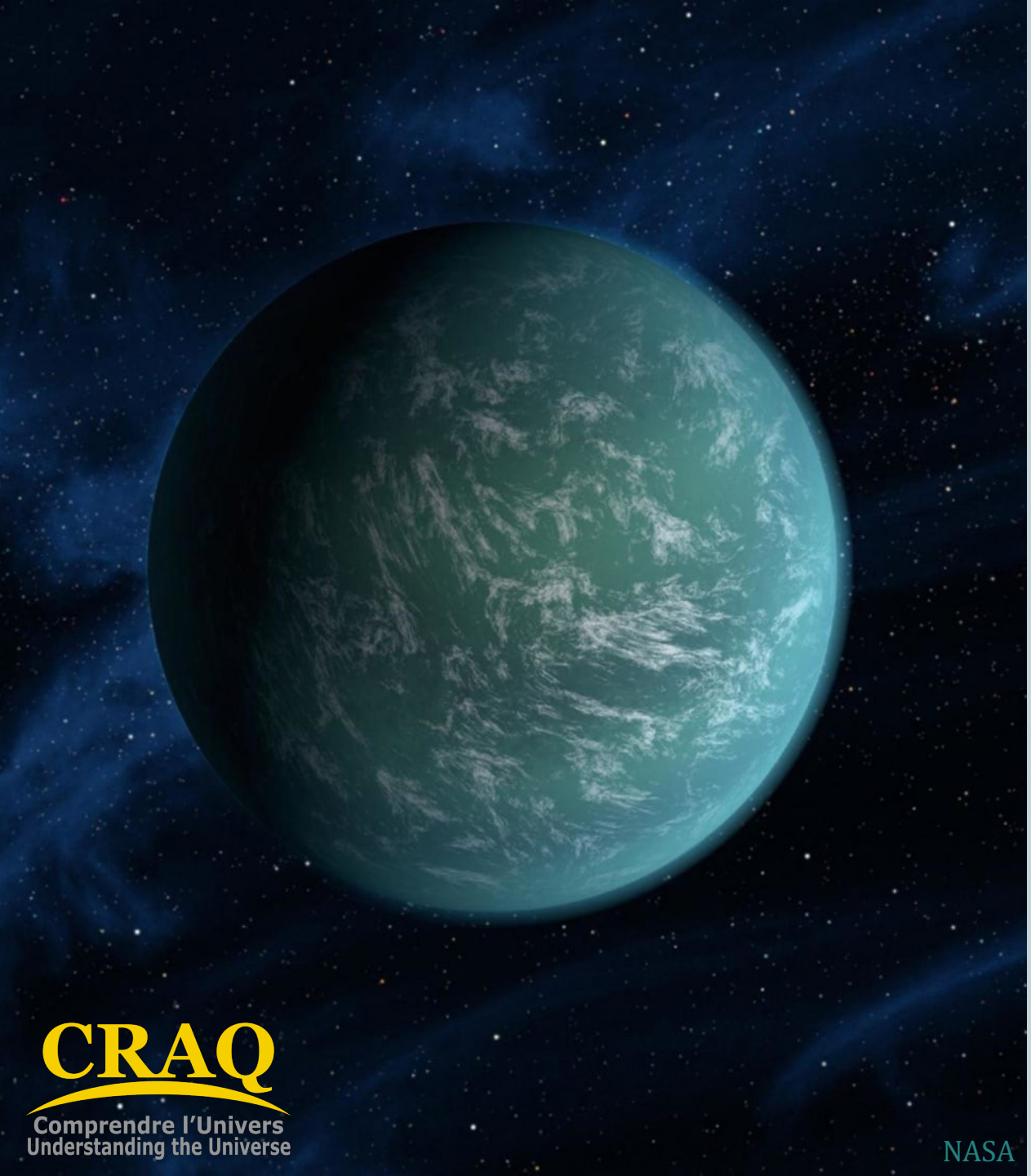


TOI-2120 b

A temperate sub-Neptune transiting a M4.5V dwarf revealed by SPIRou and TESS

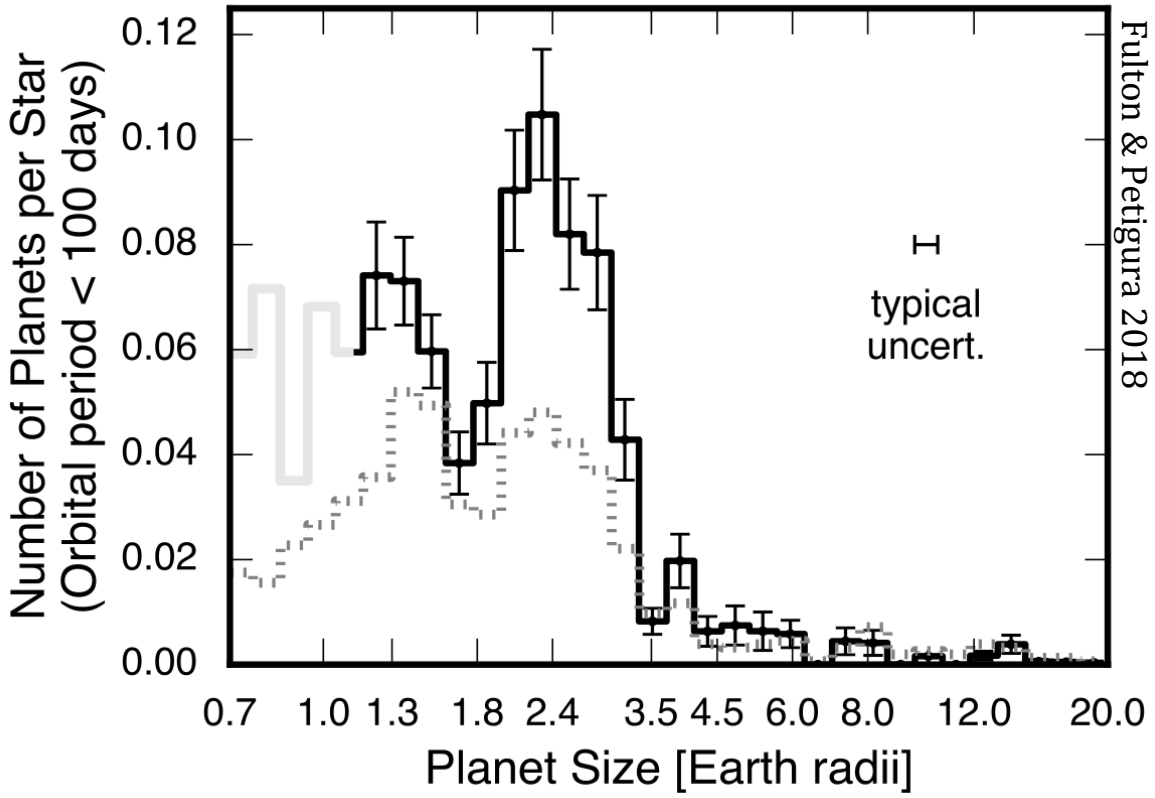
Alexandrine L'Heureux

Supervisor: René Doyon

CRAQ annual meeting
May 8th 2024

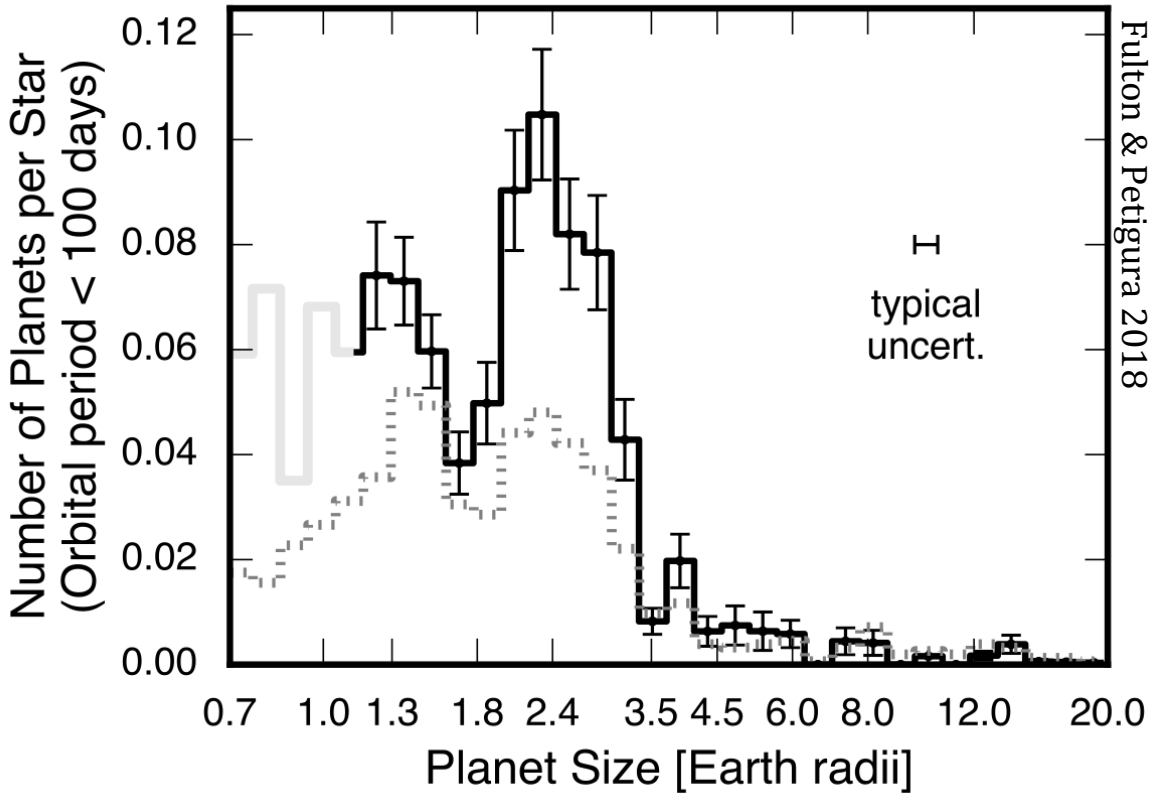
Université de Montréal
iREx
Fonds de recherche Nature et technologies Québec

