

Subaru Telescope 20th Anniversary Conference

P30

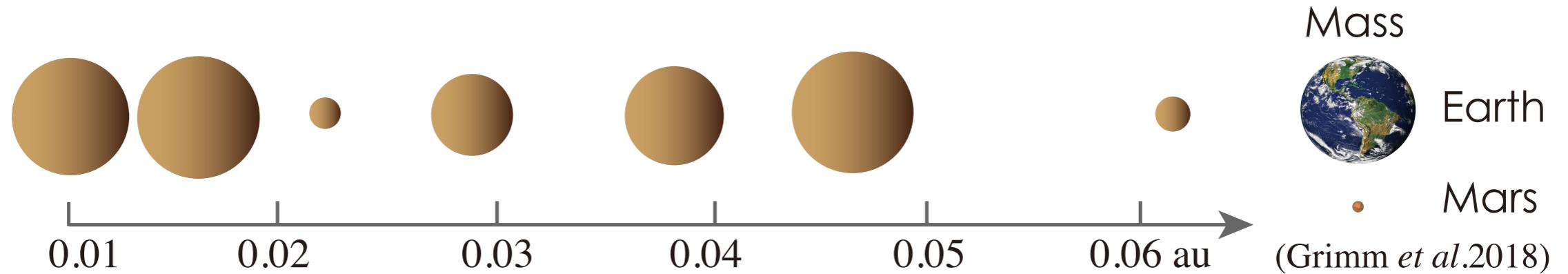
Do the TRAPPIST-1 Planets Have Hydrogen-rich Atmospheres?

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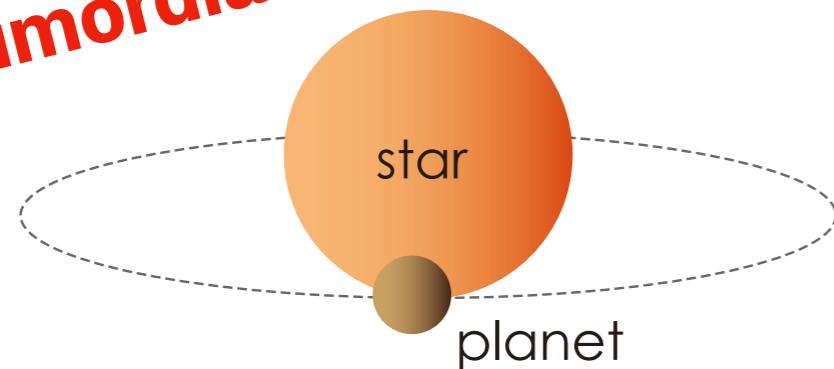
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Seven Earth-sized Planets Orbiting TRAPPIST-1



- Six inner planets form a (near-) resonant chain. (Gillon *et al.* 2017)
- TRAPPIST-1f, 1g, and 1h are likely to be in the Laplace resonance. (Leger *et al.* 2017)
- All the planets are on a nearly co-planar orbit.

No primordial atmospheres?



Transit spectroscopy of the TRAPPIST-1
planets using HST/WFC3

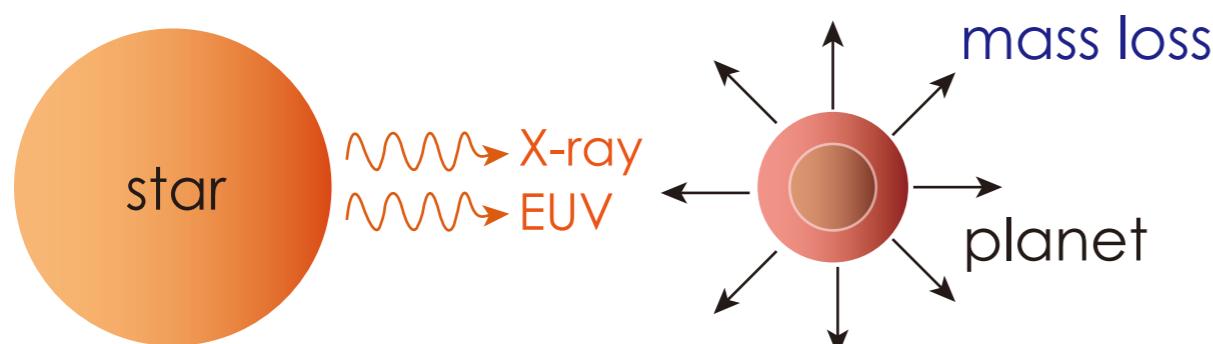
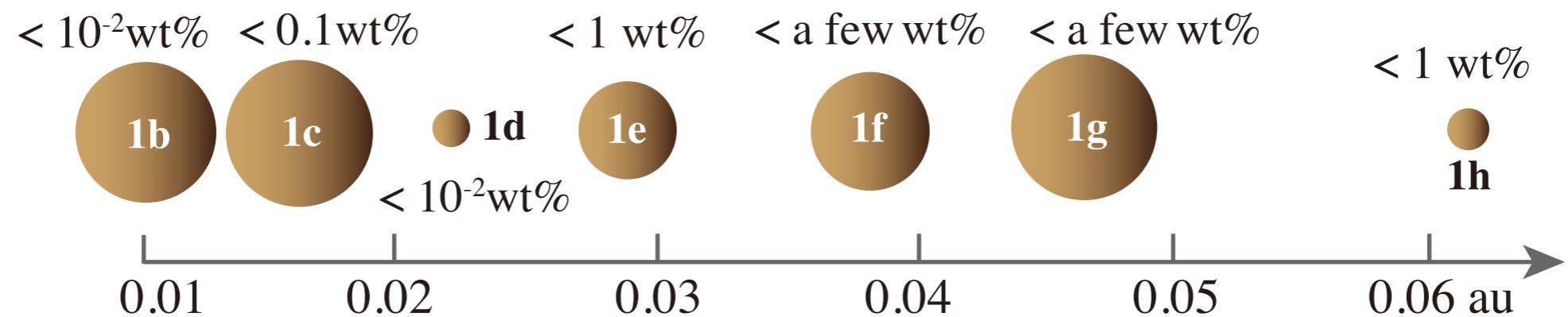
- No prominent absorption features at NIR wavelengths in transmission spectra of the atmospheres of the TRAPPIST-1 planets rule out cloud-free hydrogen-rich atmospheres.

