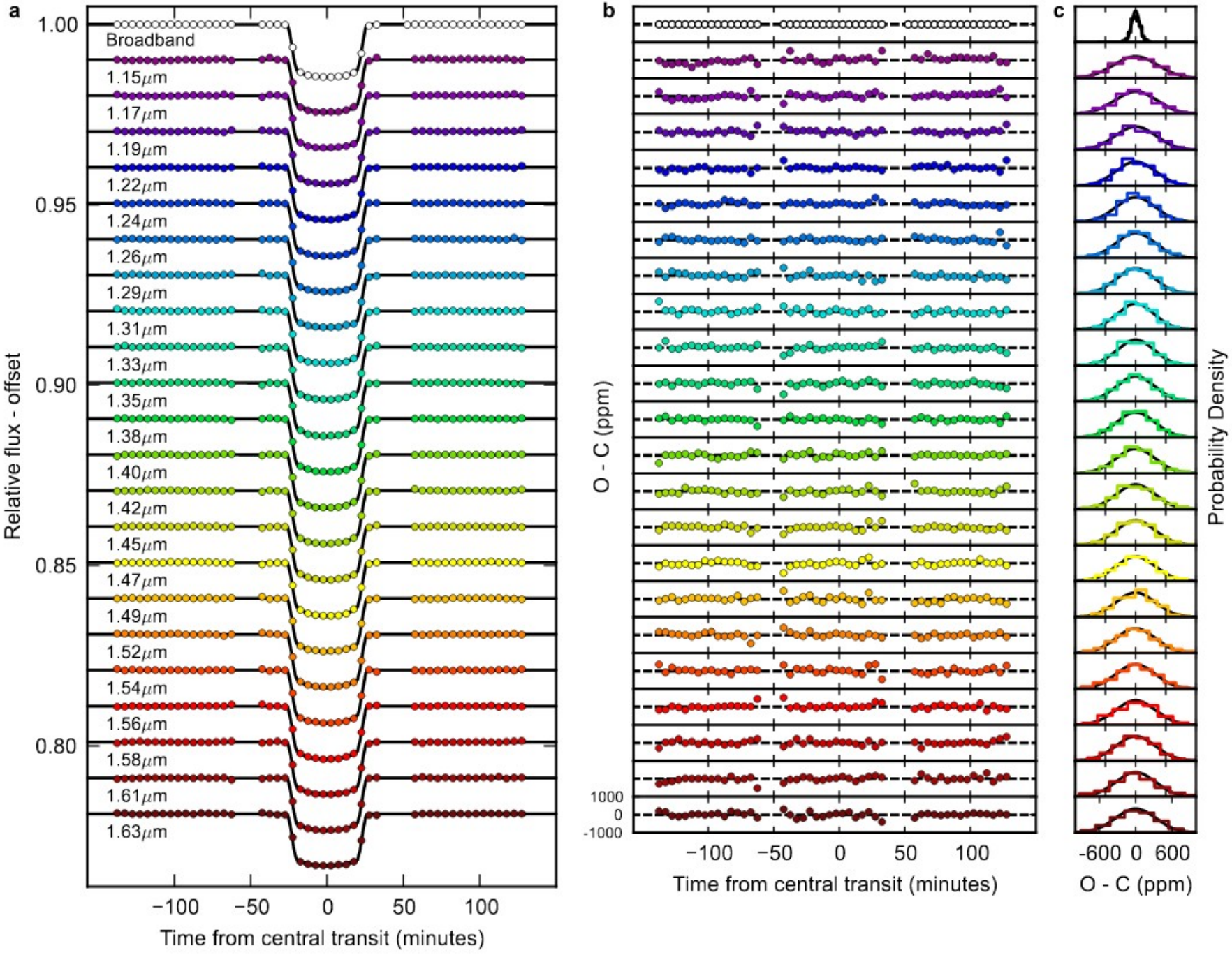
Atmospheres: spectrophotometry



Know your star: limb darkening!

