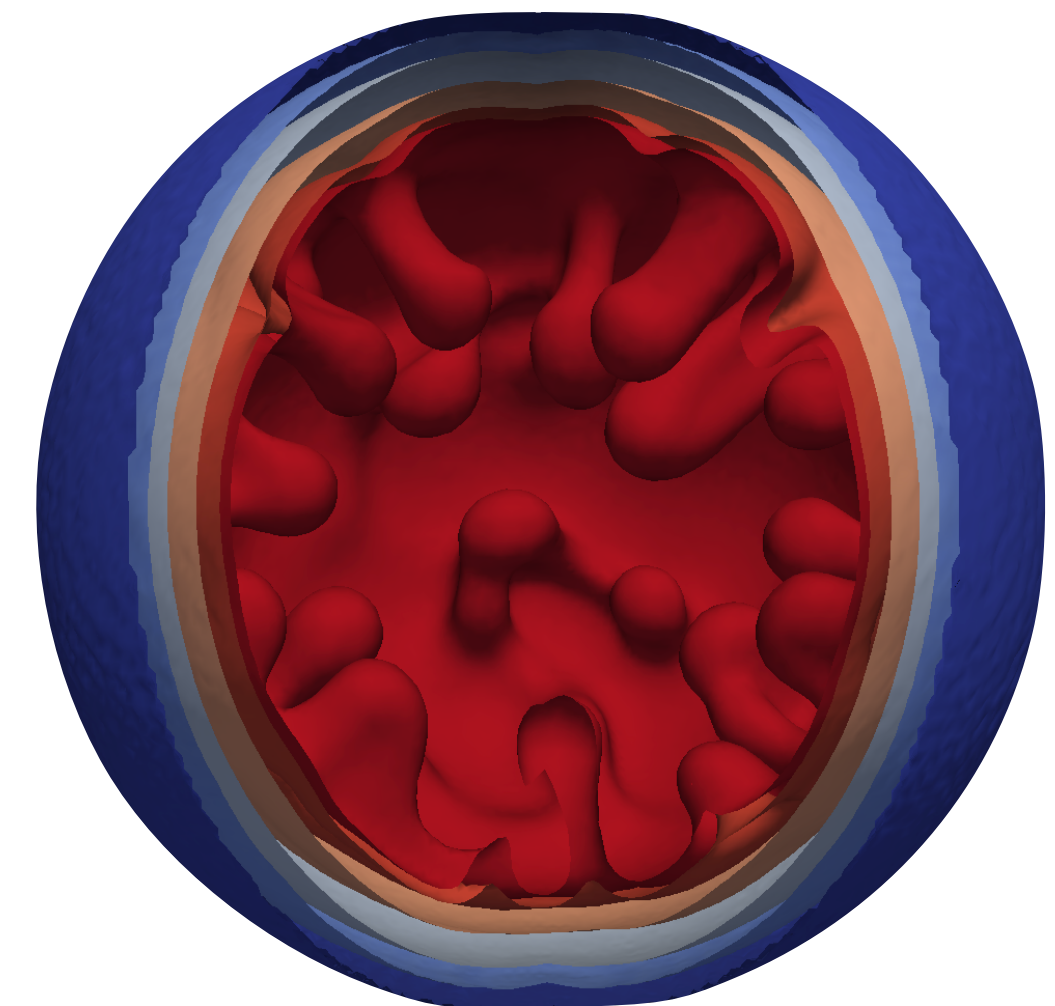


# A water budget dichotomy of rocky protoplanets from $^{26}\text{Al}$ -heating

Tim Lichtenberg

Gregor Golabek (BGI Bayreuth)  
Michael Meyer (U Michigan)  
Taras Gerya (ETH Zürich)

Remo Burn (U Bern)  
Yann Alibert (U Bern / CSH)  
Christoph Mordasini (U Bern / CSH)

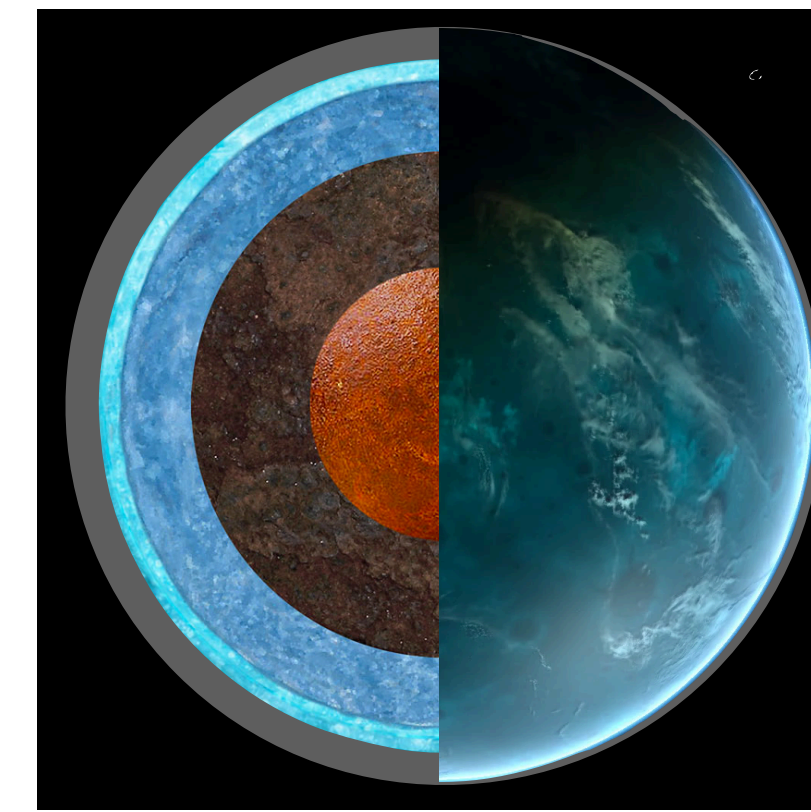
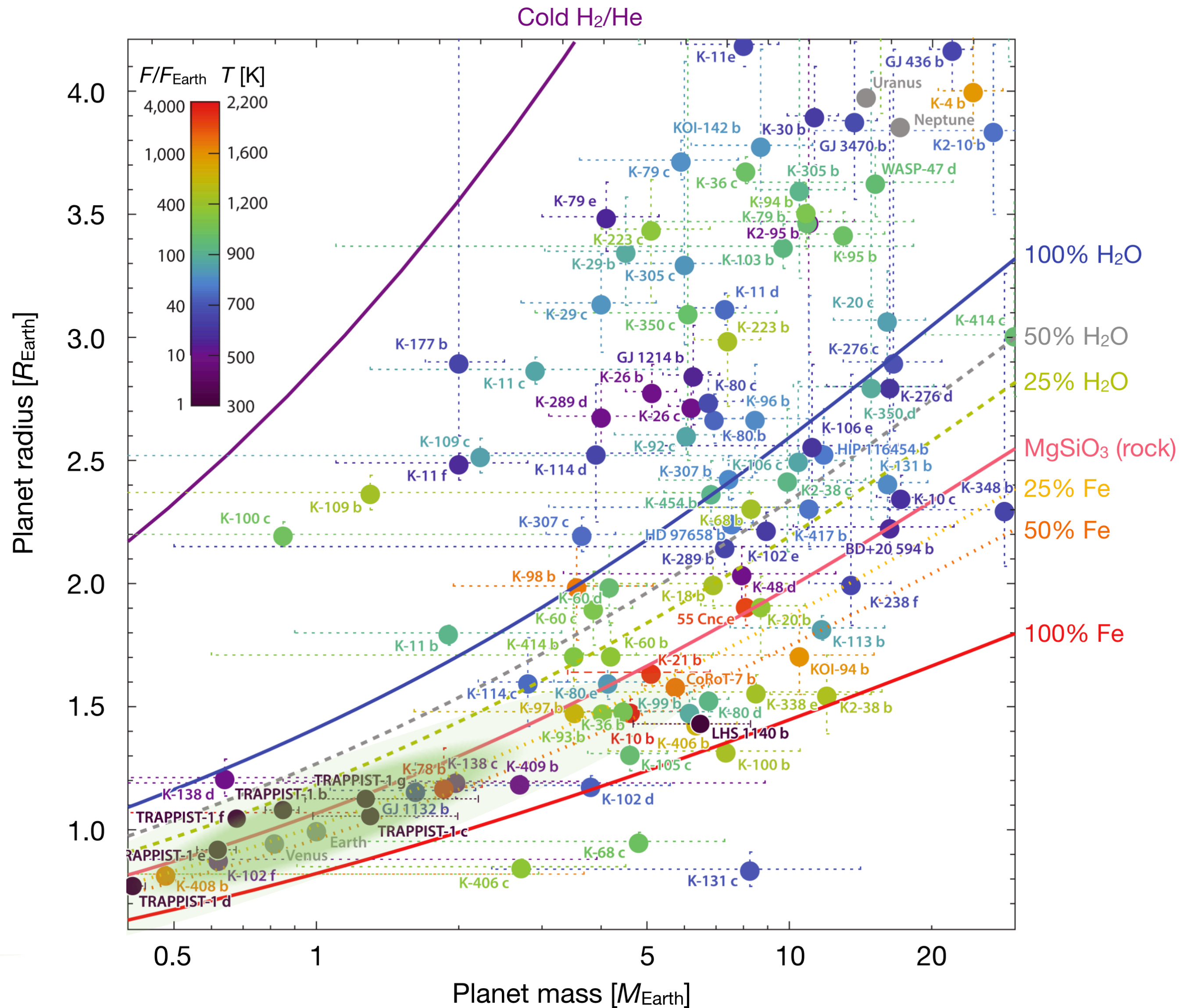


# $^{26}\text{Al}$ key control on rocky planet composition

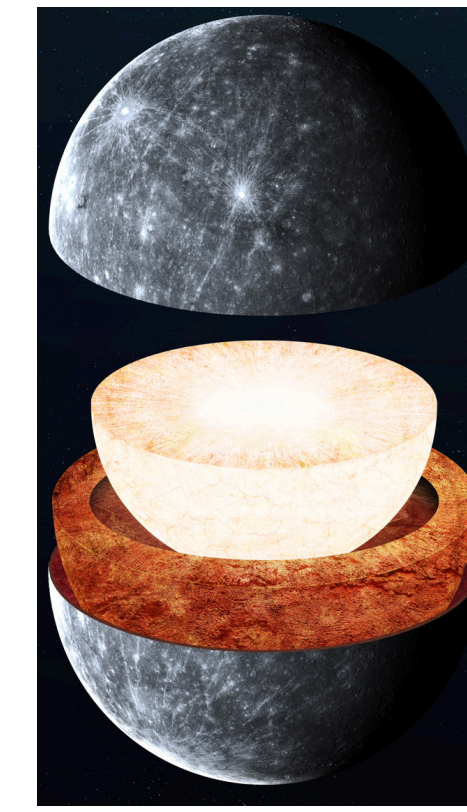


- Fraction of planetary systems enriched with  $^{26}\text{Al}$ 
  - ➔ Volatile loss & differentiation in planetesimals
- Systemic dichotomy:
  - ➔ Enriched: water-poor (proto-)planets
  - ➔ Not-enriched: ocean worlds
- ◉ Statistically traceable w/ near-future data?
  - ➔ Discernible by *transit radius* alone
  - ➔ Increasing statistics on M star systems