The Kepler Survey: A tale of small planets



The Kepler Survey: A tale of small planets

- Short-period planets (P < 100 d) are **small**
  - Two distinct populations



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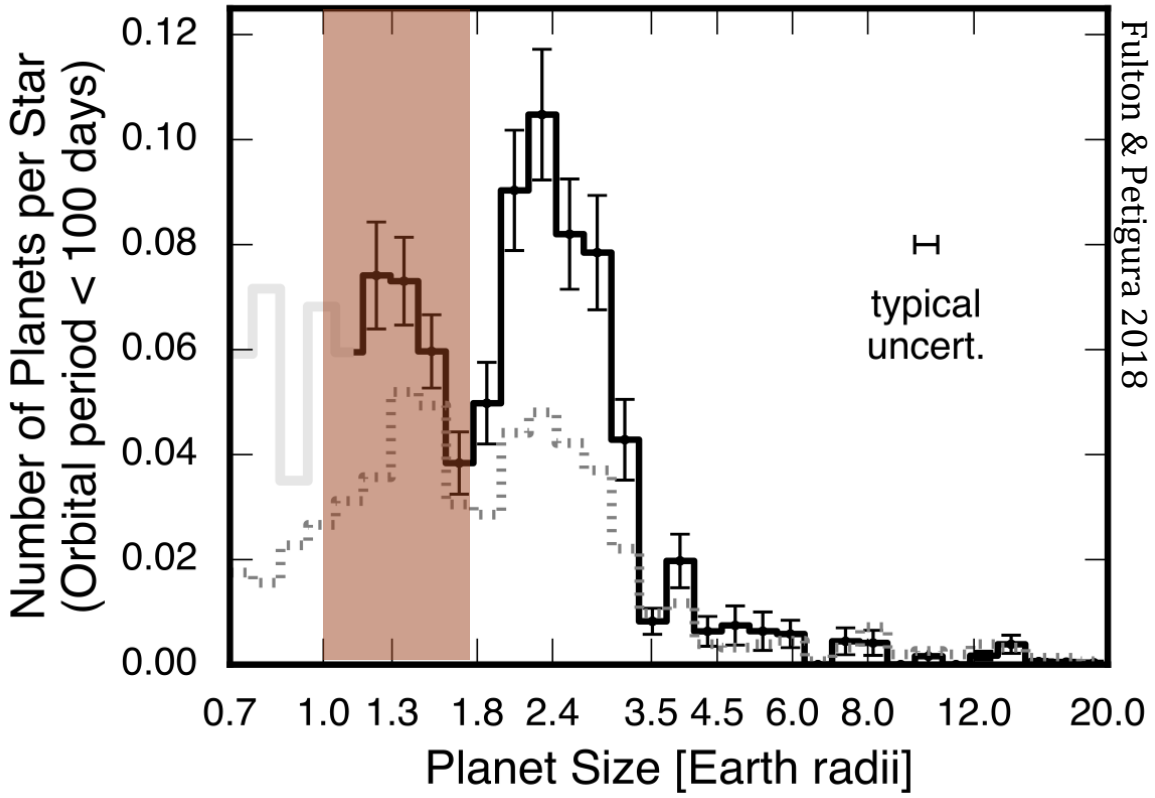

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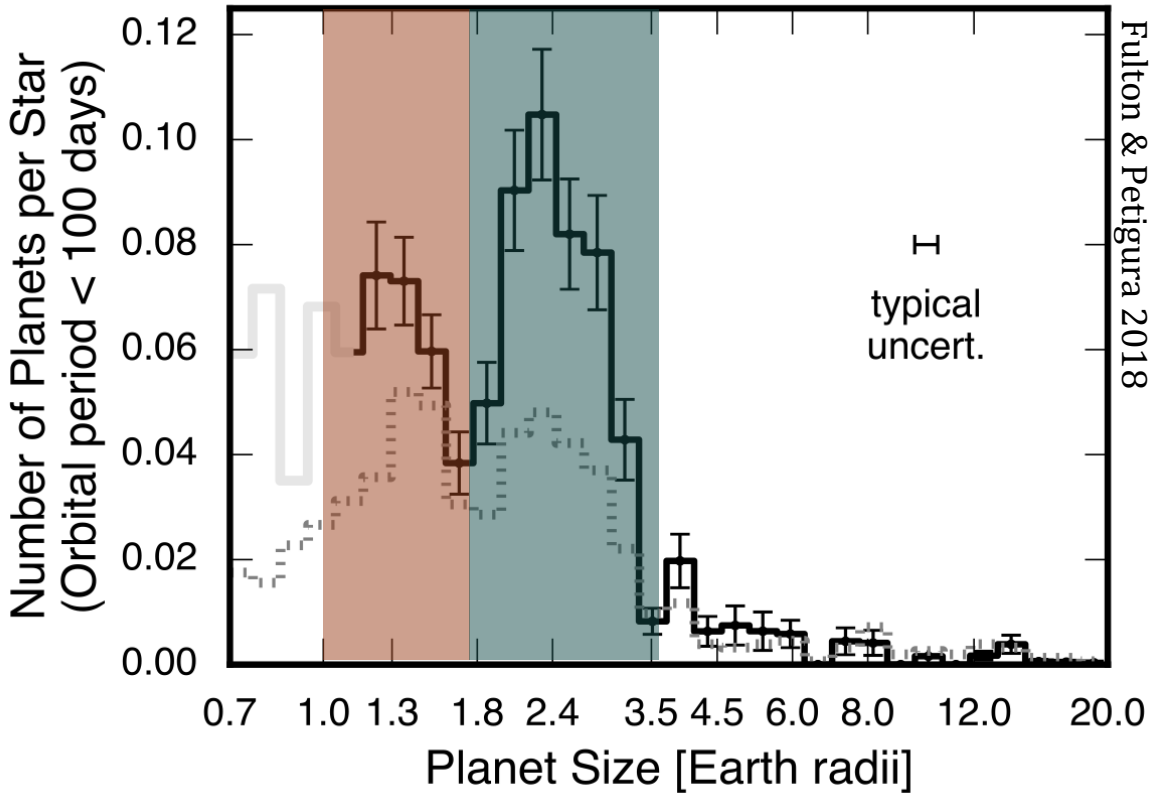
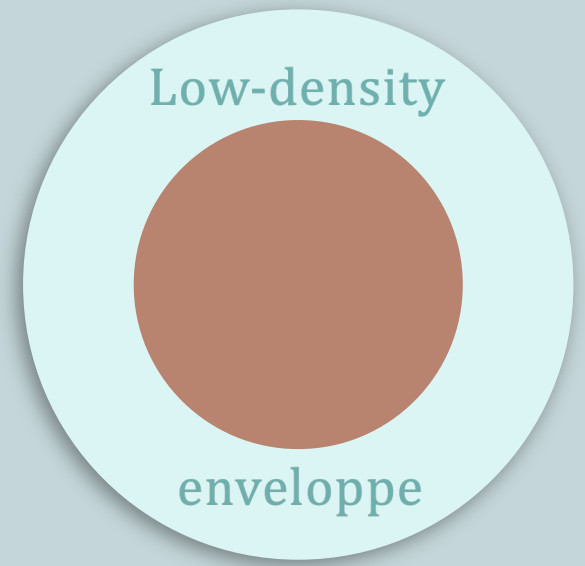
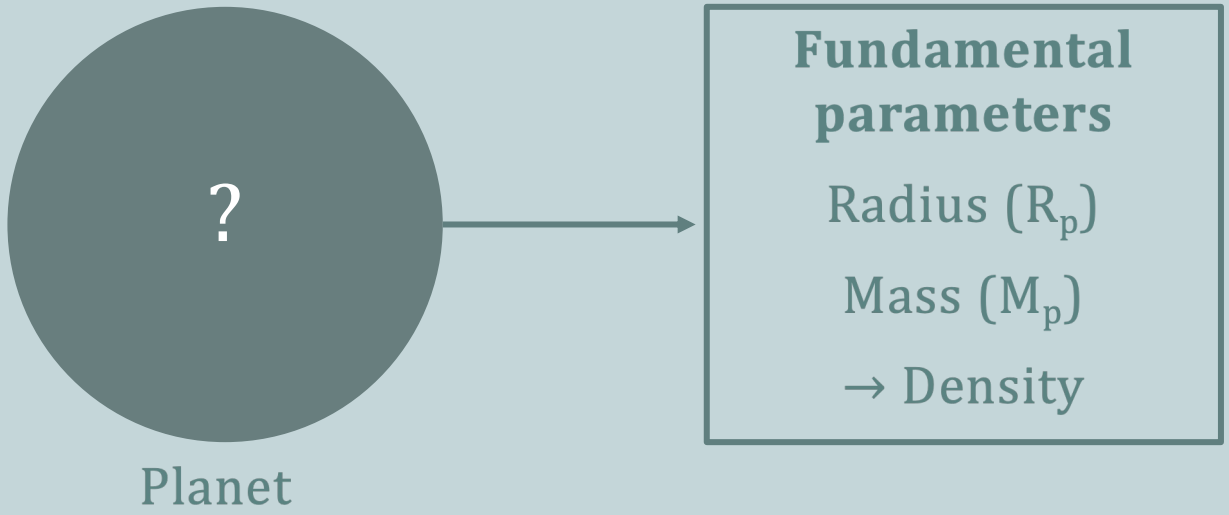


Super-Earths

Sub-Neptunes



Sub-Neptunes: Common, yet elusive



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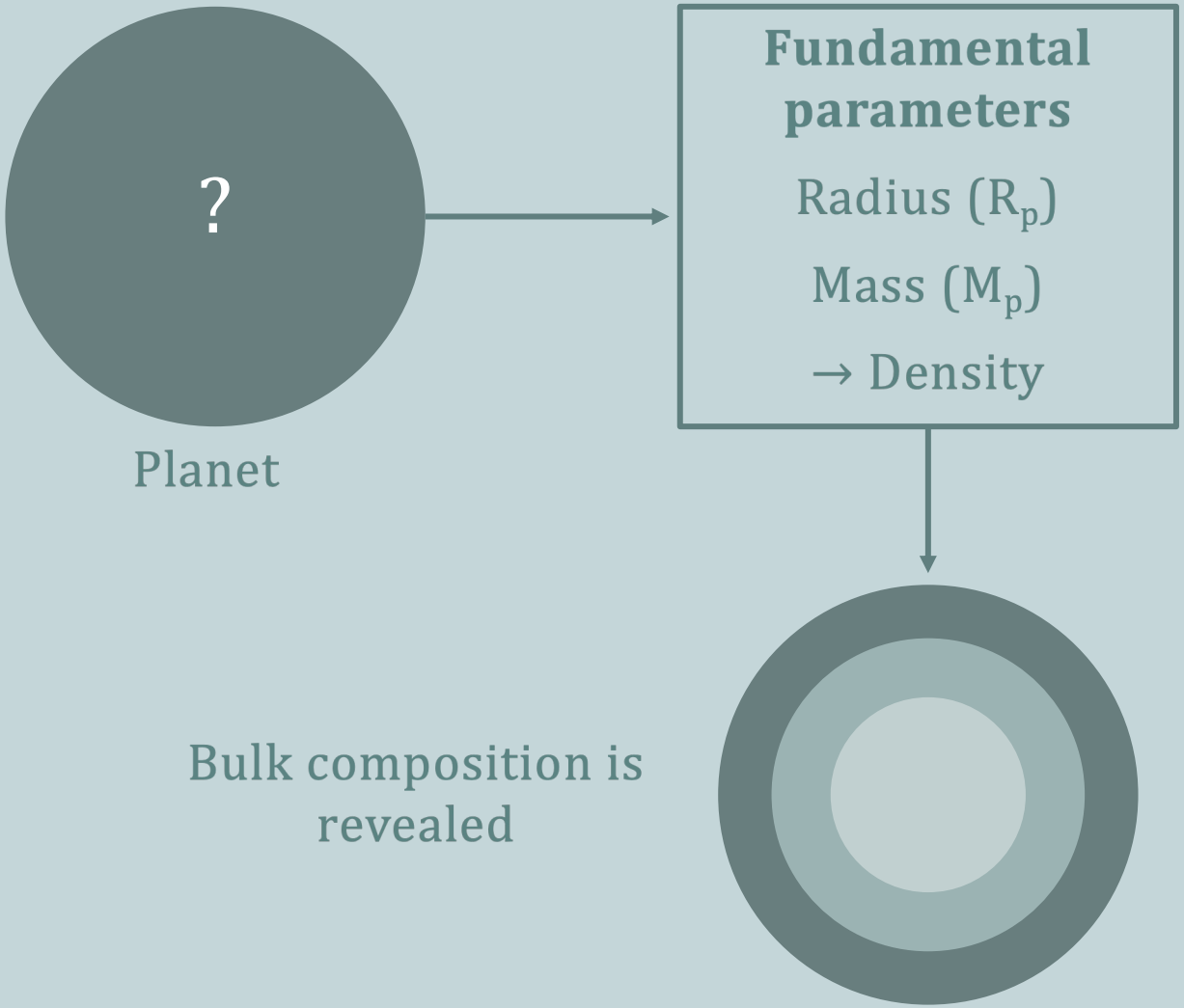