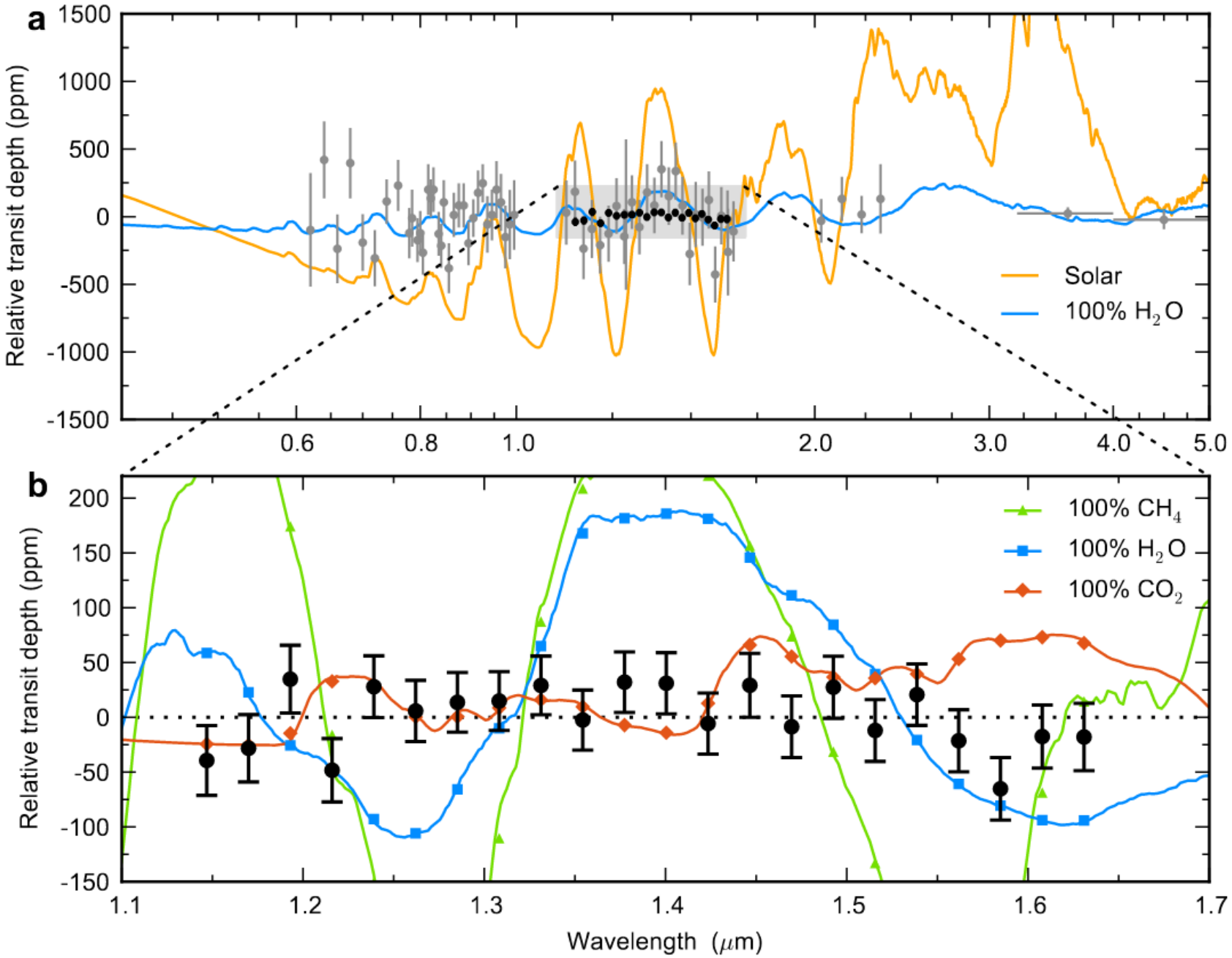
image credit Uppsala University

Super-earth GJ 1214



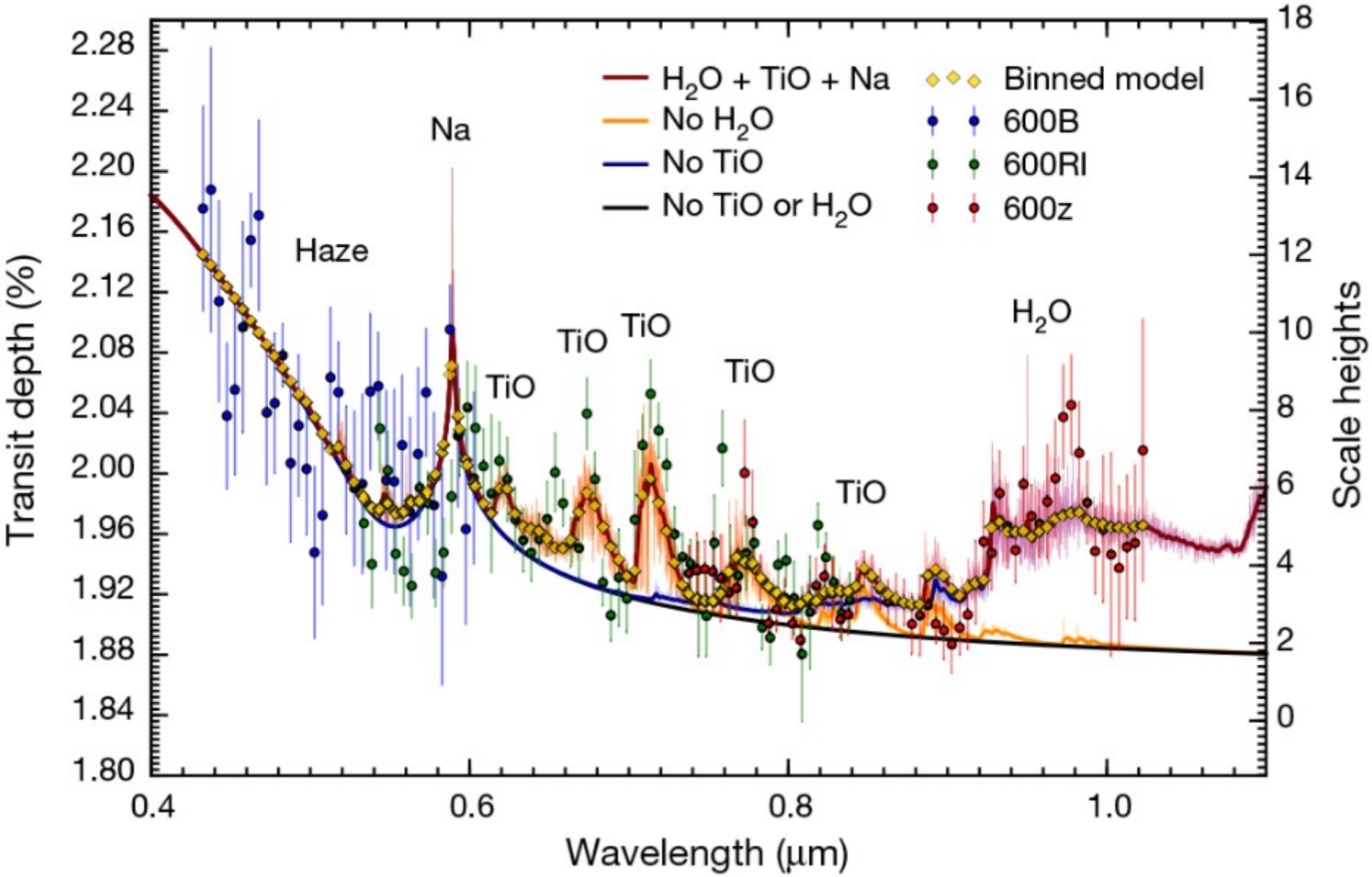
Kreidberg et al. 2014

Super-earth GJ 1214



Kreidberg et al. 2014

Hot Jupiter WASP-19b



Sedaghati et al. 2017

Hot Jupiter theoretical model (petitRADTRANS)