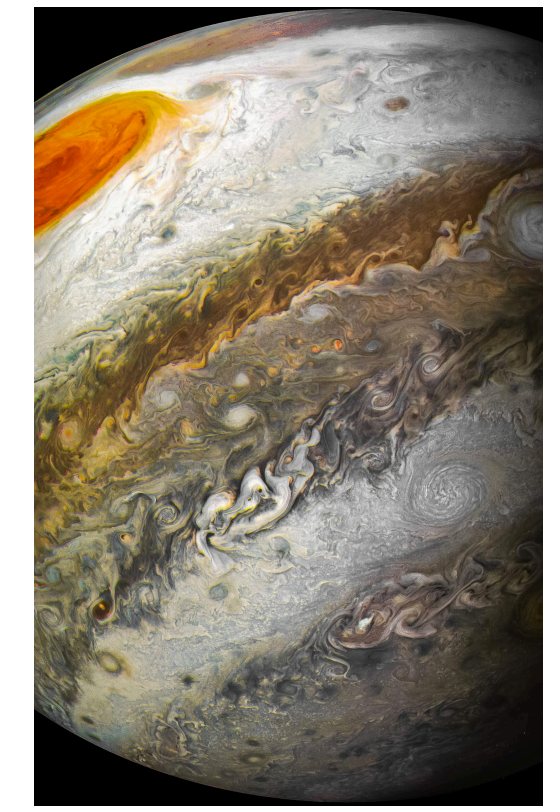
# Exoplanet diversity



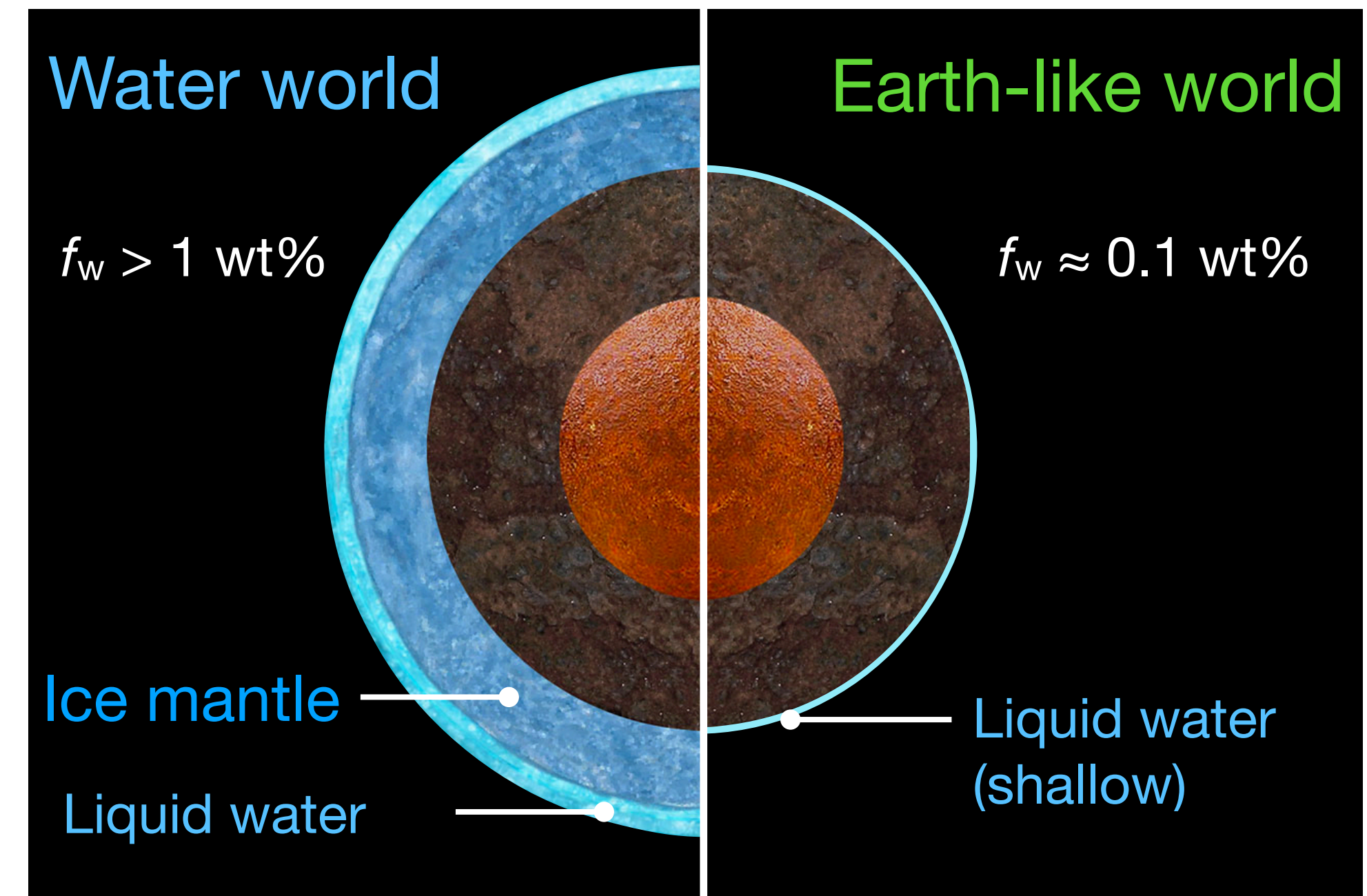
$\text{H}_2\text{O}$



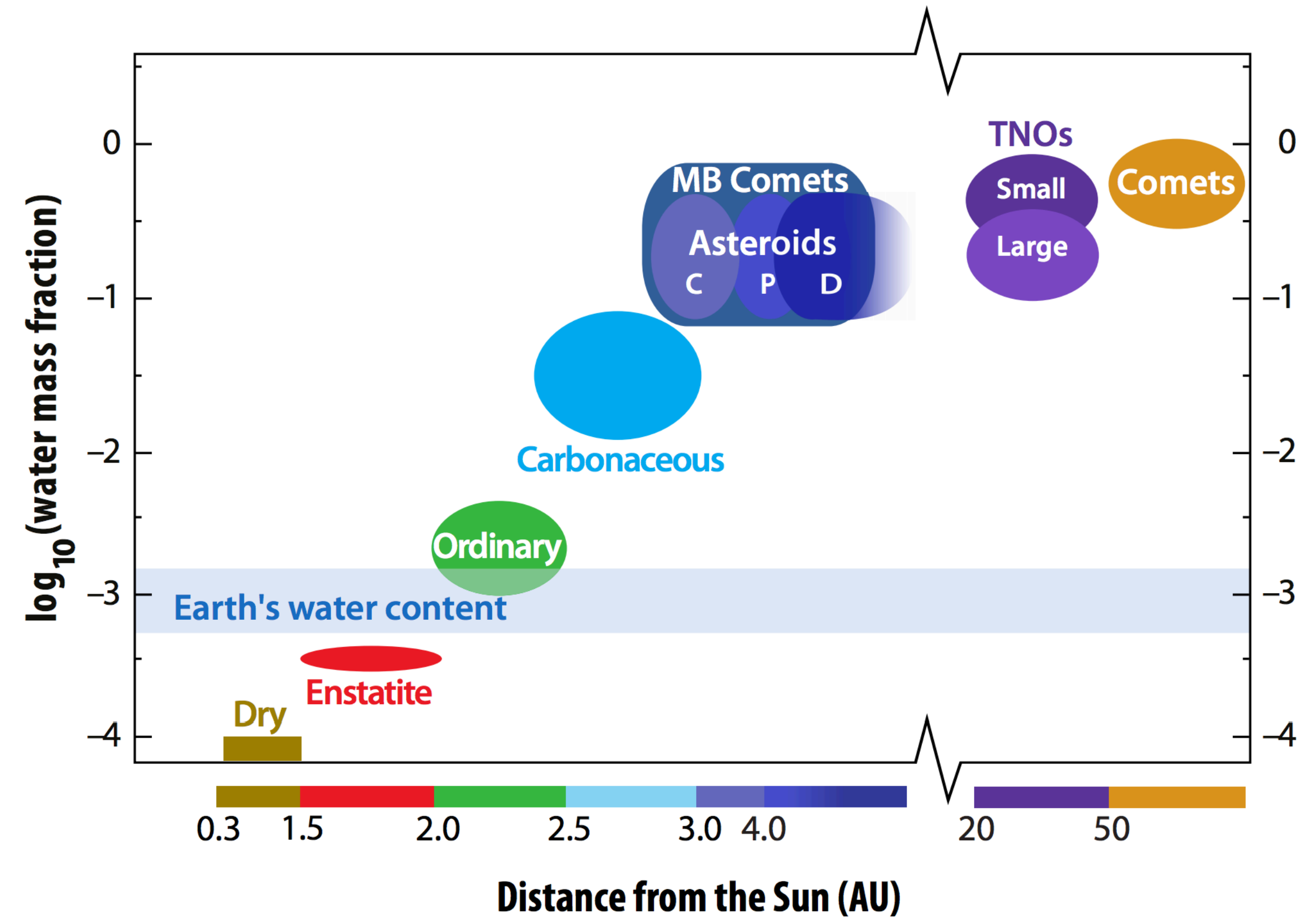
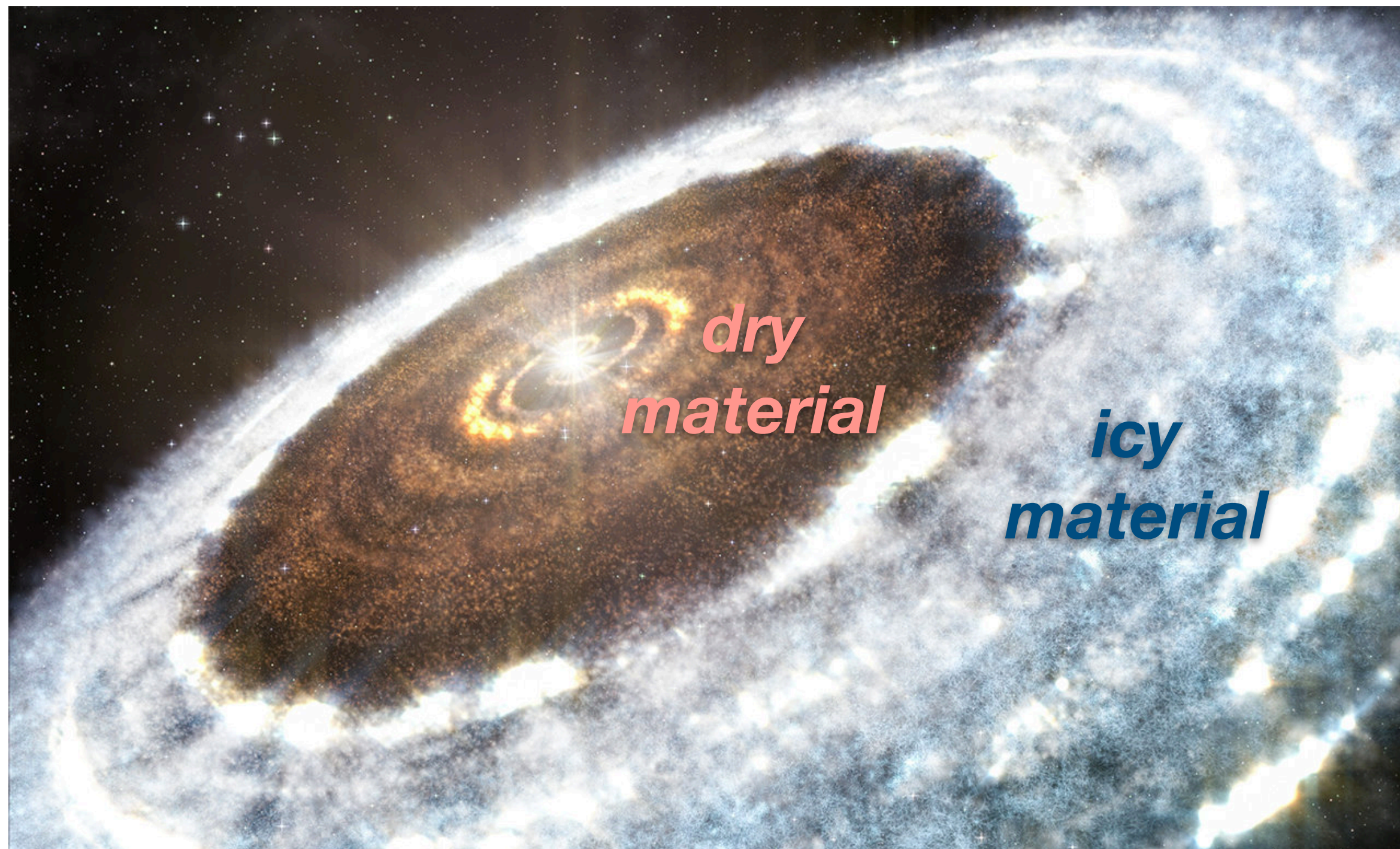
Fe