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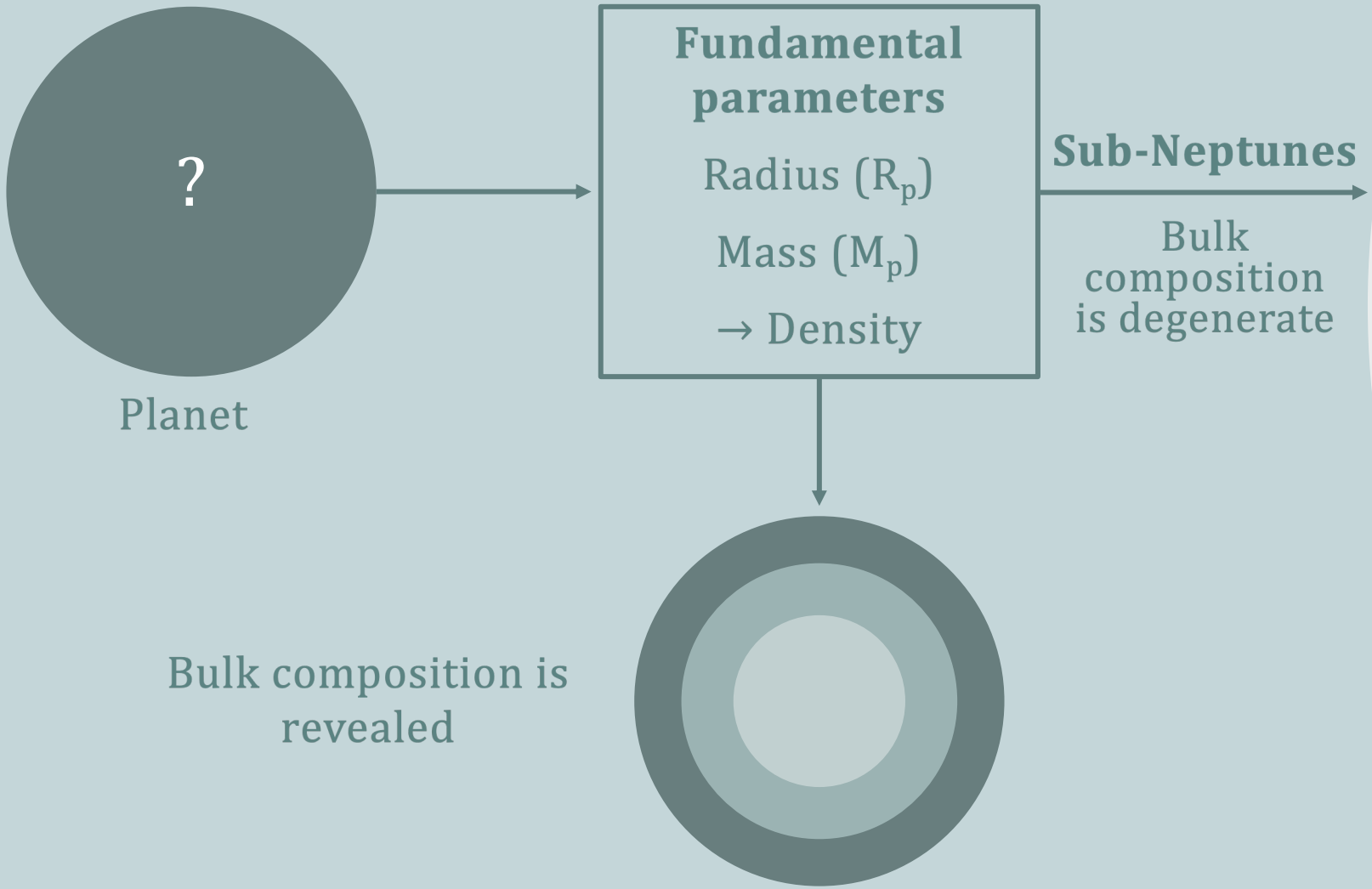
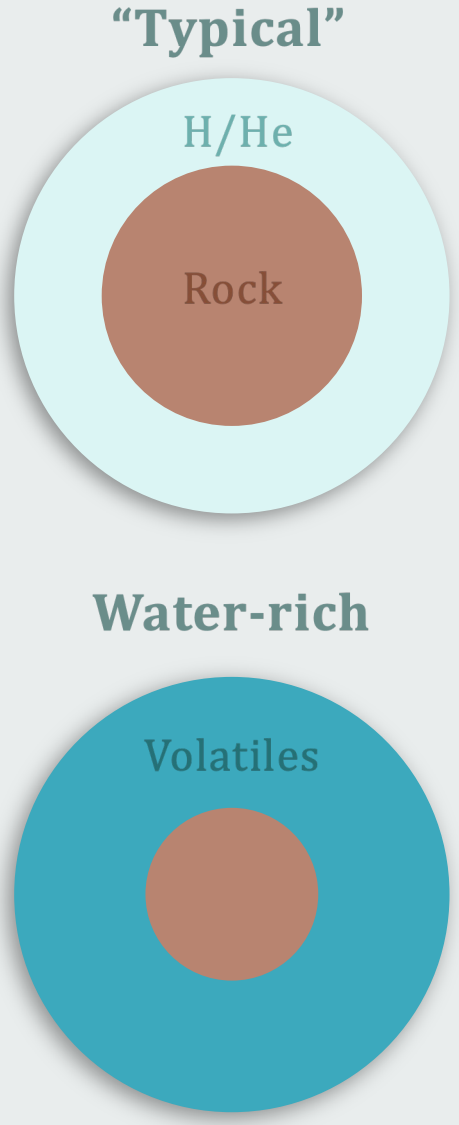
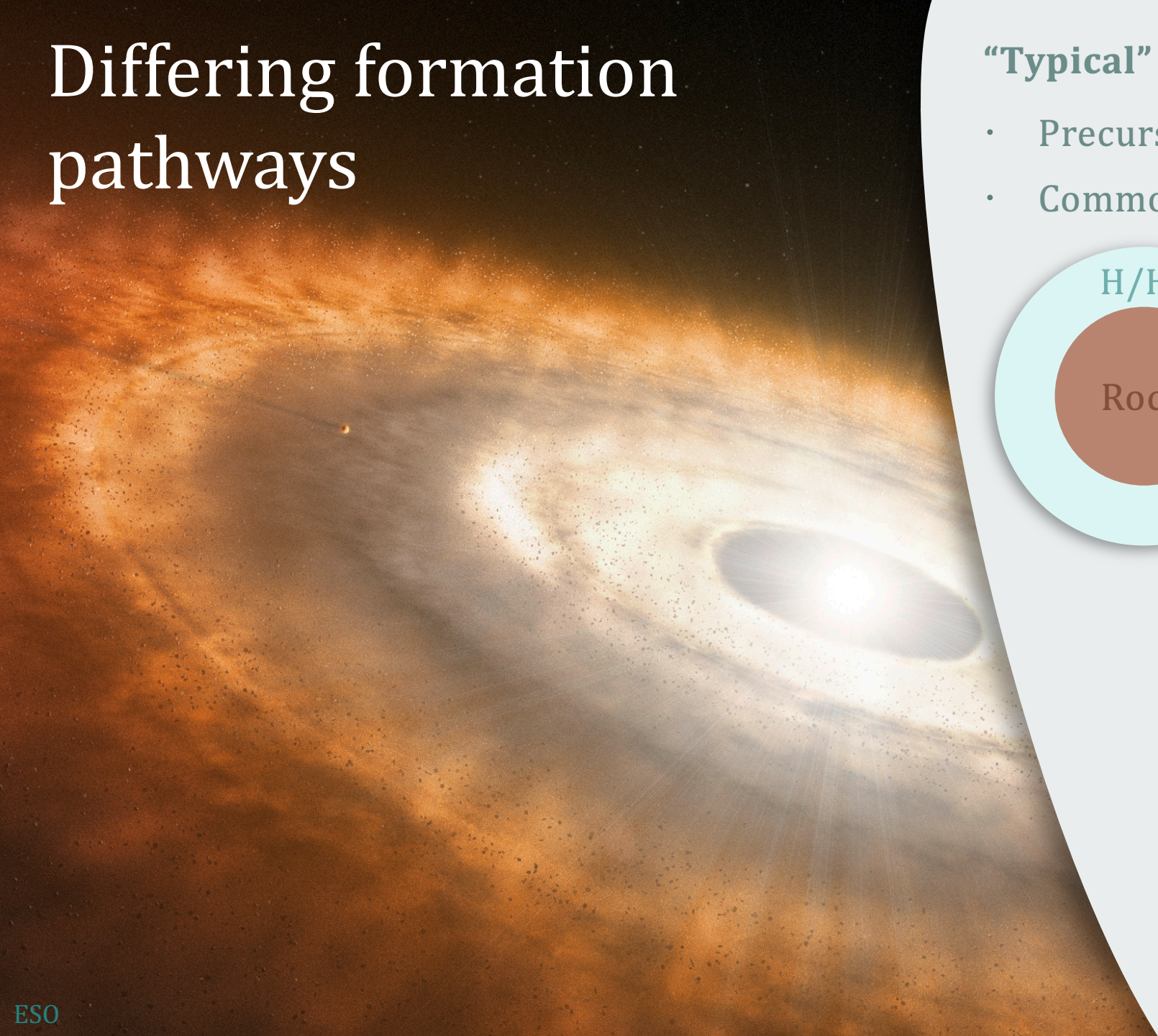