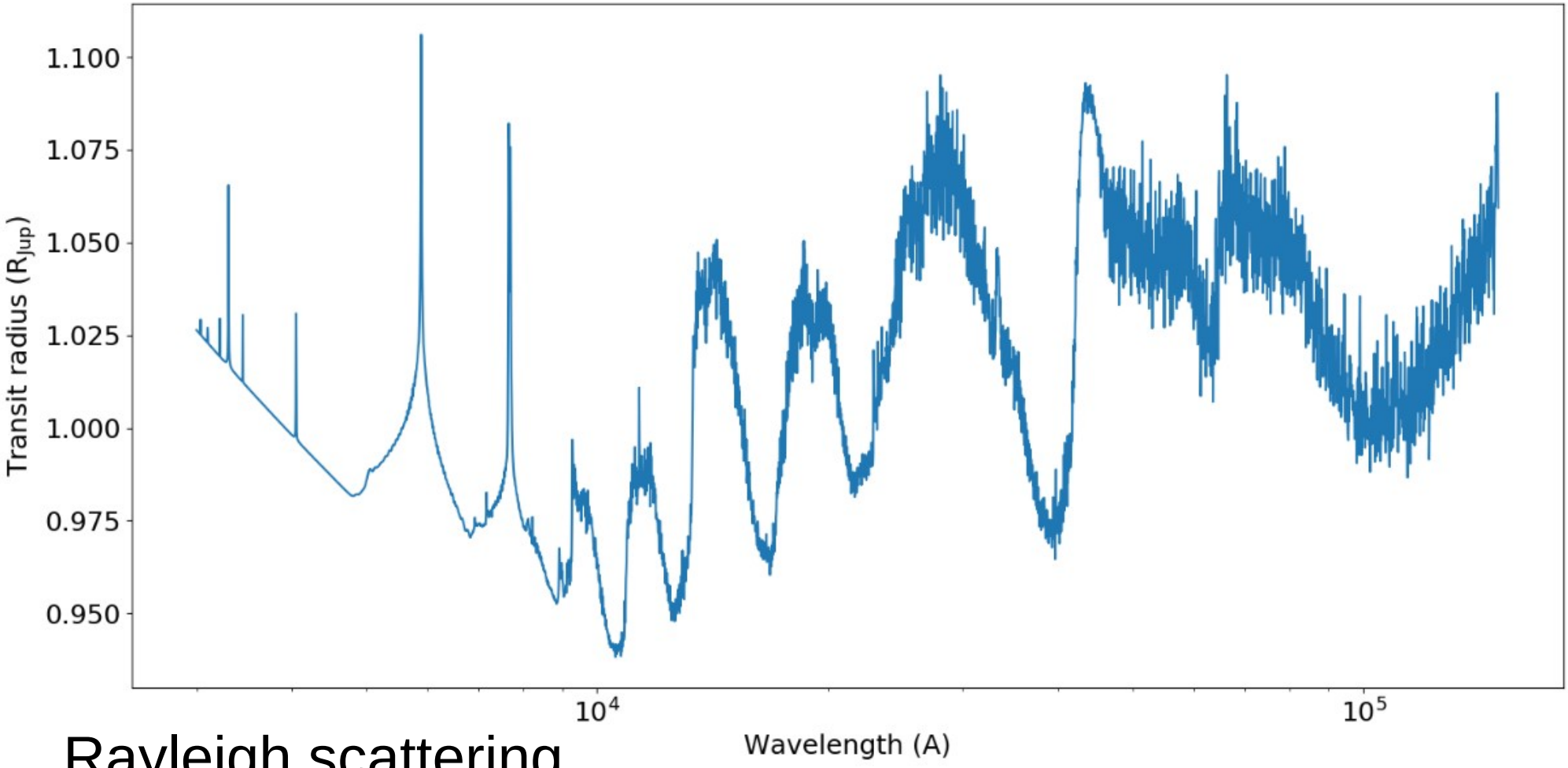
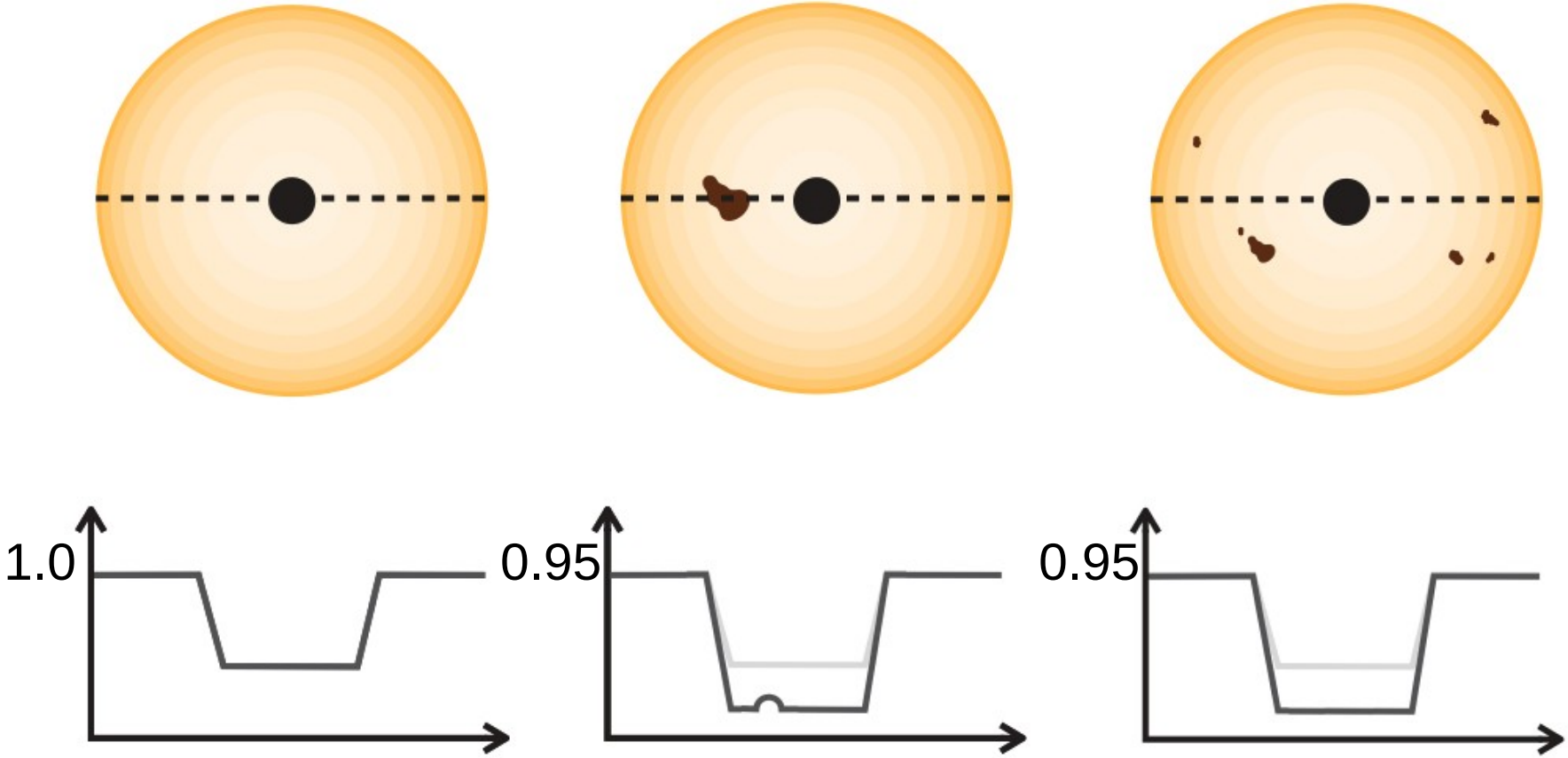


image credit: S. Czesla

Rayleigh scattering
Strong features of alkali metals (Na, Ka)
Molecular bands (H2O, CO, CO2, CH4)