(de Wit *et al.* 2016; 2018; Zhang *et al.* 2018; Wakeford *et al.* 2019; Burdanov *et al.* 2019)

Orbital migration?

Accumulation and Retention of H₂-rich Atmospheres

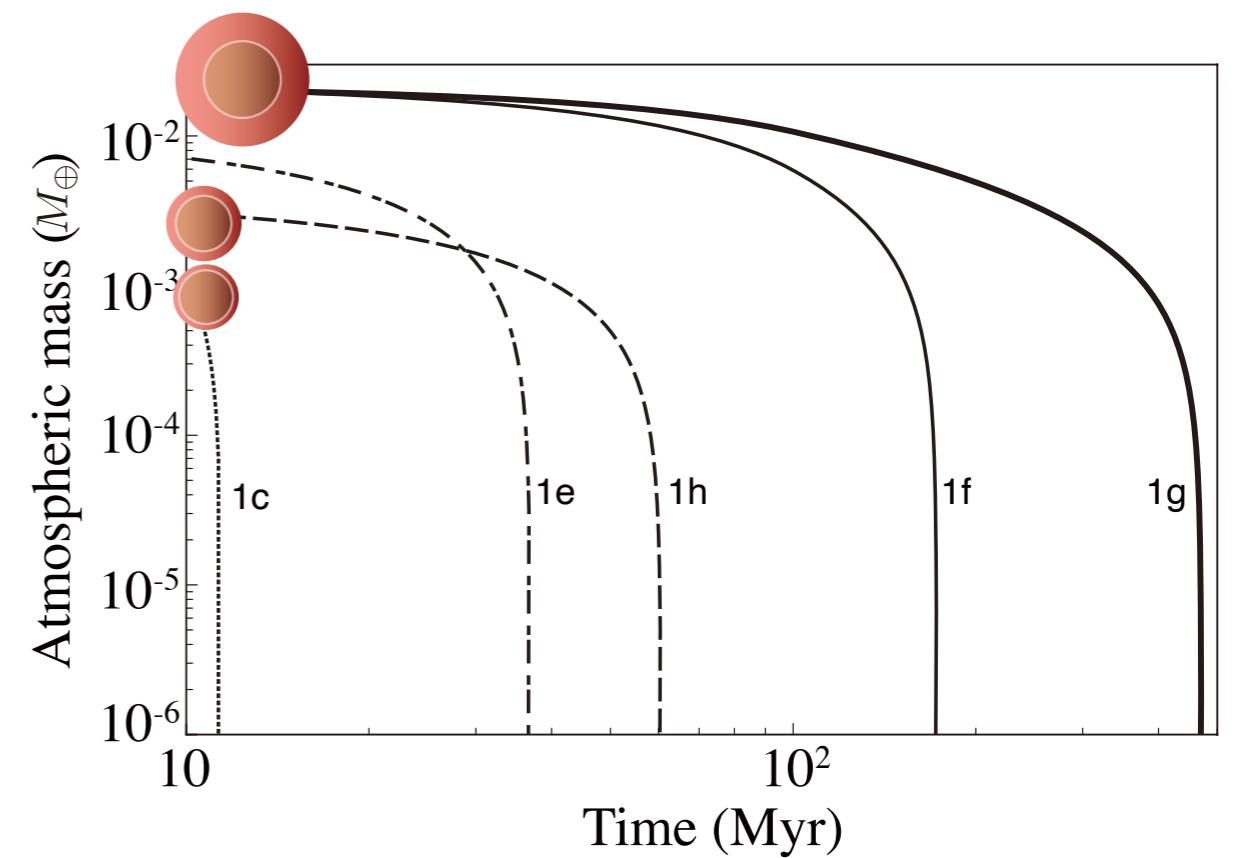
The amount of an accreted hydrogen-rich gas:



Mass loss rate:

Energy-limited hydrodynamic escape

$$\dot{M}_{\text{esc}} = \frac{\eta F_{\text{XUV}} \pi R_{\text{XUV}}^3}{GM_p K_{\text{tide}}} \quad (\text{e.g. Erkaev et al. 2007})$$



All the hydrogen-rich atmospheres that TRAPPIST-1 planets accreted from the ambient disk were lost!