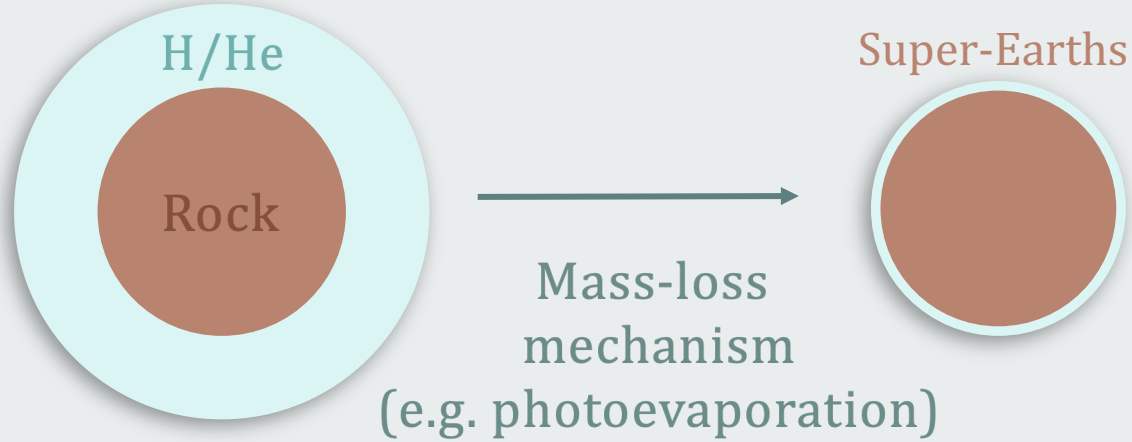
Differing formation pathways



ESO

“Typical” sub-Neptunes

- Precursors of super-Earths
- Common origin



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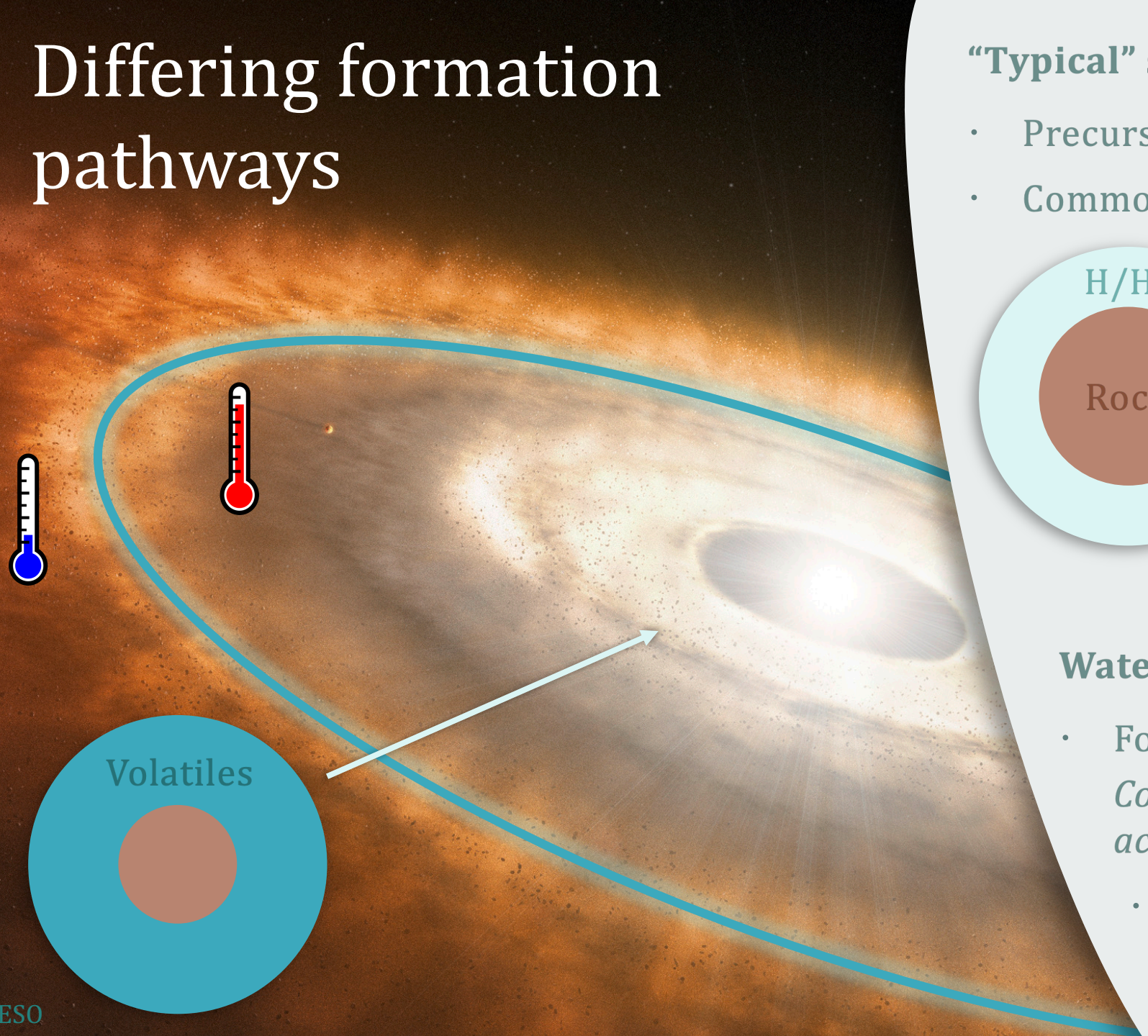

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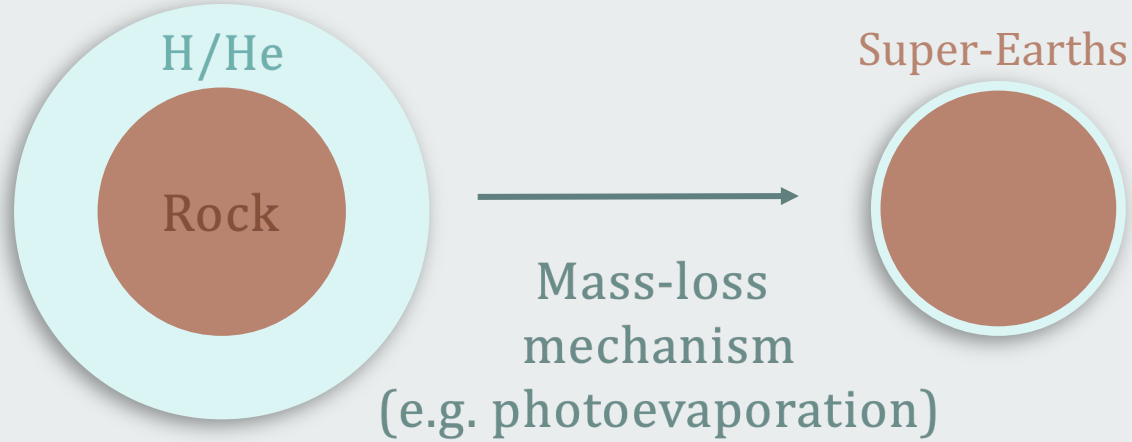

Water-rich sub-Neptunes

- Form outside the snow line

  Condensed volatiles are available as accreting material

  - Independent population from super-Earths

Unveiling the composition of sub-Neptunes

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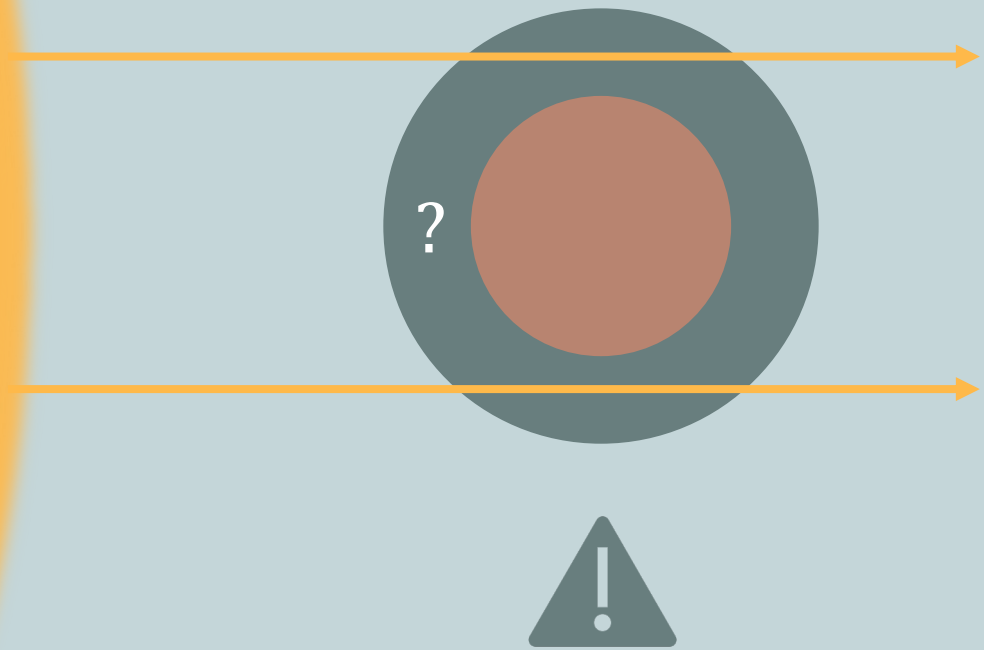

Precise mass and radius measurements are essential to correctly interpret the transmission spectrum

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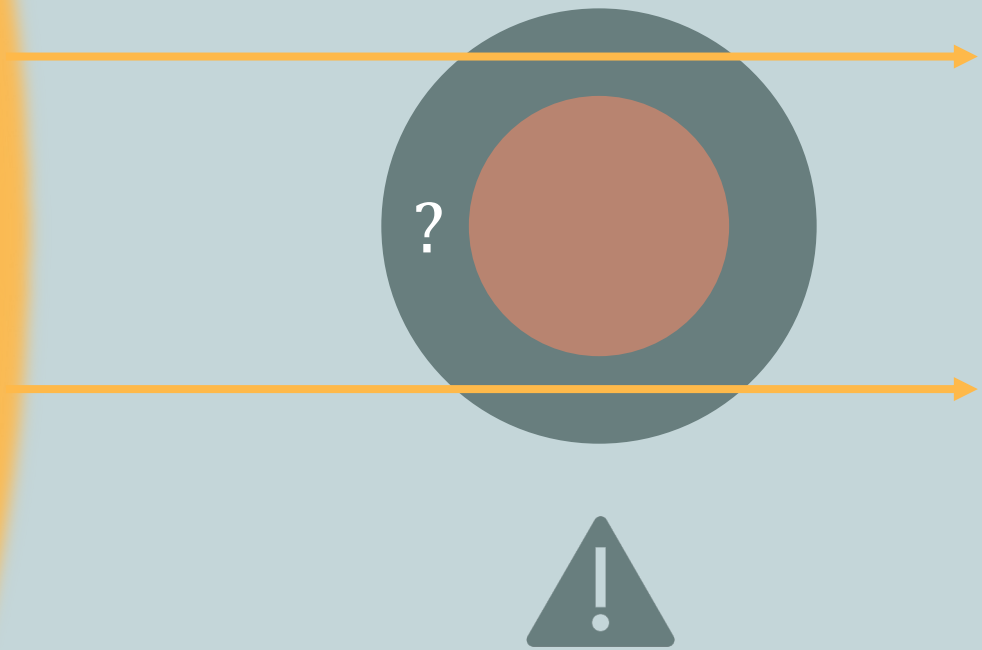