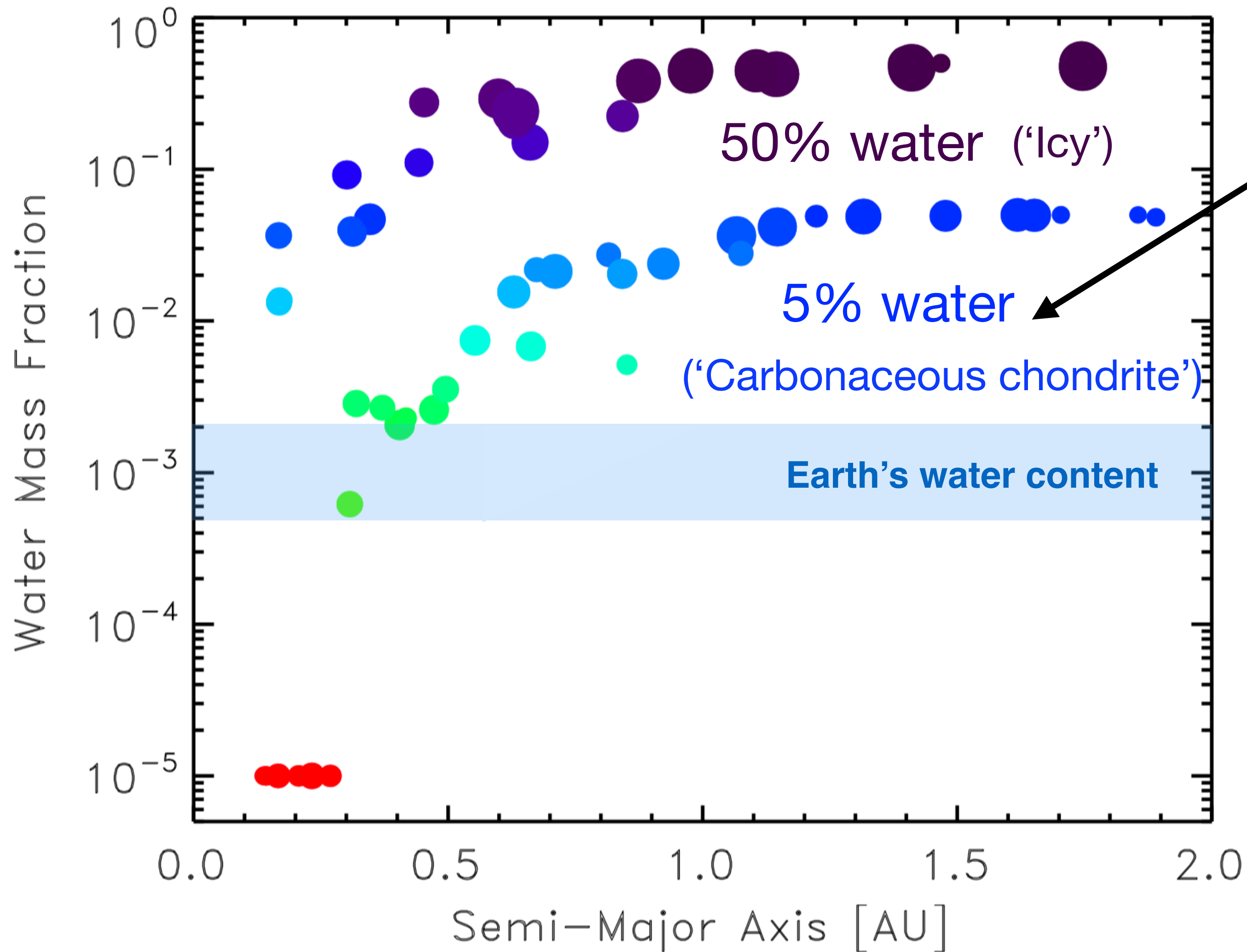
$\text{H}_2/\text{He}$



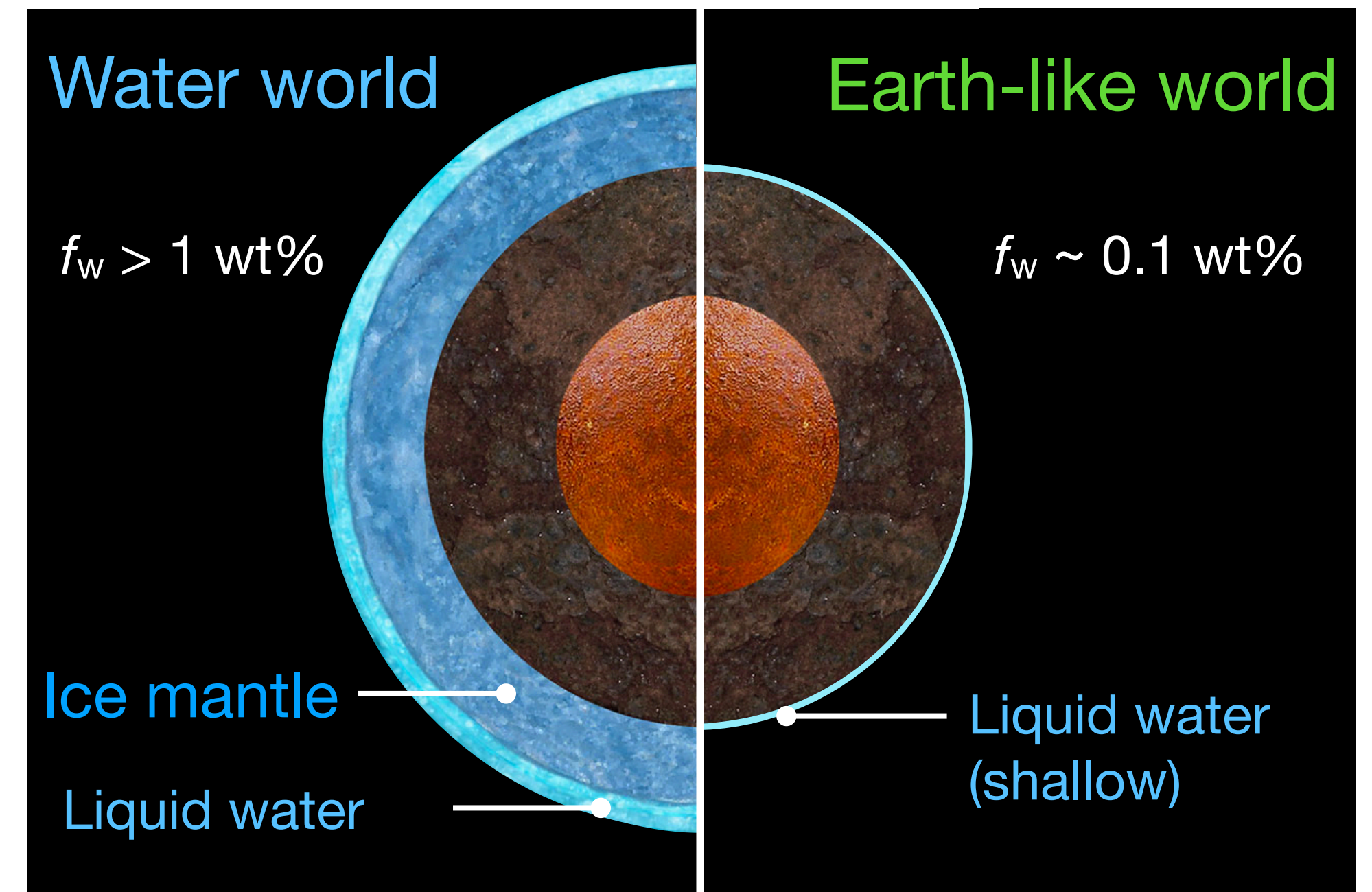
# Water carrier during accretion?



# Plethora of water worlds (?)



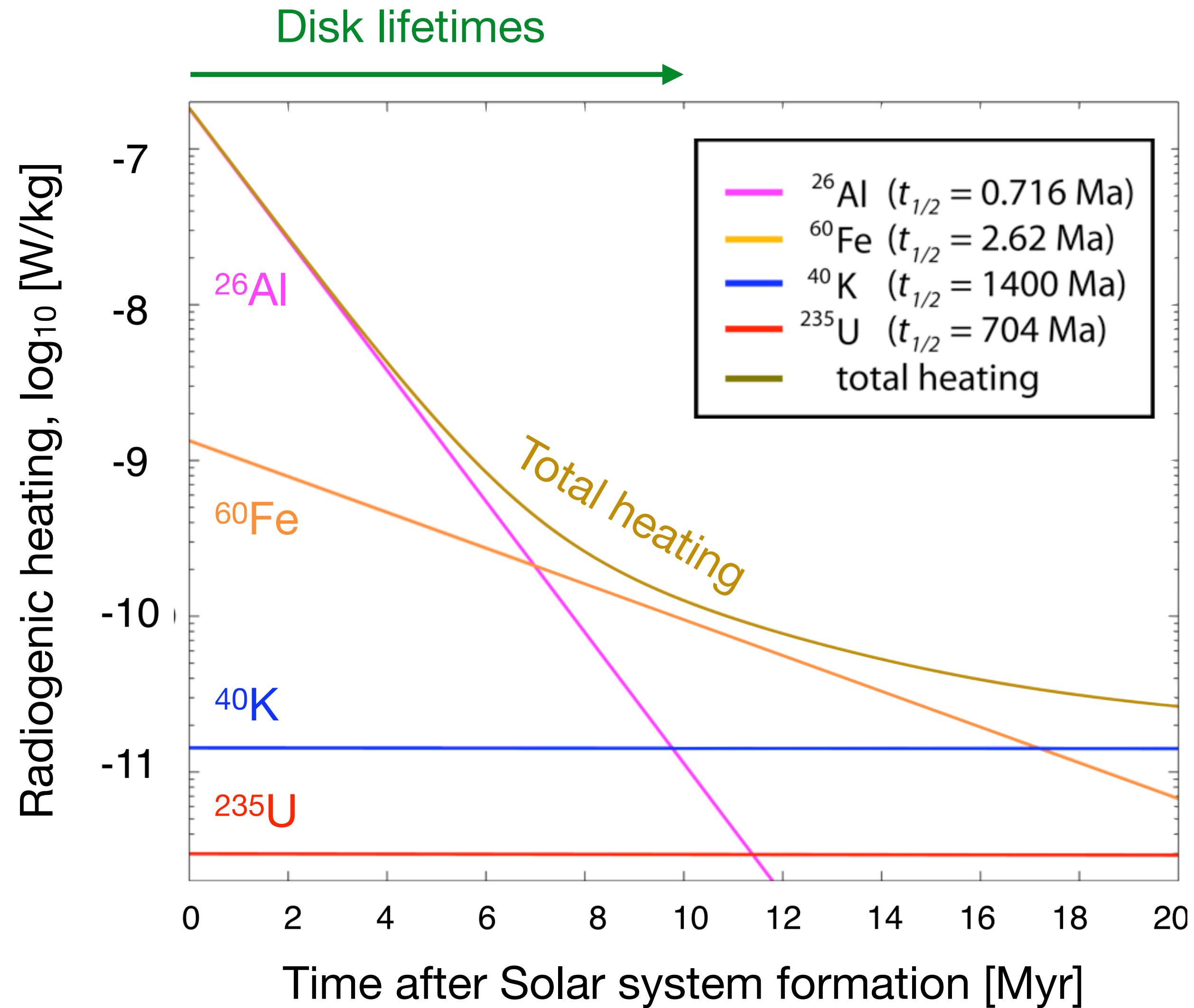
Planetesimal water content [wt%]