Caveat: starspots

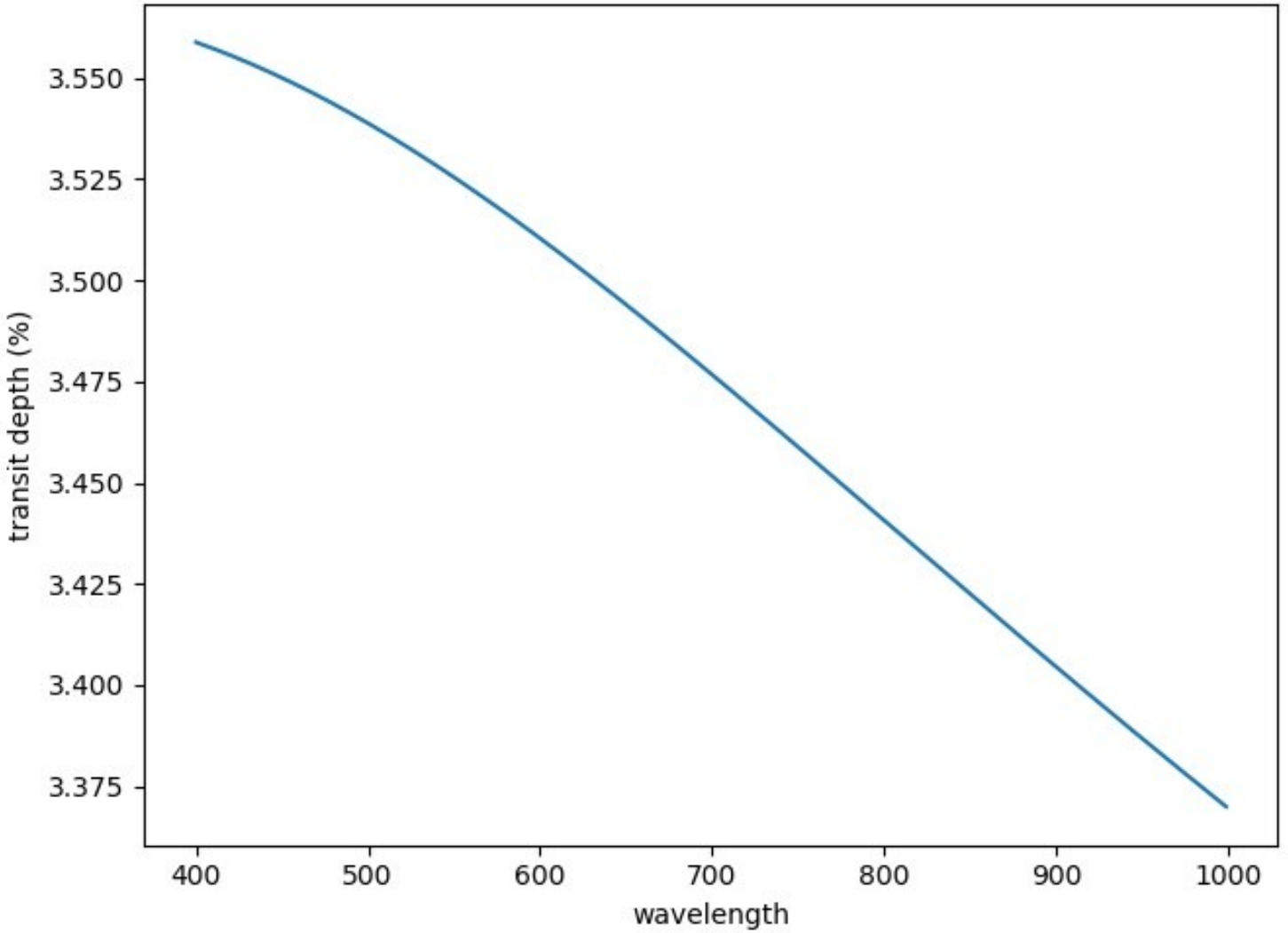
$$\frac{R_p}{R_*} = \sqrt{\delta(1-\epsilon)}$$