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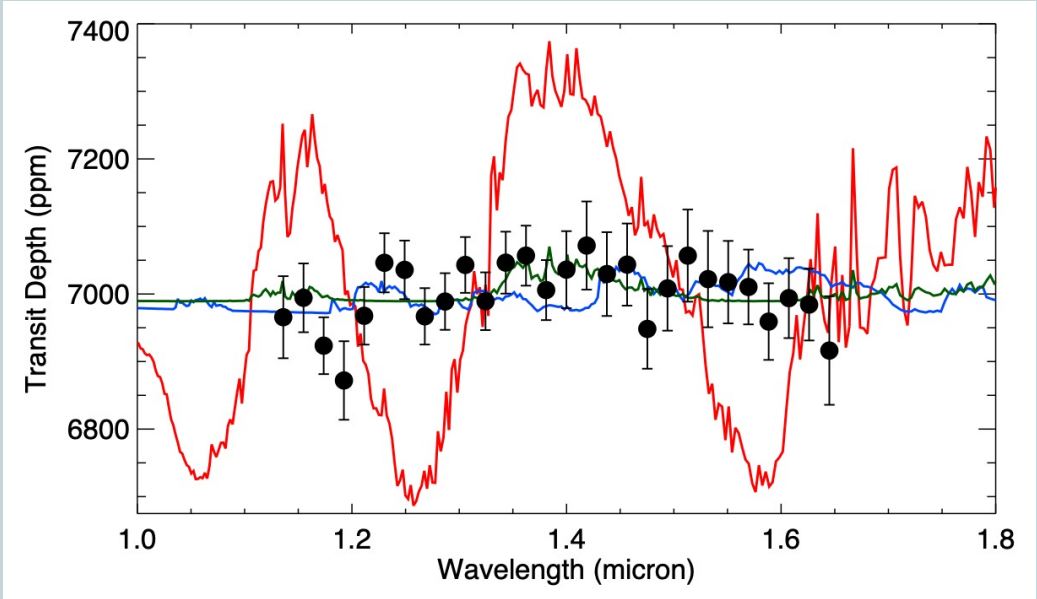
GJ 436 b



Knutson et al. 2014

No molecular features detected

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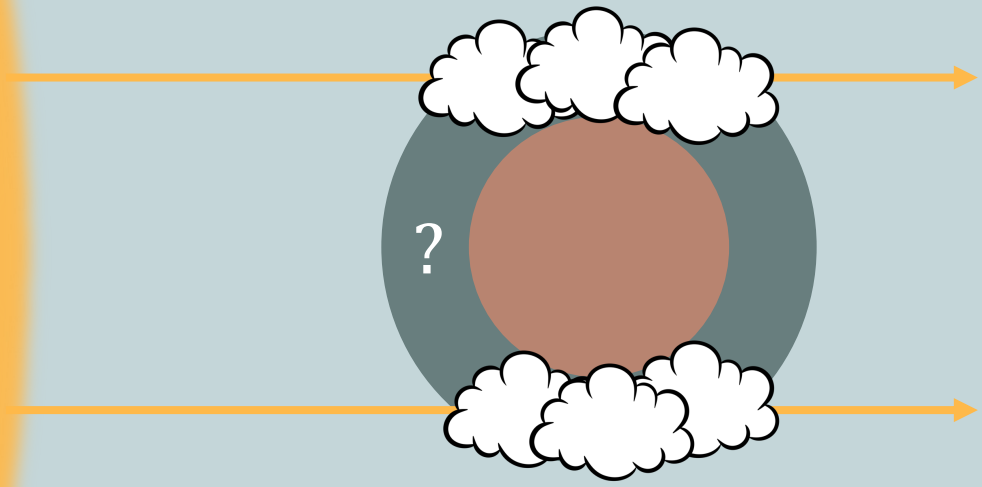

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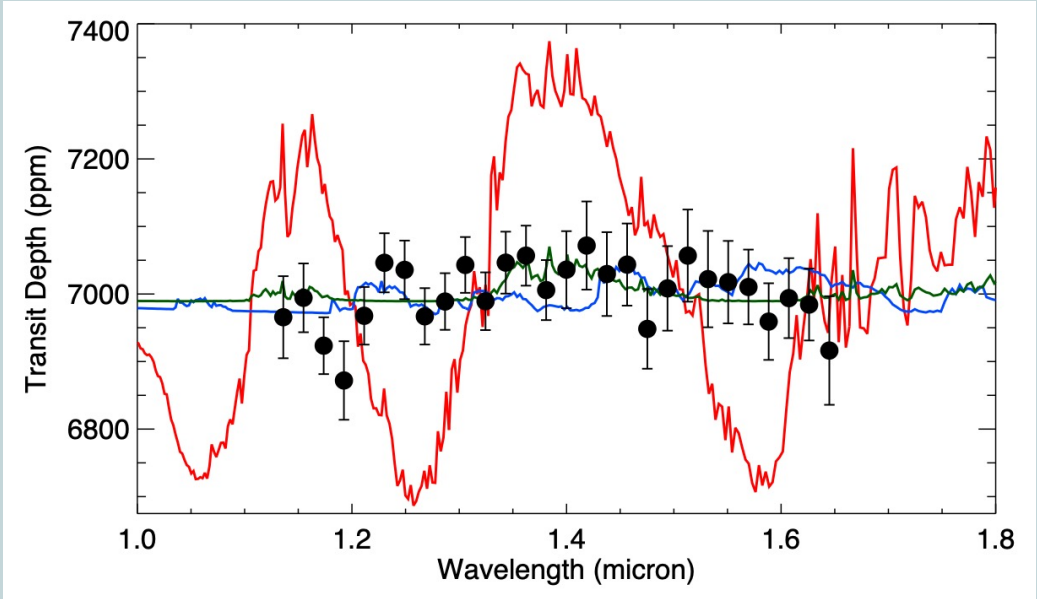

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Clouds mute the features

The clear-skies opportunity

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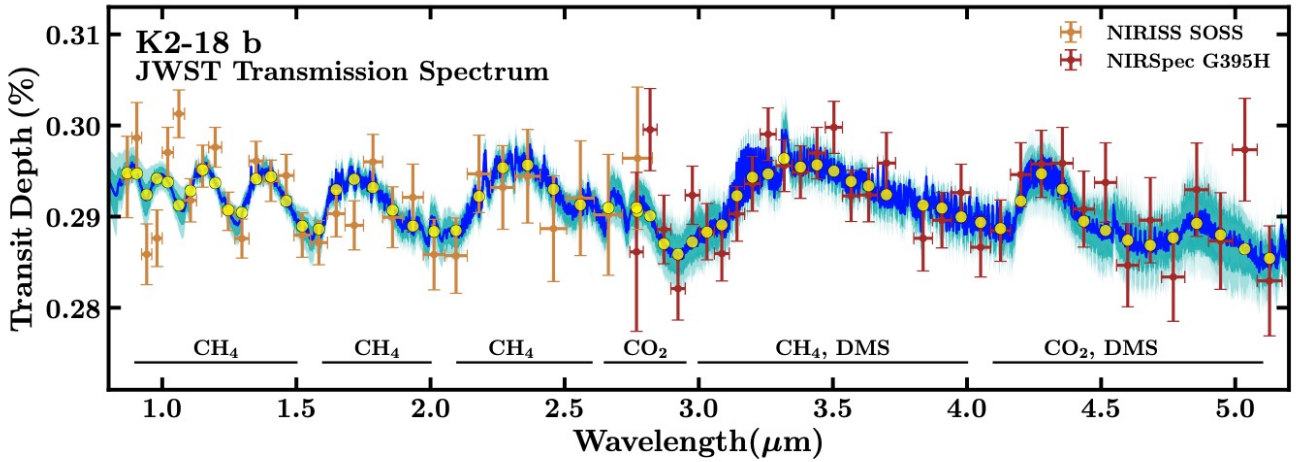
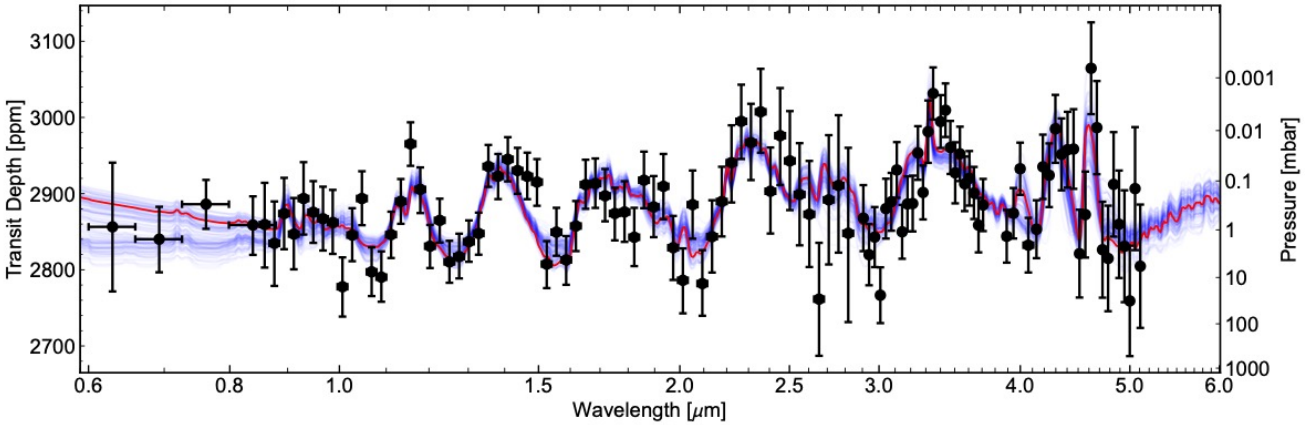
Less cloud formation in the temperate regime (200-400 K)

K2-18 b



Madhusudhan et al. 2023

TOI-270 d



Benneke et al. 2024

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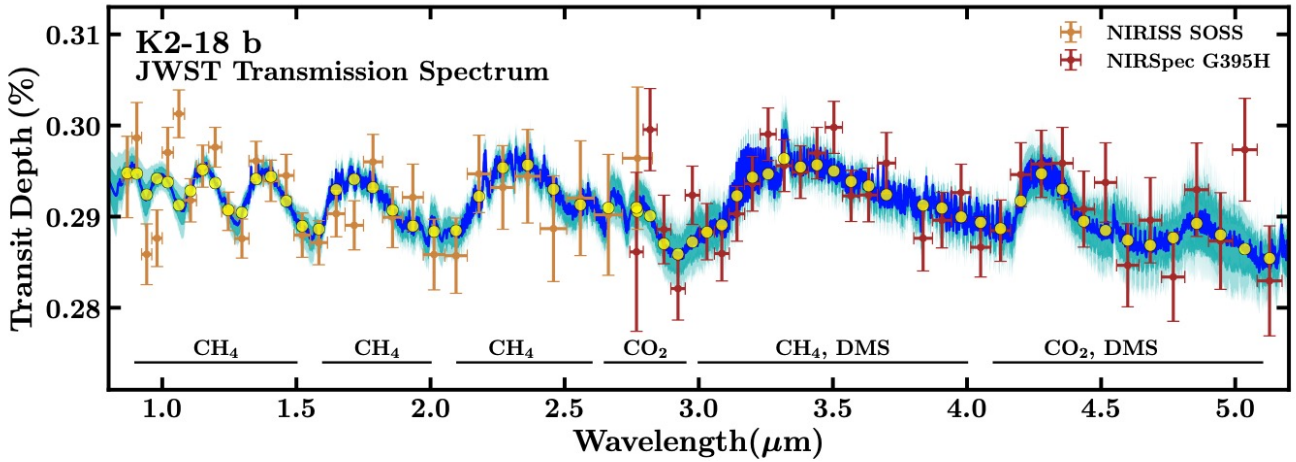
Temperate sub-Neptunes are key in unveiling the composition of the most common outcome of planet formation