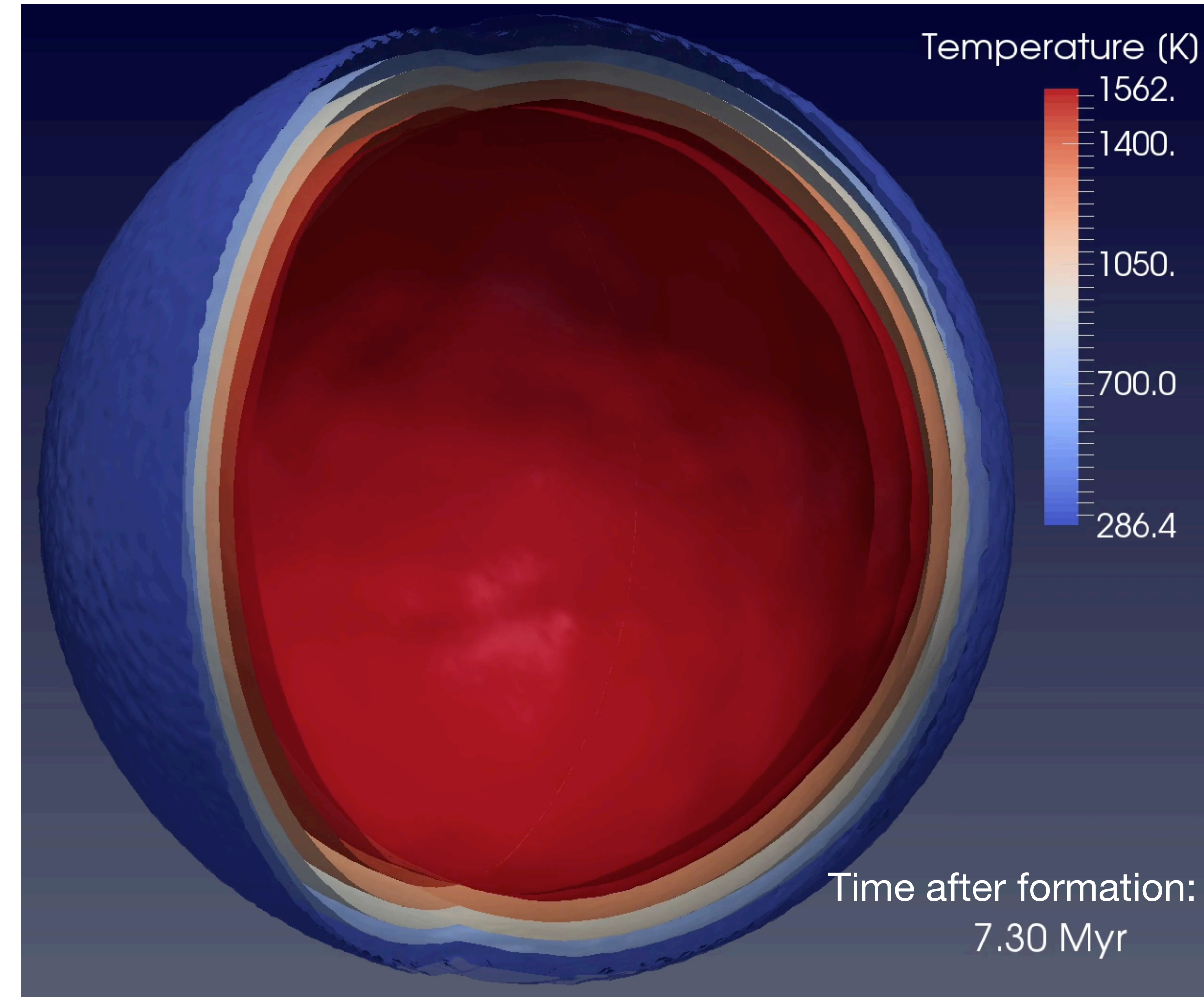
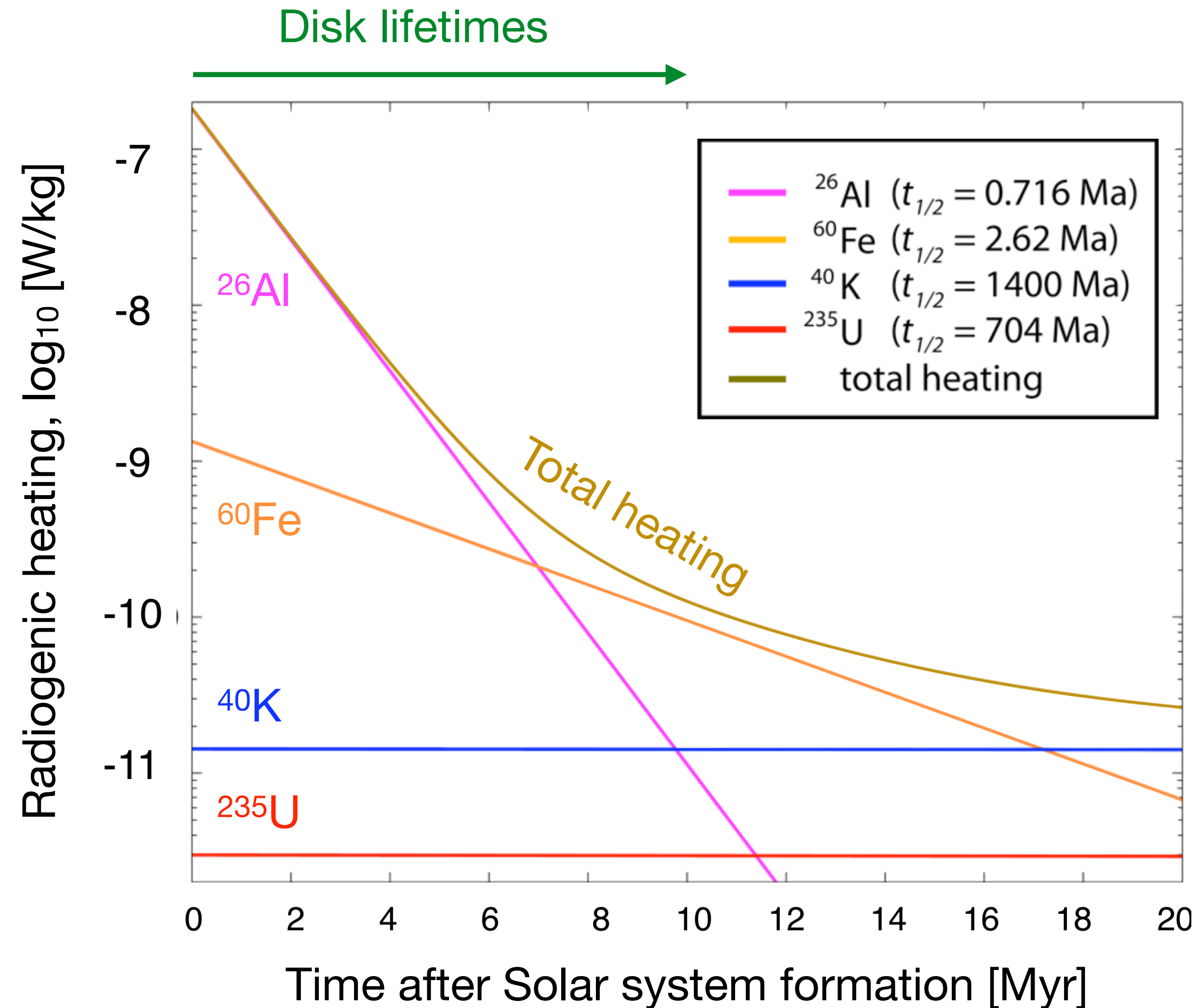
**Limited storage in terrestrial core+mantle**

e.g., Kuchner 03, Leger+ 04, Sotin+ 07, Tian & Ida 15, Noack+ 16/17, Alibert & Benz 17, Simpson 17, Ramirez & Levi 18, Zain+ 18, Izidoro+ 19