Spot crossing effect and Out Of Transit effect

image credit Helen Giles

Caveat: starspots



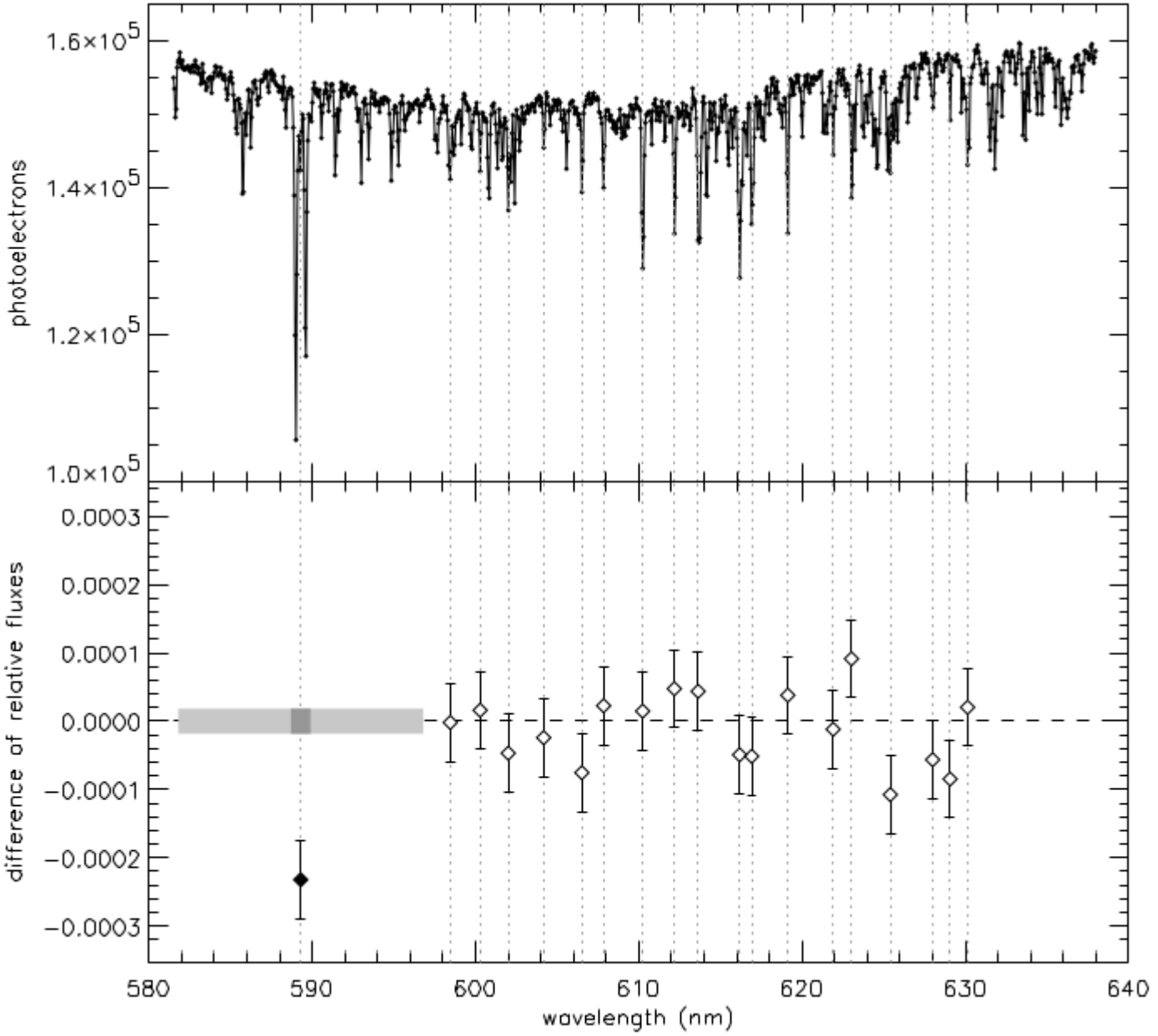
Atmospheres: transmission spectroscopy

Calculate from data:

Spectrum during transit / spectrum out of transit

Relative measurement, no absolute flux measurement. But spectral lines corresponding to absorbers in the planet's atmosphere will be deeper.