K2-18 b



Madhusudhan et al. 2023

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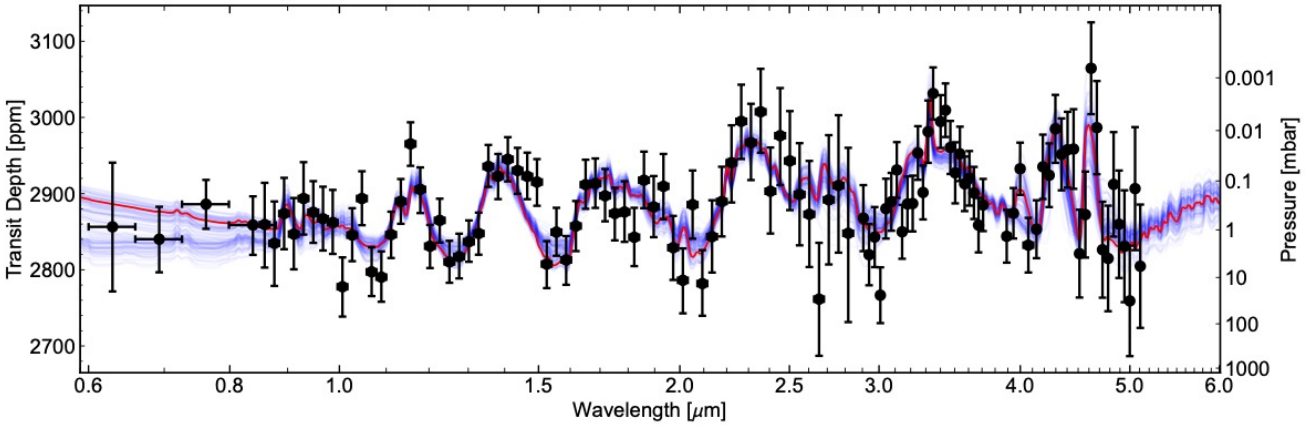

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The temperate sub-Neptune TOI-2120 b

TOI-2120: M4.5V (3140 K) dwarf star ~20% the mass and radius of the Sun

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- **TESS**: detection by **transit** in five sectors → **radius (R_p)**
- **SPIRou**: radial velocity (**RV**) follow-up to confirm the planetary nature (84 nights) → **mass (M_p)**
- T_{eq} = 382 K (A_B = 0) → temperate
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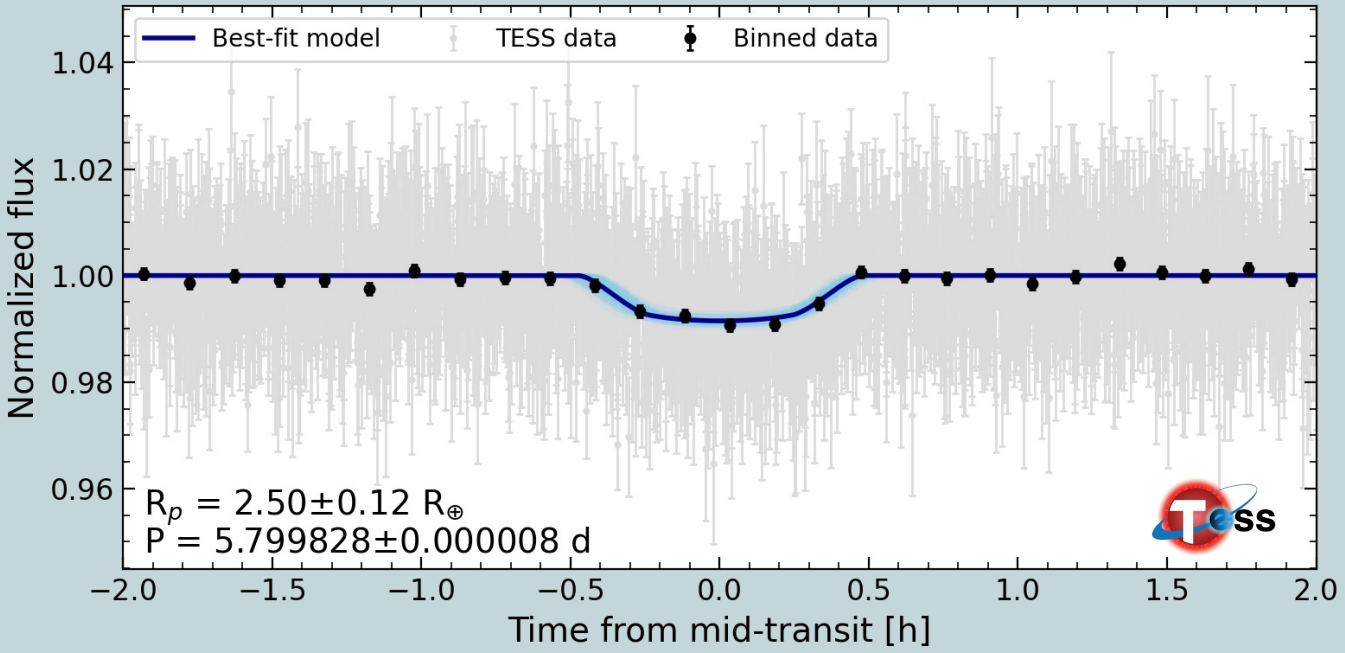
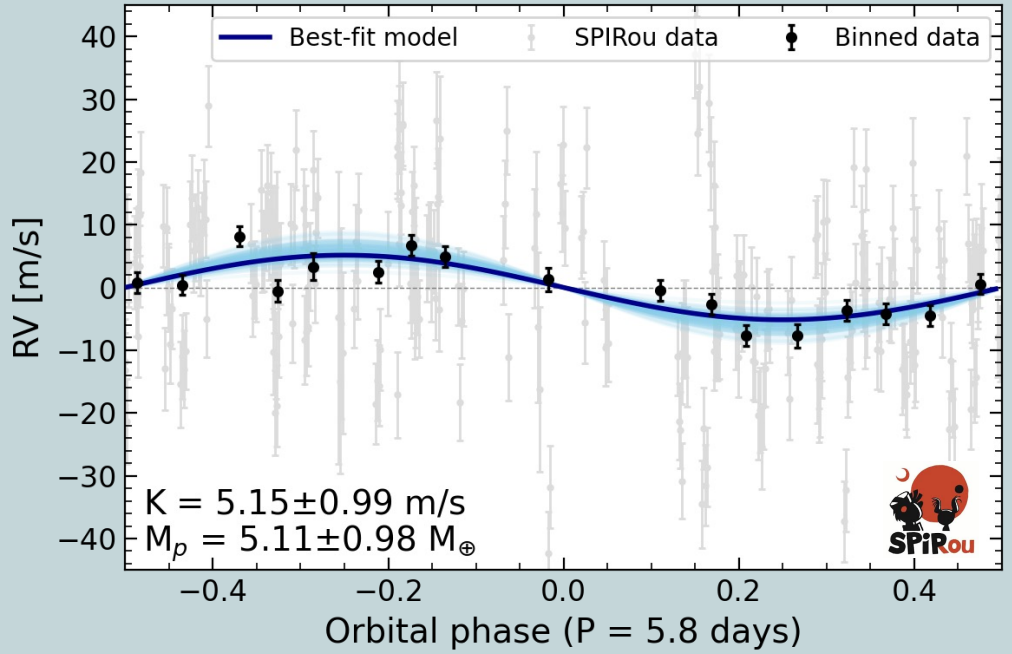
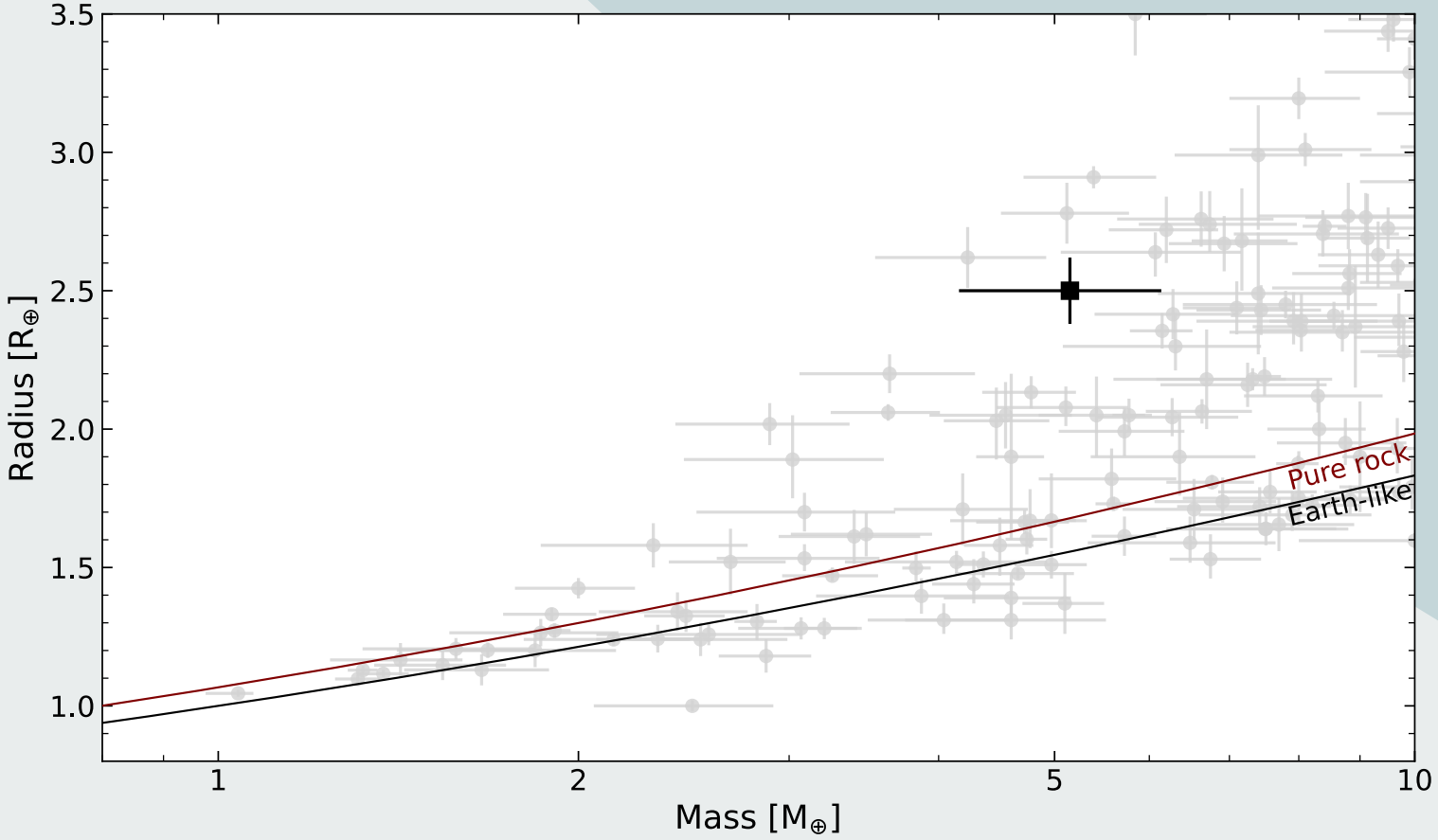