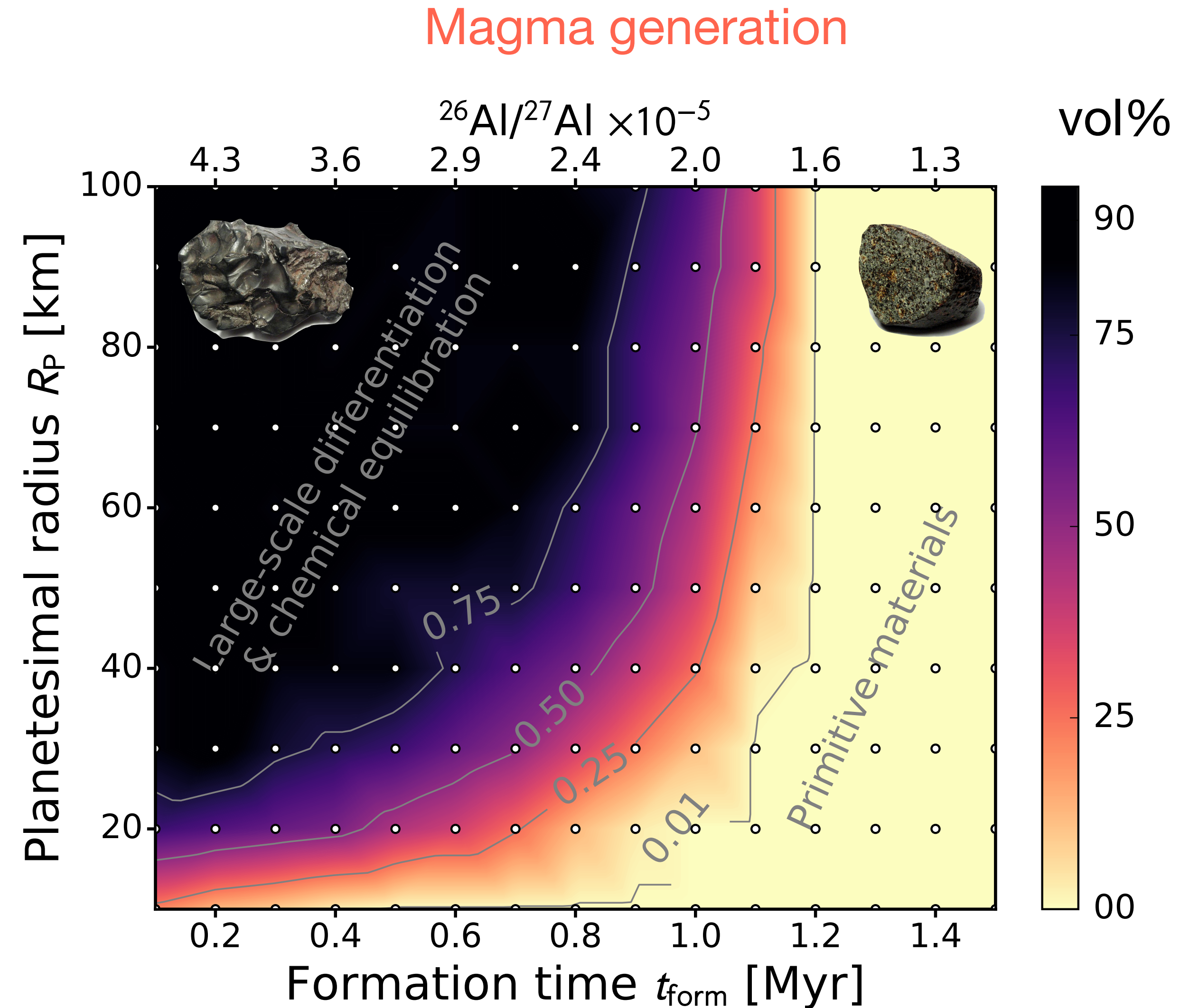
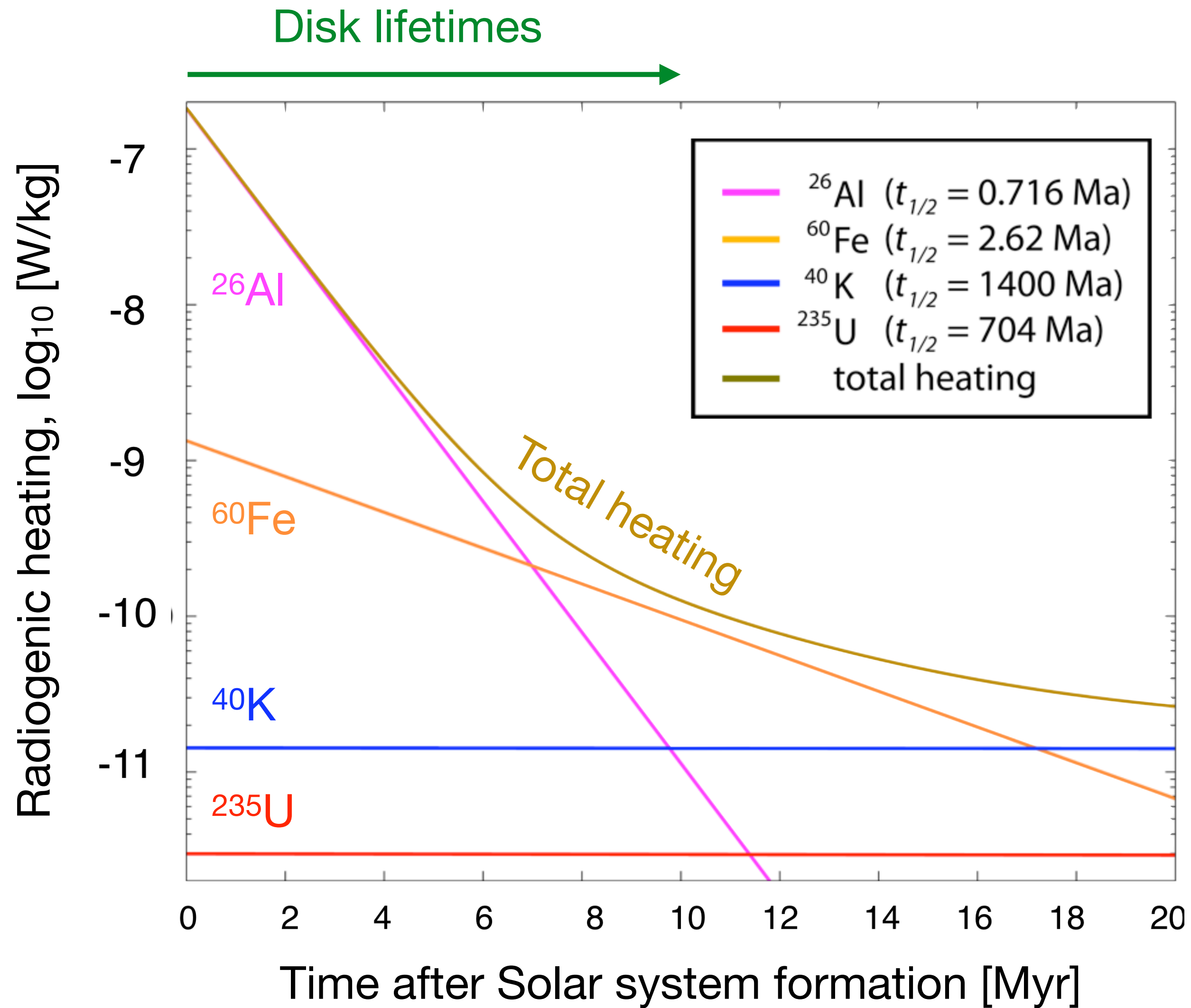
# Radiogenic heating in early Solar System



# Radiogenic heating in early Solar System



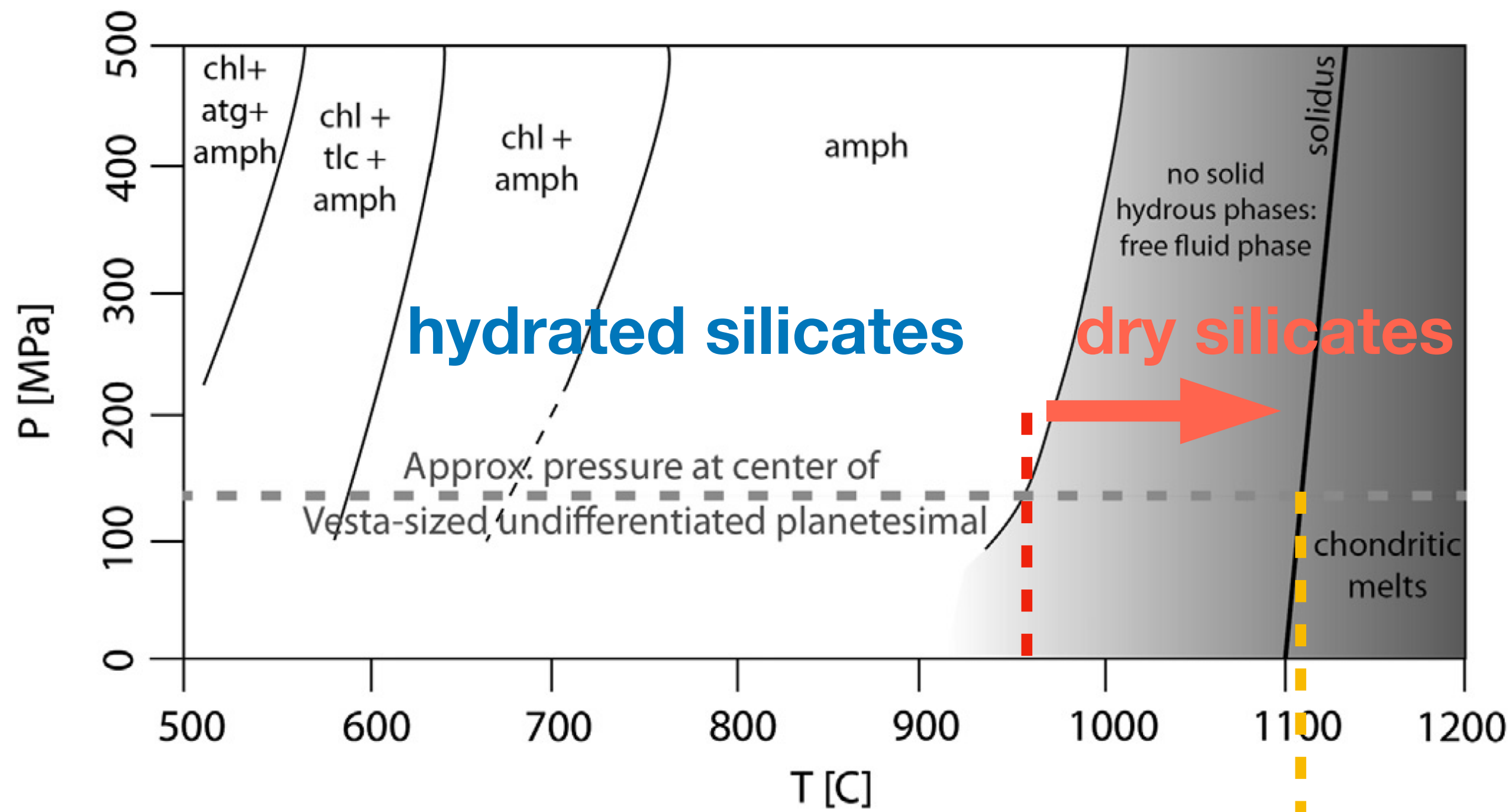
# Geodynamic evolution of planetesimal interiors