Atmospheres: transmission spectroscopy



Charbonneau et al. 2002

Exoplanet atmospheres: single spectral lines

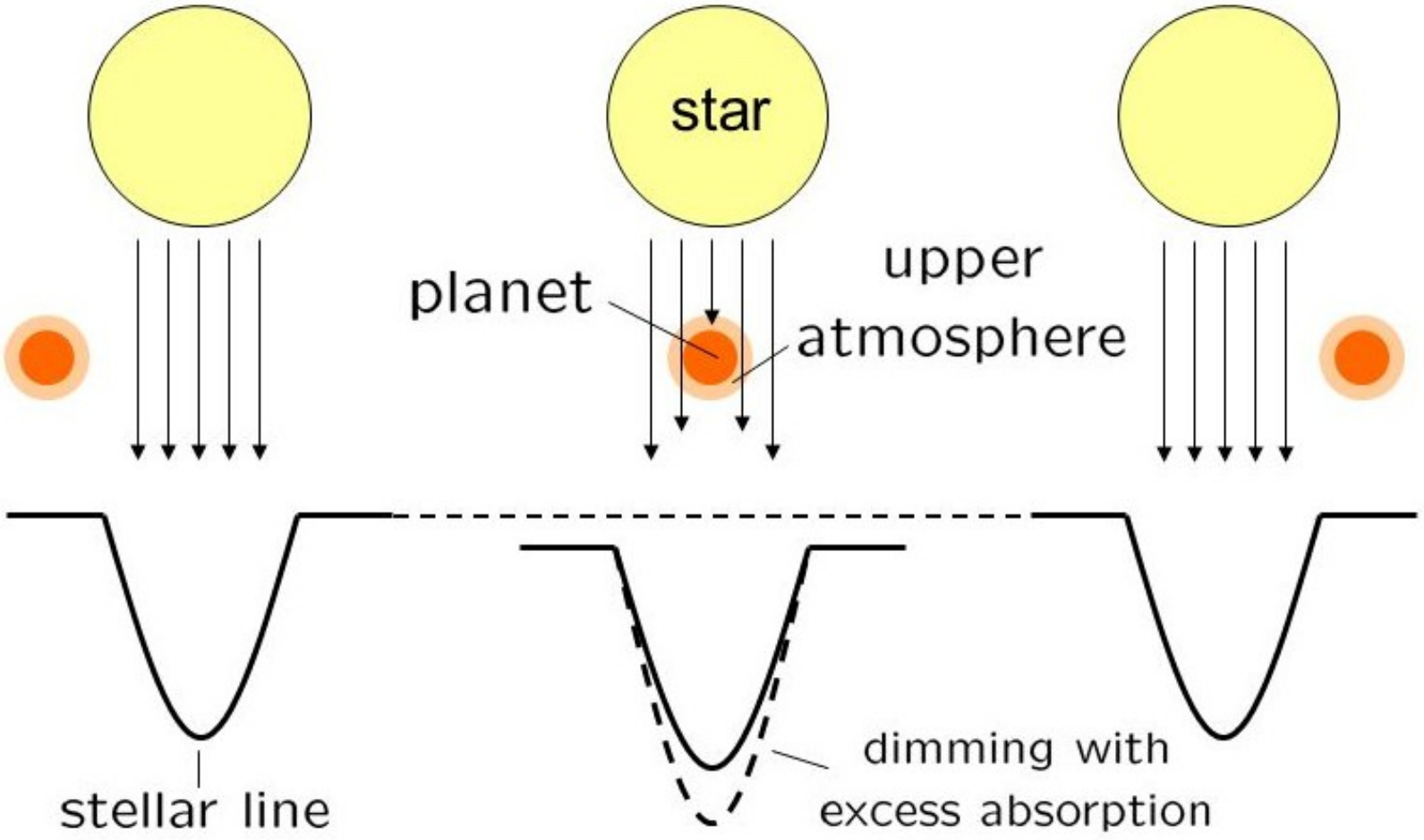
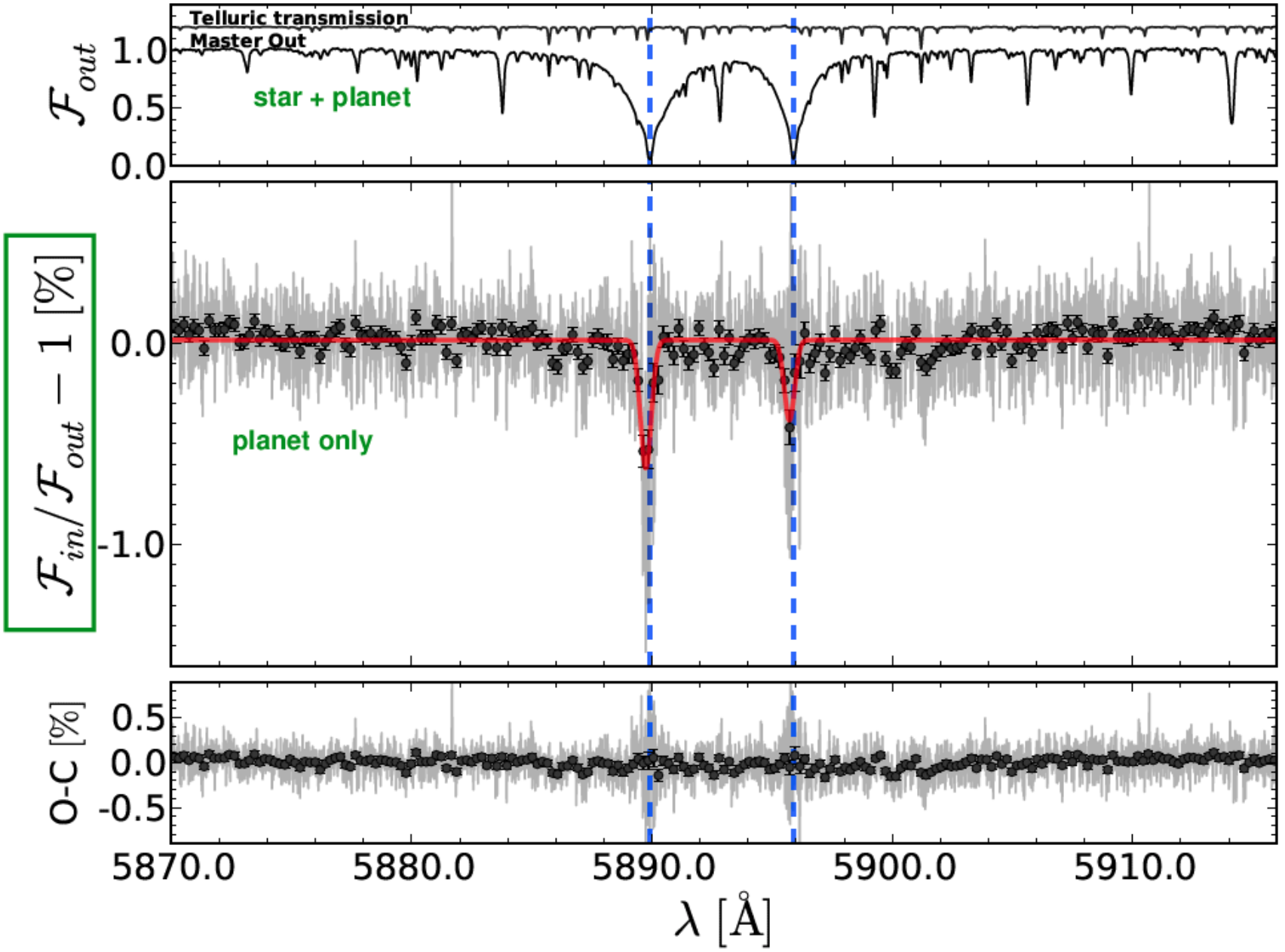