Possible bulk compositions



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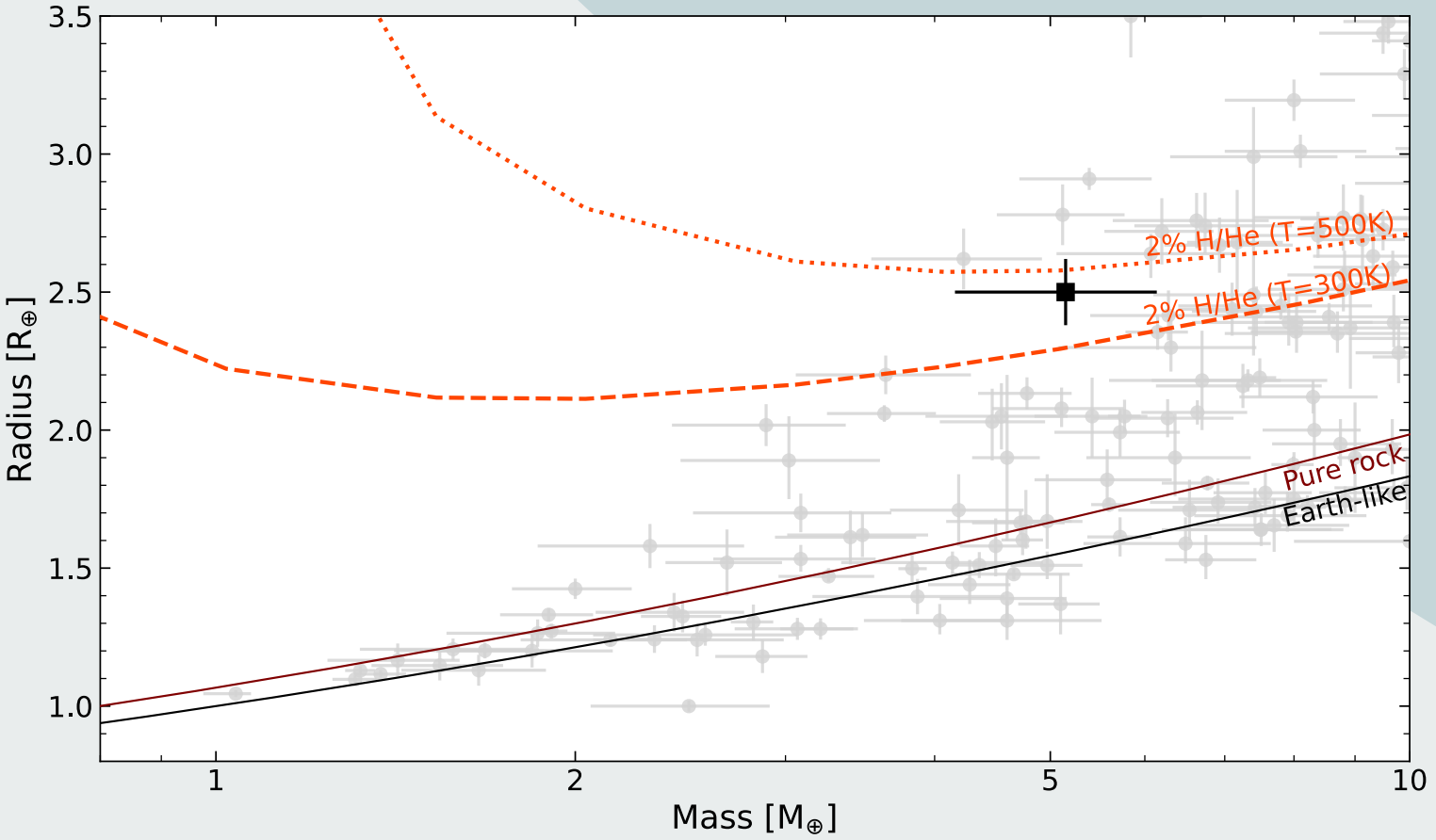

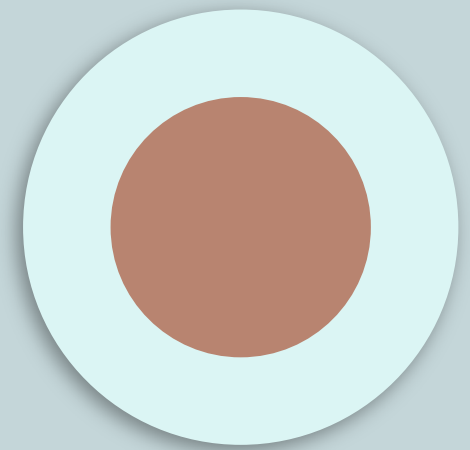

$2.82^{+0.74}_{-0.71}$ % H/He

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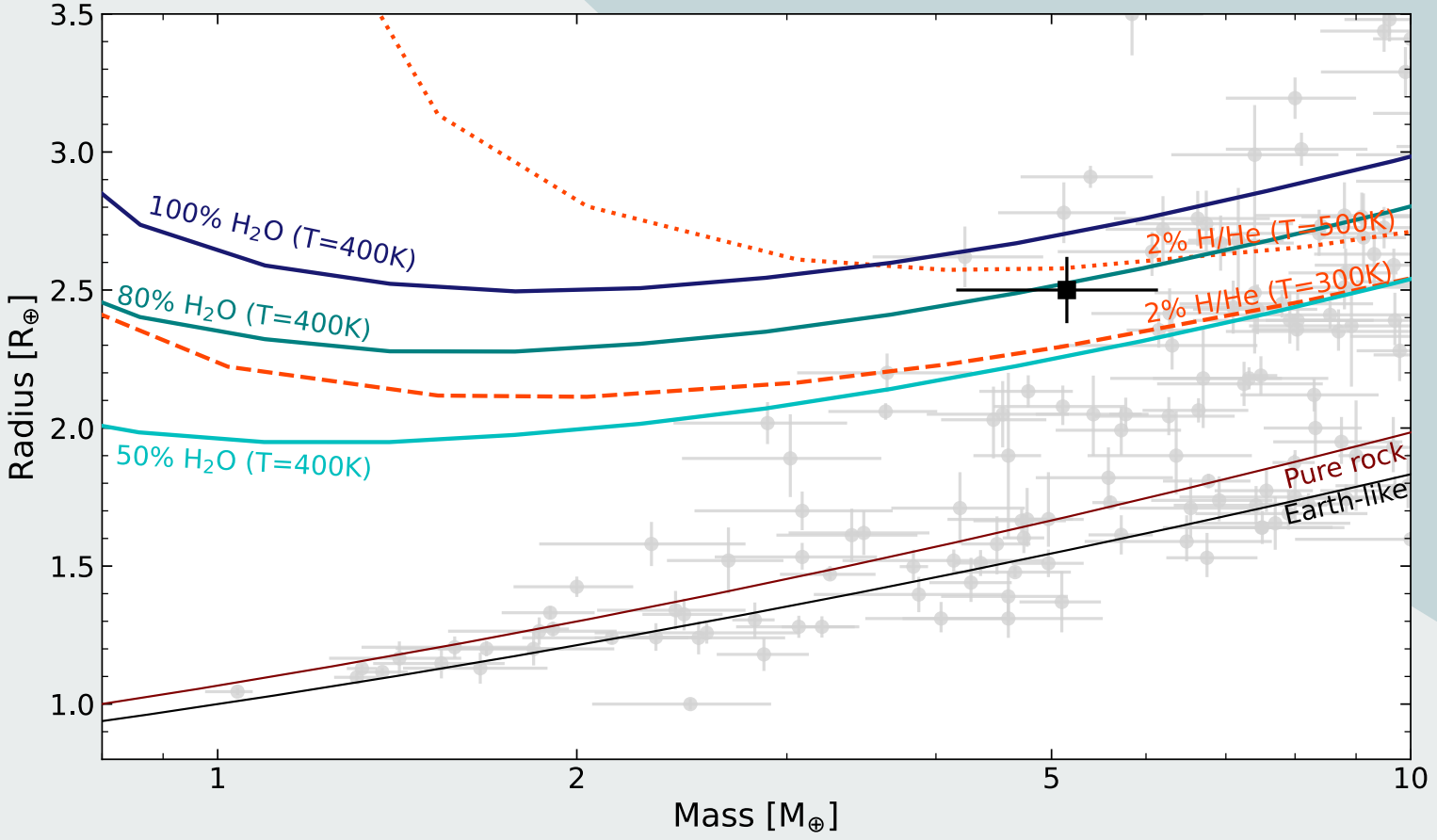
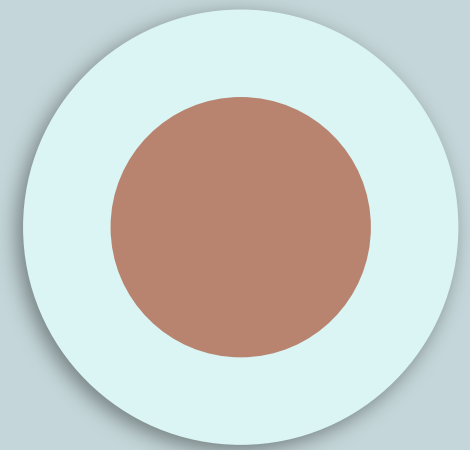