# Water loss from planetesimals

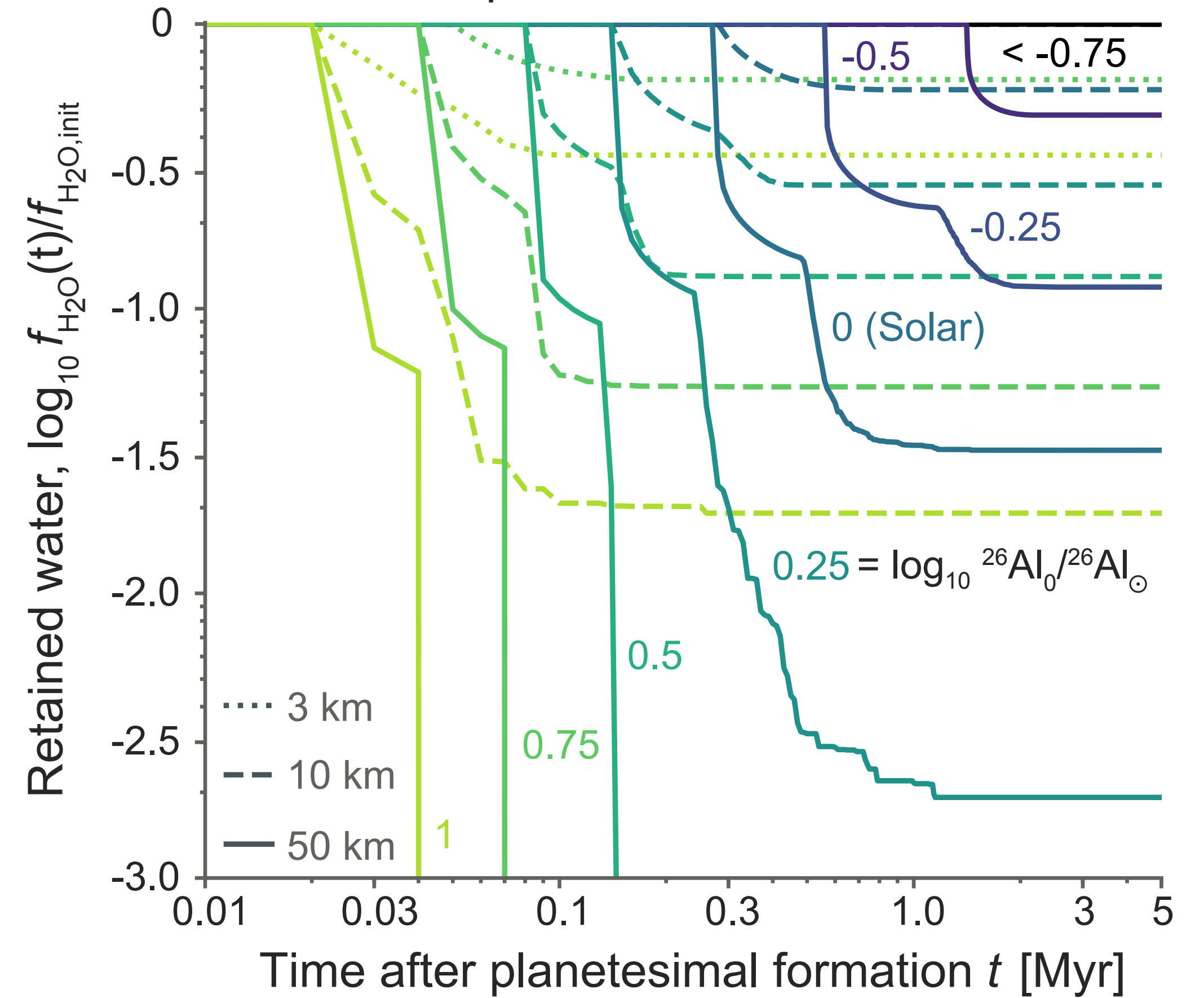
## Stability of hydrated silicates



←  $T = 0 \text{ }^\circ\text{C}$ : Water ice melts

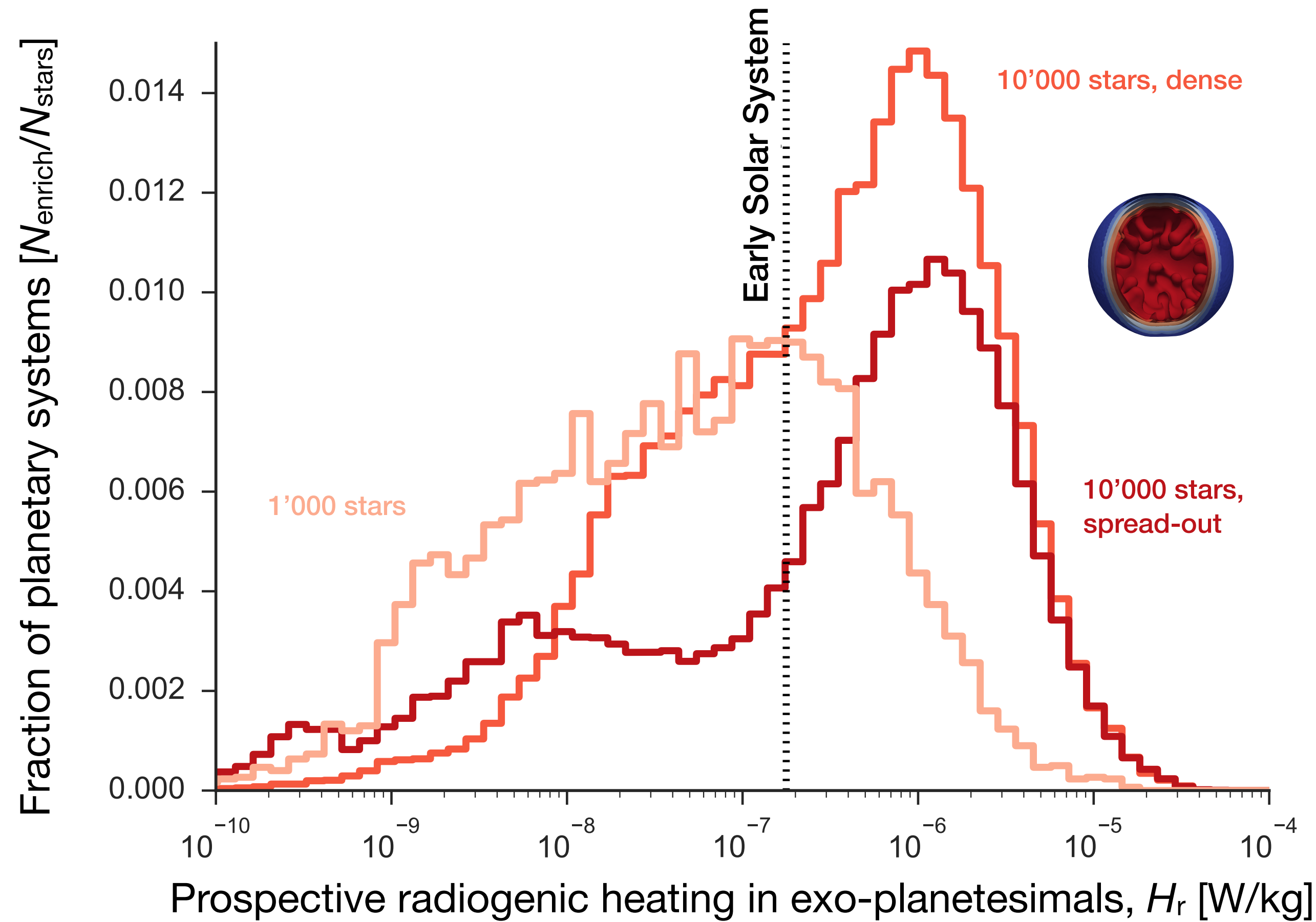
→ silicate melting

## Decrease of planetesimal water abundance



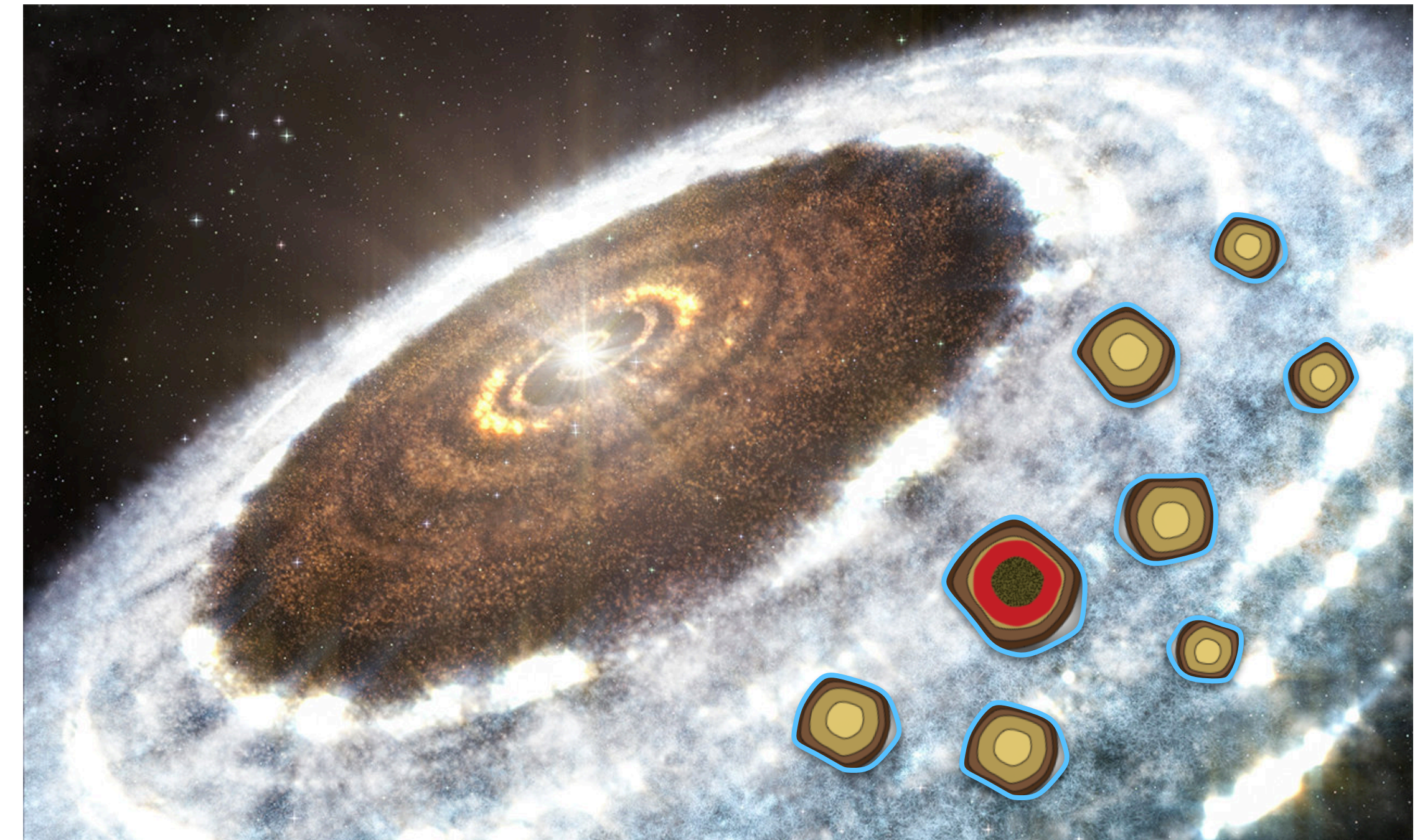
# Planet accretion altered by $^{26}\text{Al}$

Enrichment with short-lived radionuclides ( $^{26}\text{Al} + ^{60}\text{Fe}$ )