image credit: N. Narita

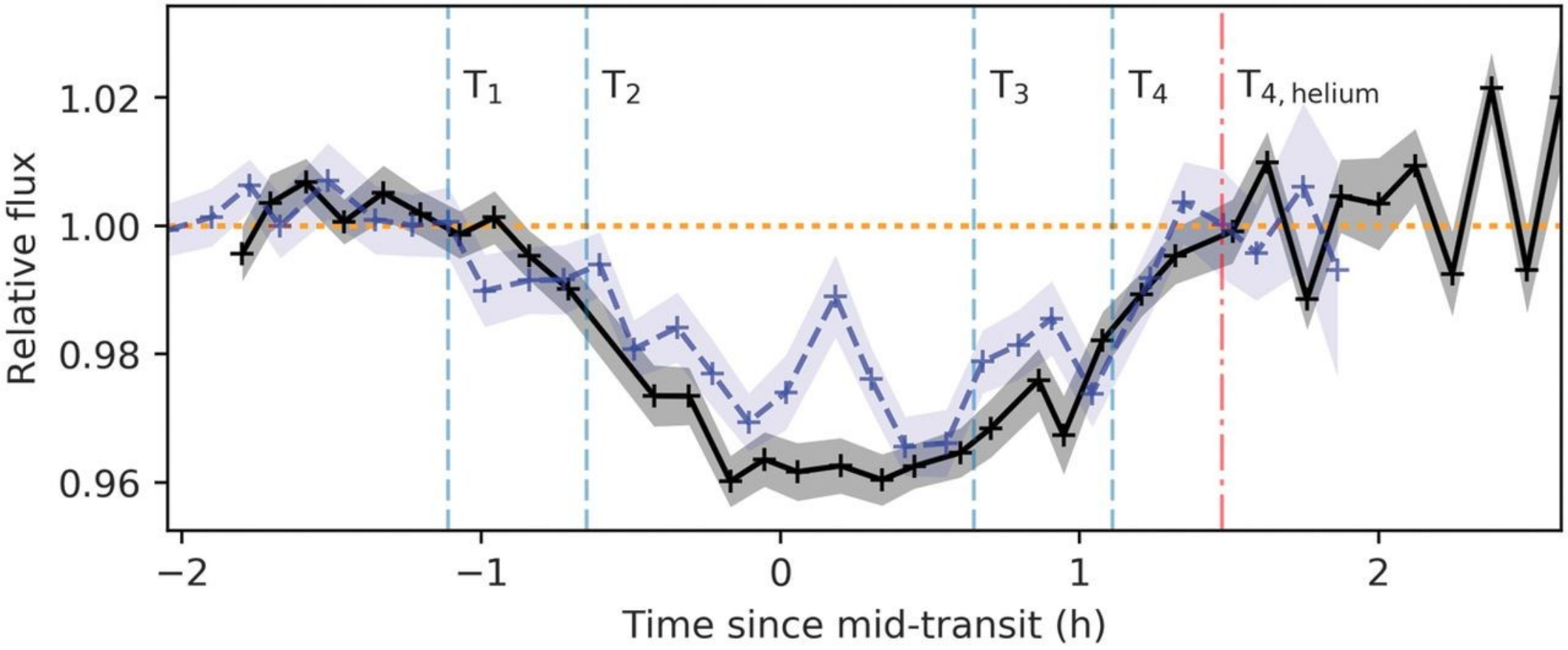
Atmospheres: transmission spectroscopy



Wyttenbach et al. 2015

Atmospheres: transmission spectroscopy

Measures **excess absorption** compared to a spectrally flat (“grey”) transit that reduces the flux by the same fraction everywhere in the spectrum.



Nortmann et al. 2018