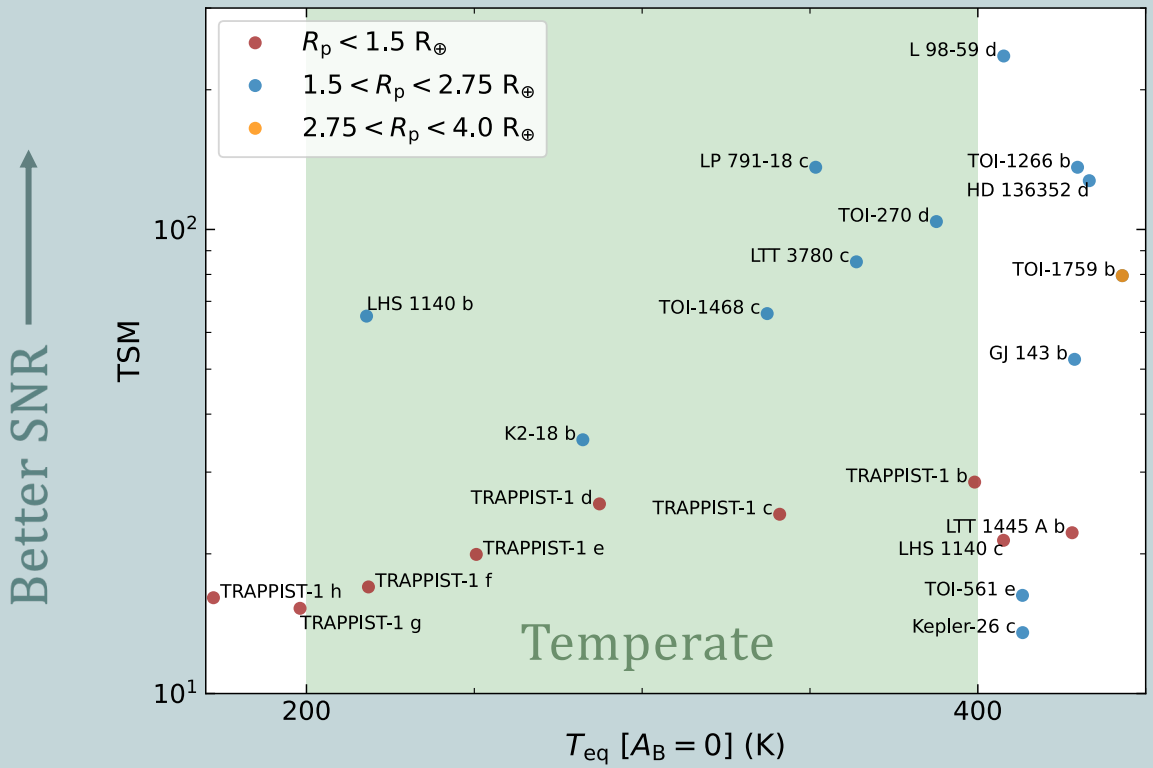


$2.82^{+0.74}_{-0.71}$ % H/He

$77^{+0.13}_{-0.15}$ % H_2O (envelope)

Prospects for atmospheric characterization

TSM: metric for the expected SNR in transmission spectroscopy



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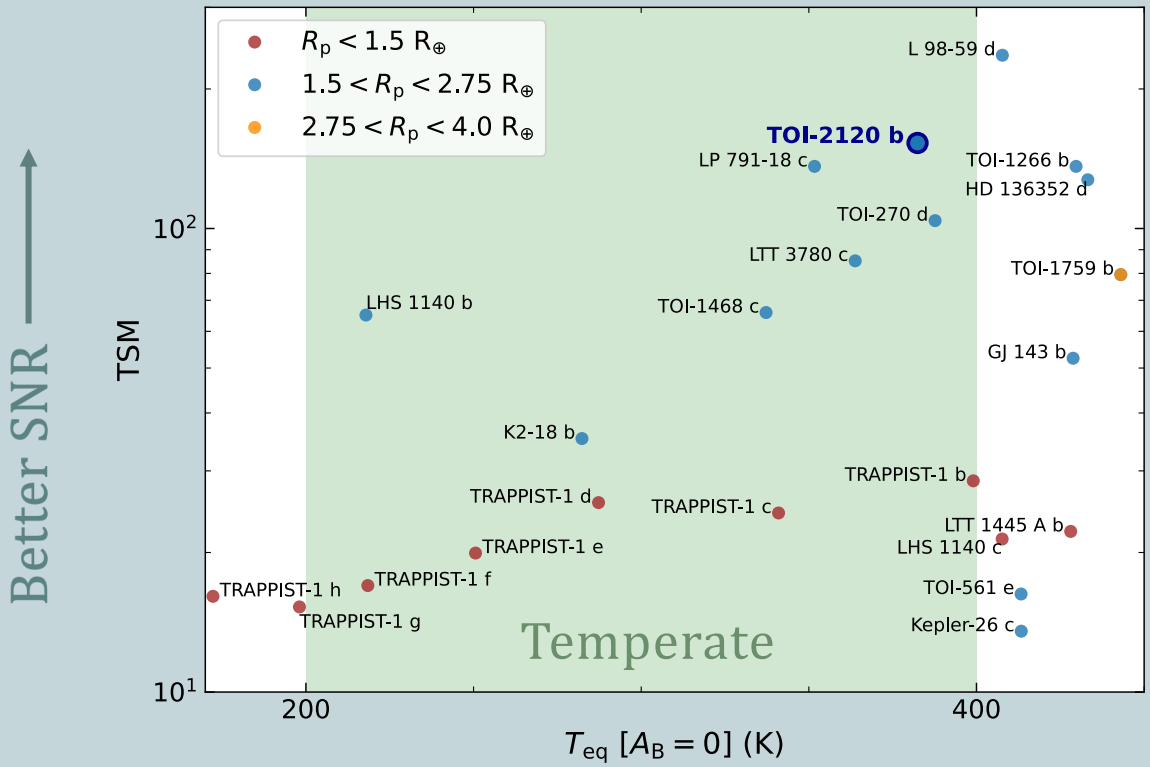

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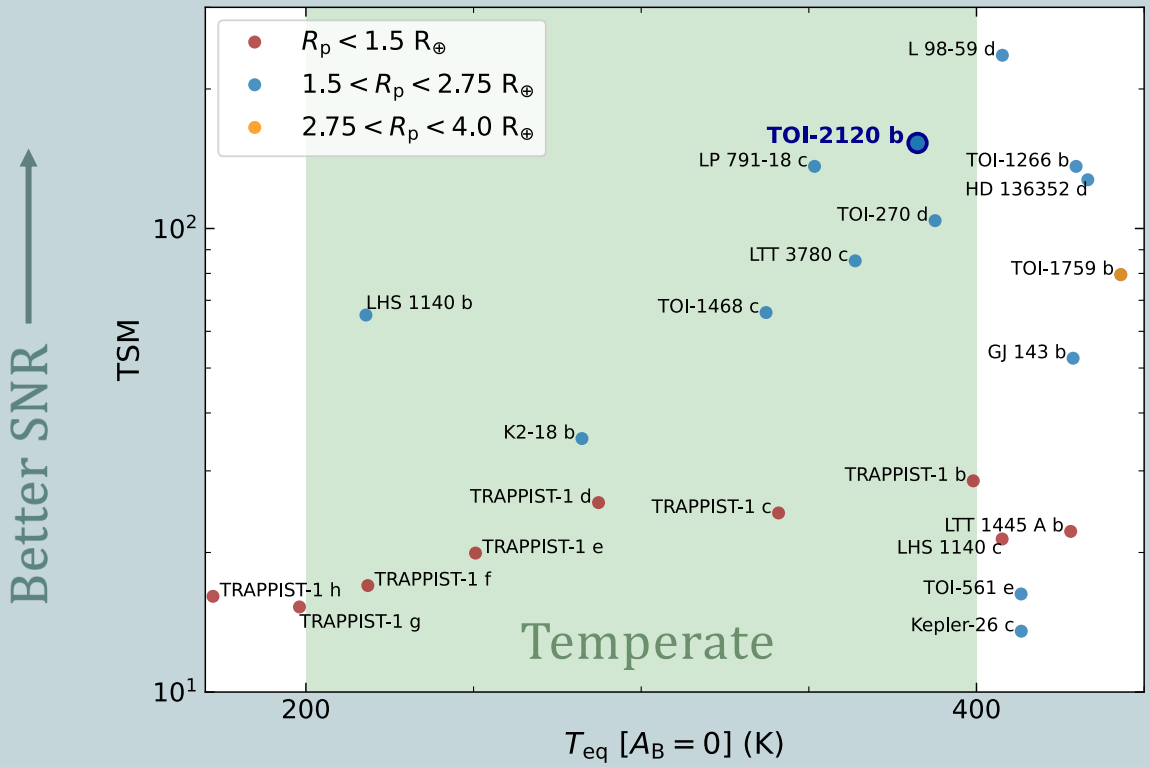
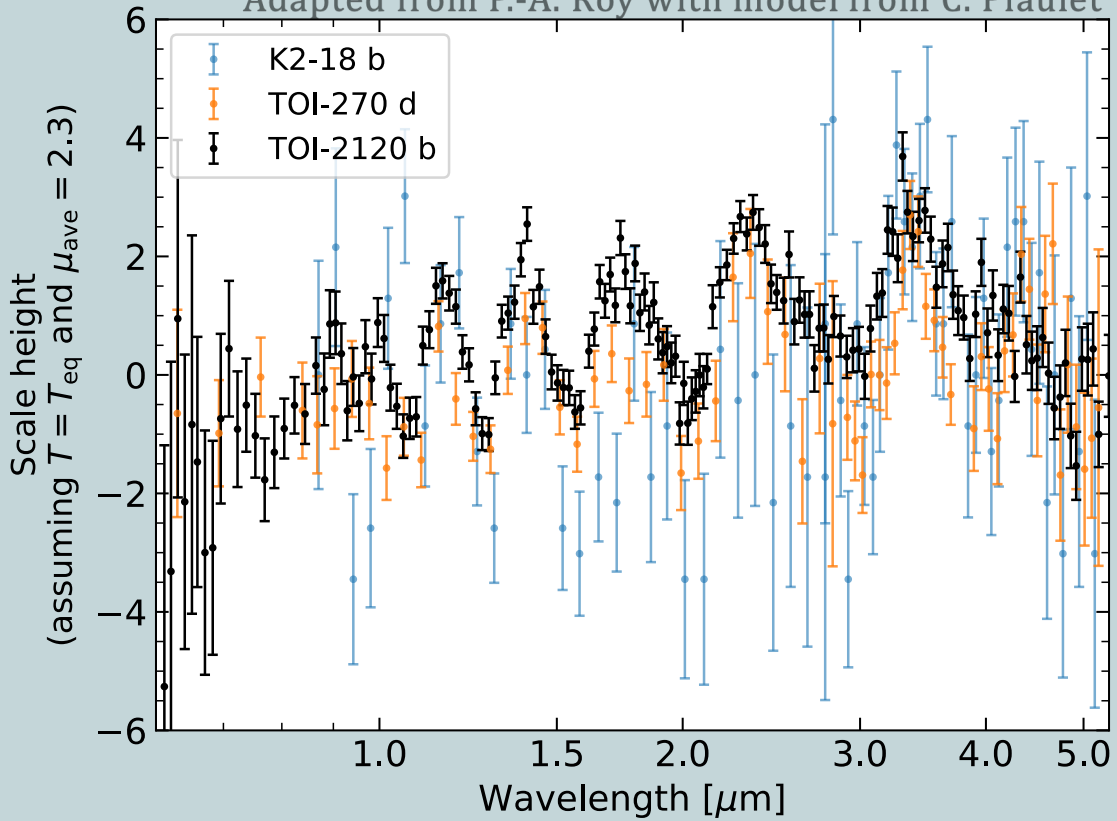


Adapted from P.-A. Roy with model from C. Piaulet



Conclusion

Characterizing sub-Neptunes

→ Understanding of planetary formation

Temperate sub-Neptunes

→ Window into their composition

TOI-2120 b

→ Recently-detected temperate sub-Neptune

→ Exciting prospects for future atmospheric characterization