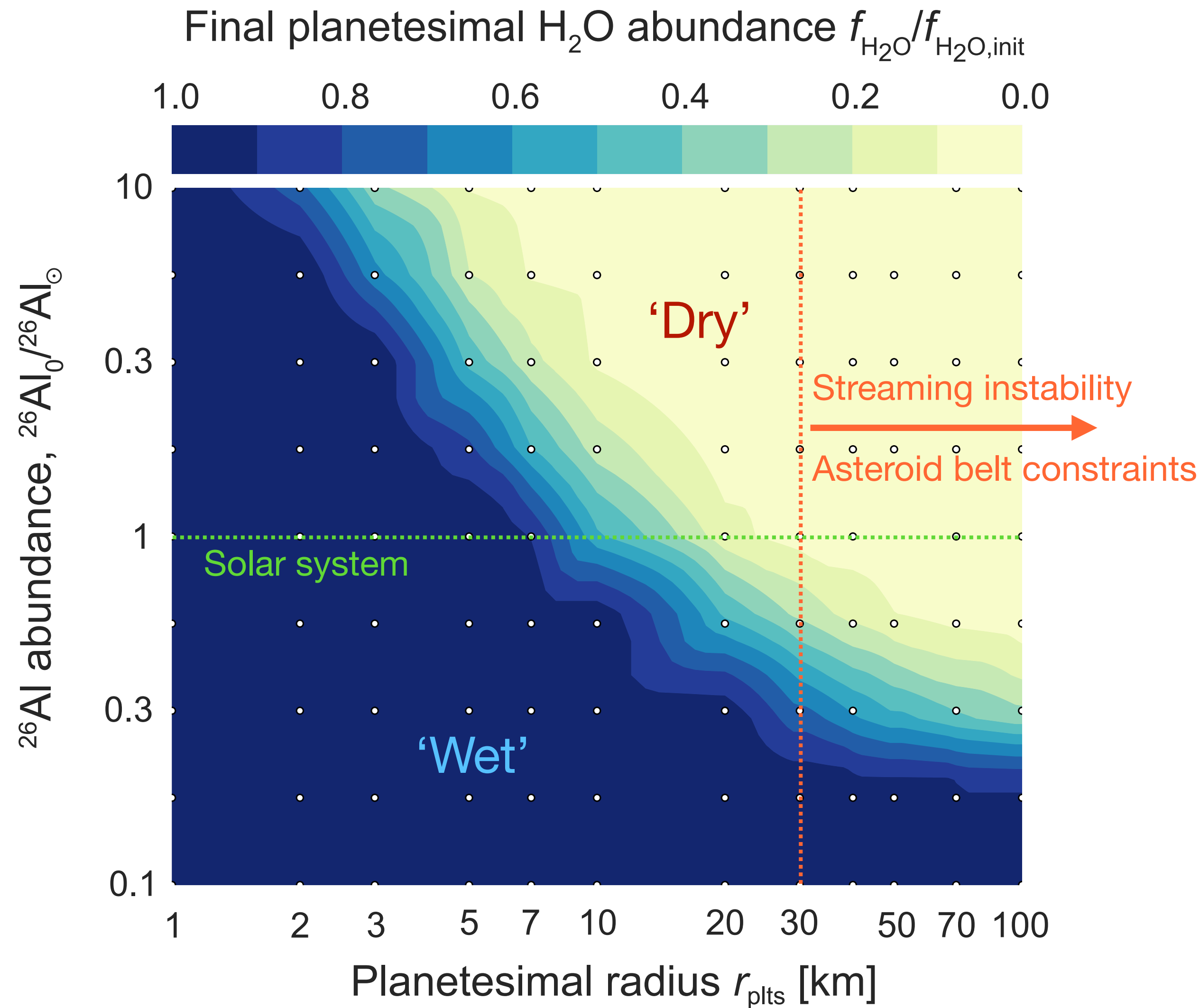


$\sim 10^2 - 10^8 \times$  Earth's present-day interior radiogenic heating

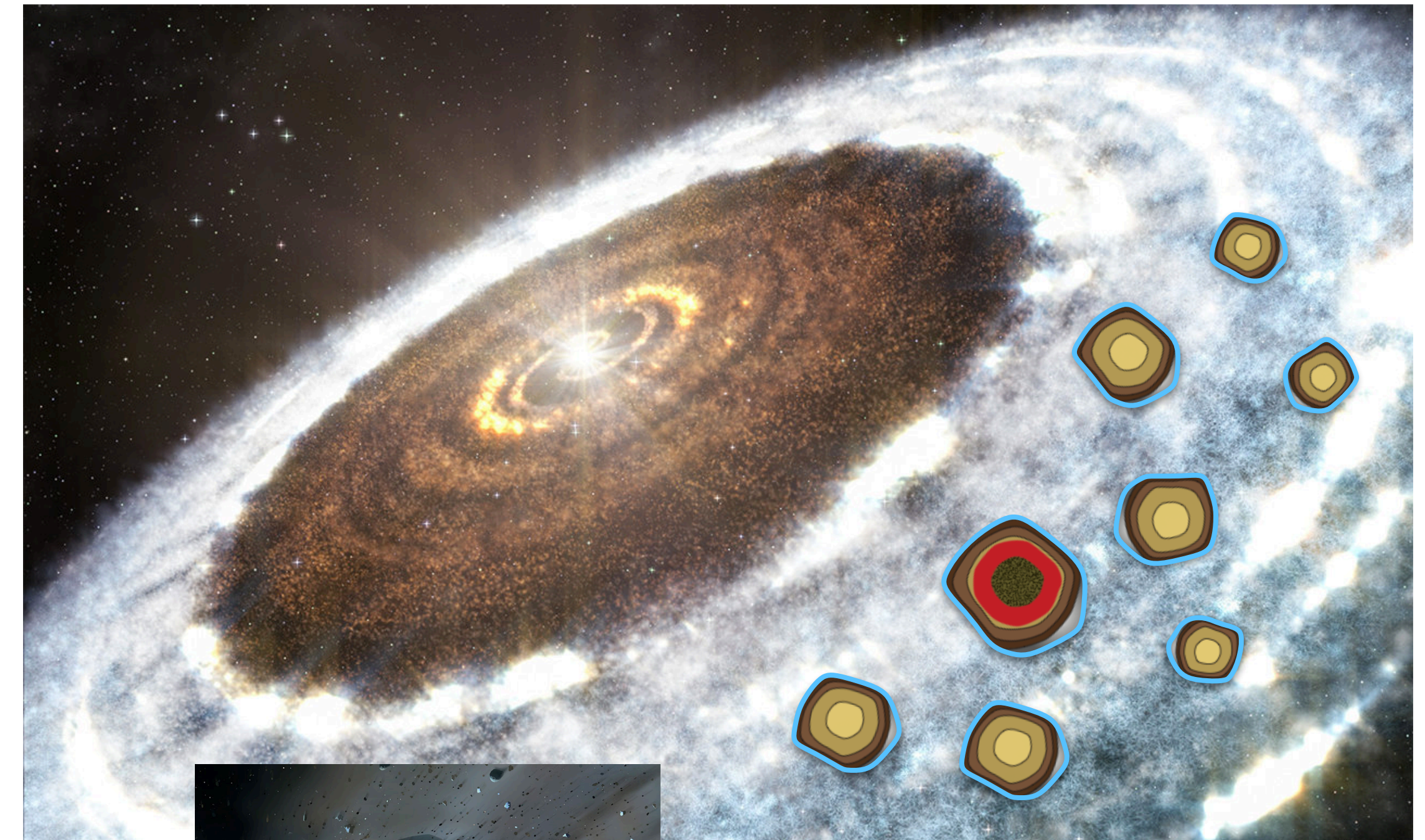
$^{26}\text{Al}$ -heated icy planetesimals forming planets



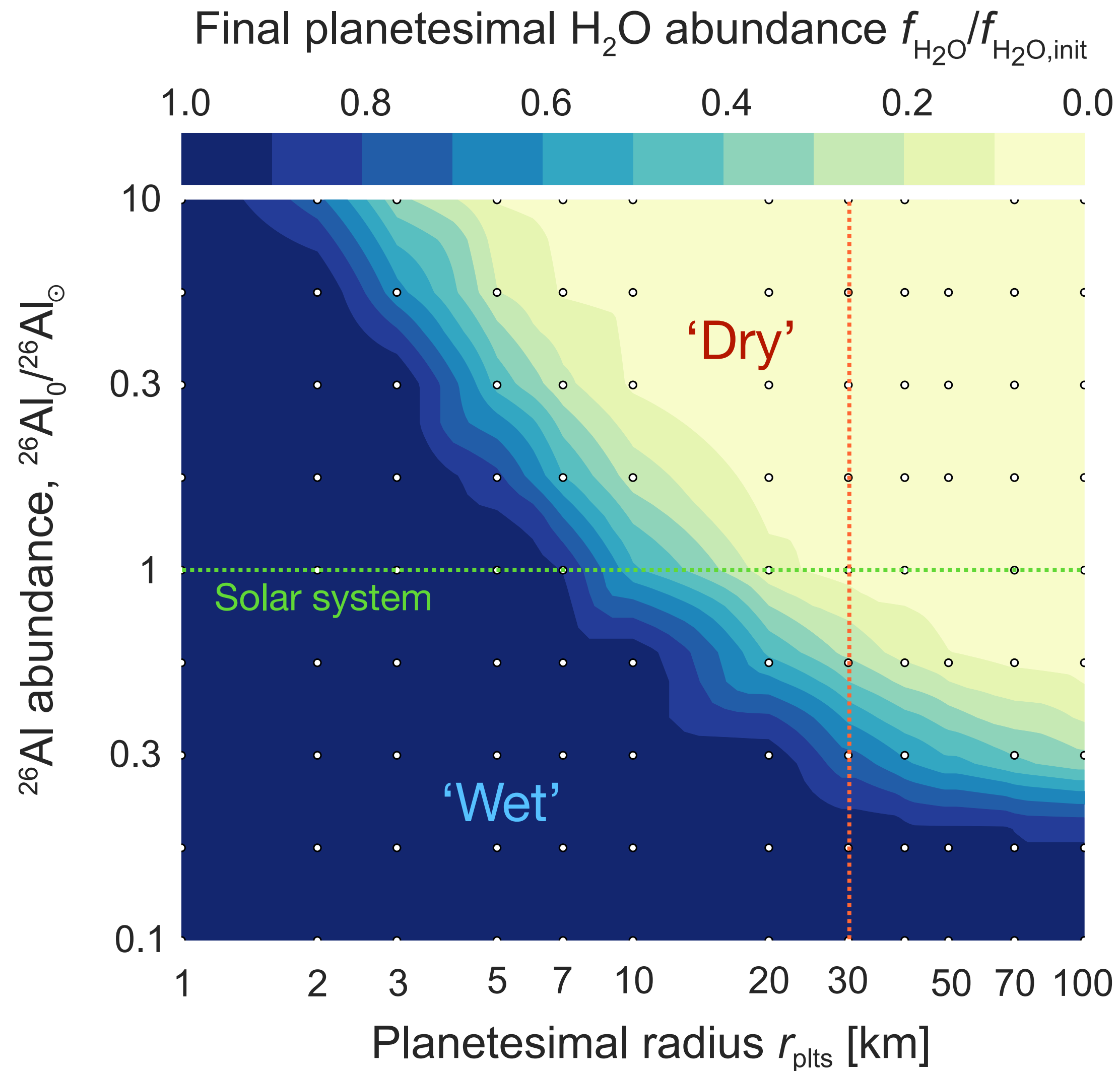
# Rapid dehydration of water-rich planetesimals



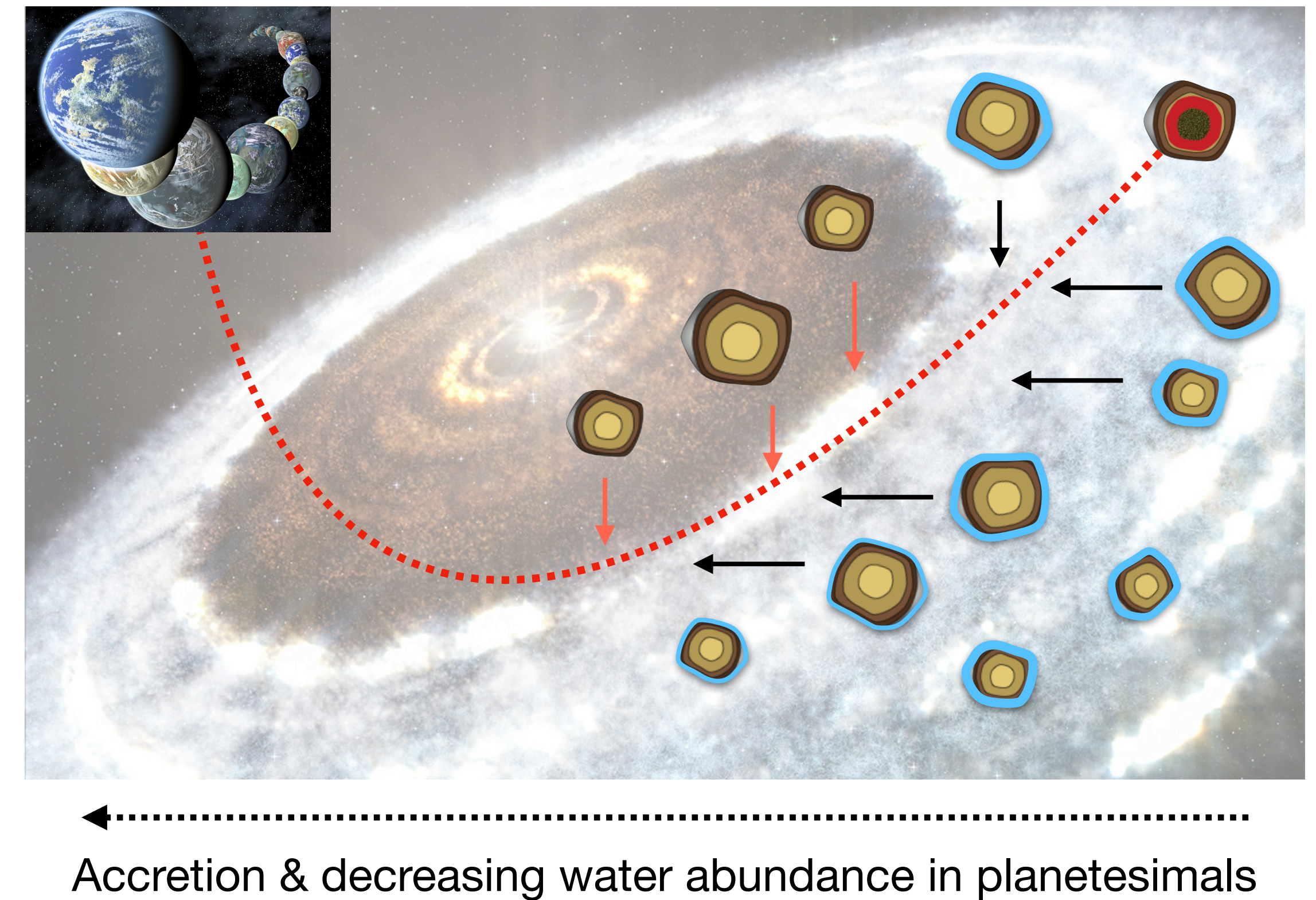
<sup>26</sup>Al-heated icy planetesimals forming planets



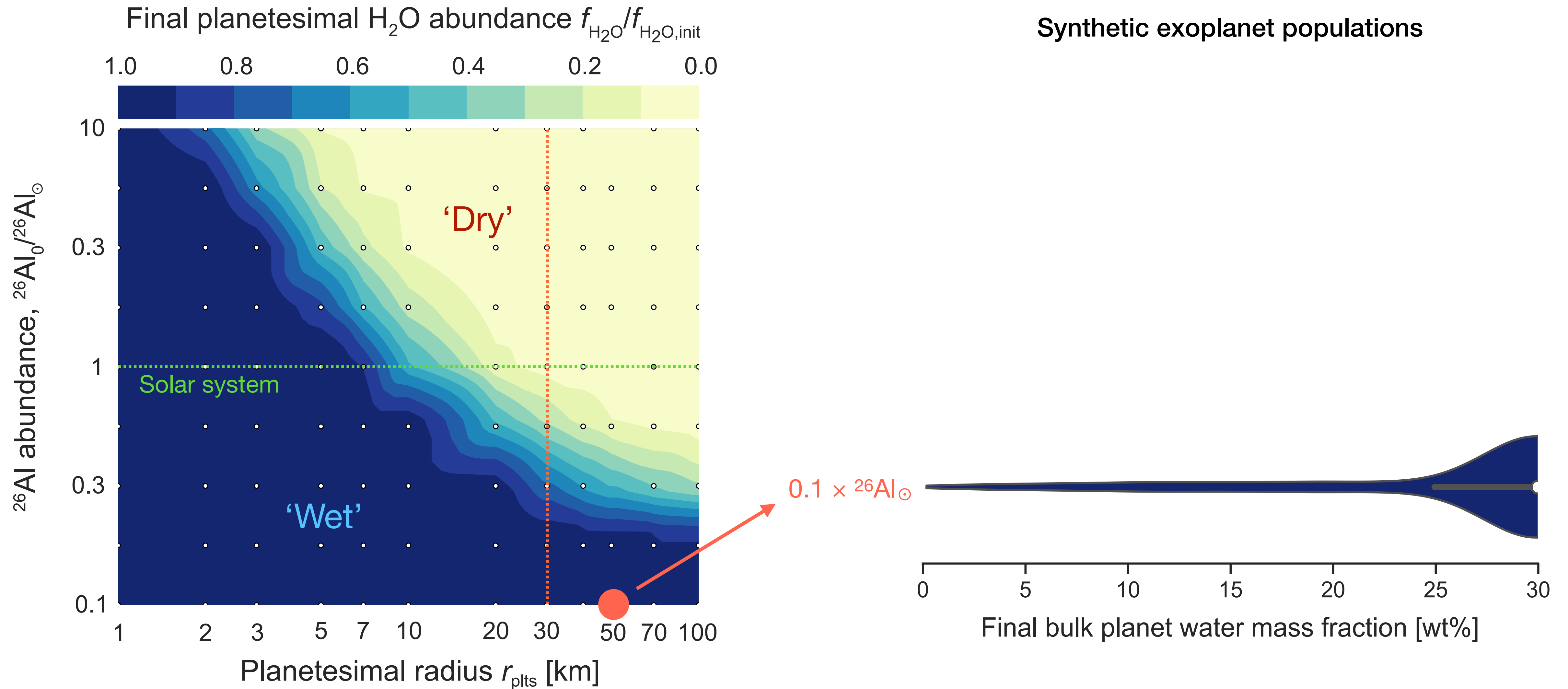
# $^{26}\text{Al}$ controls bulk water content



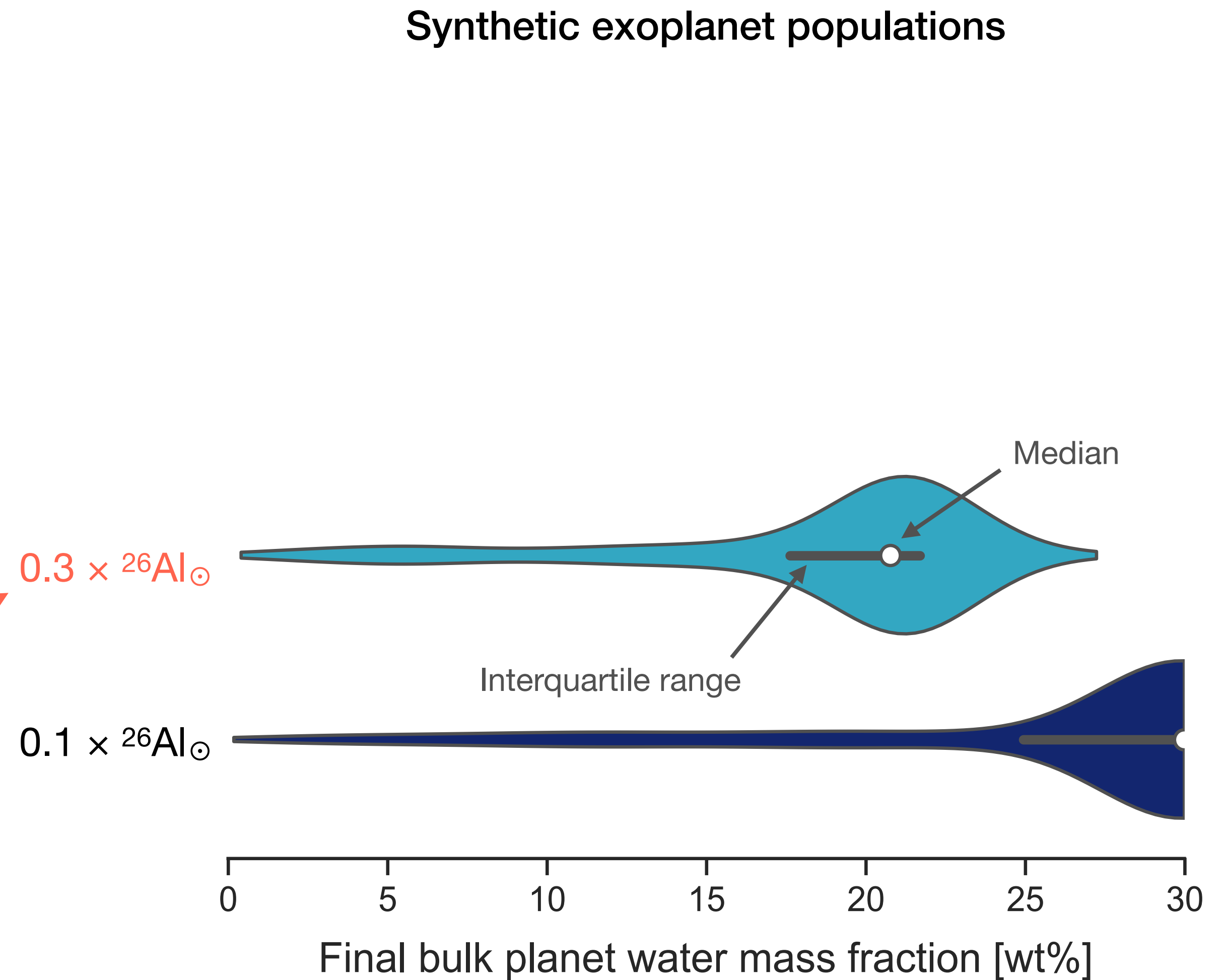
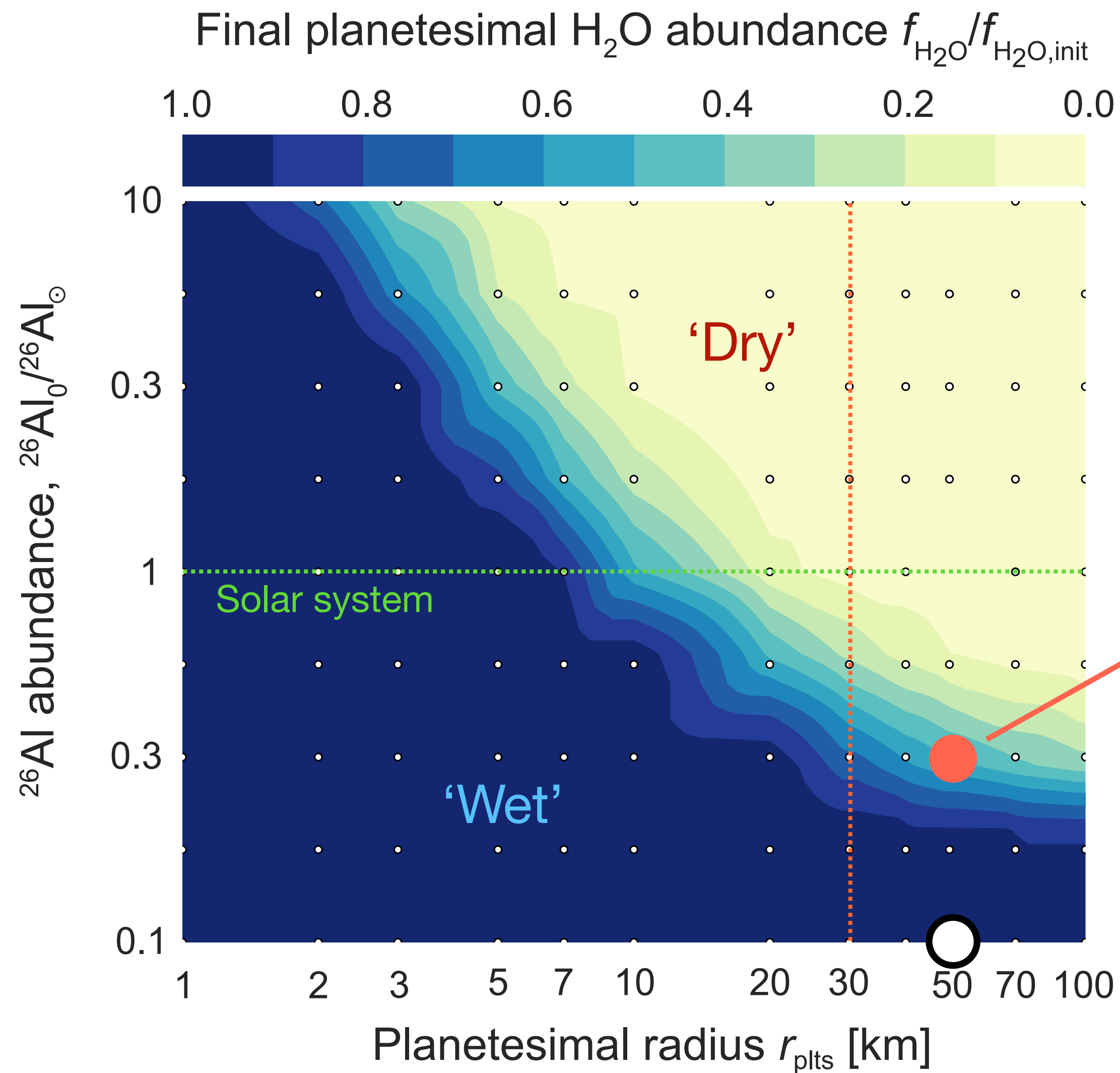
Synthetic exoplanet populations



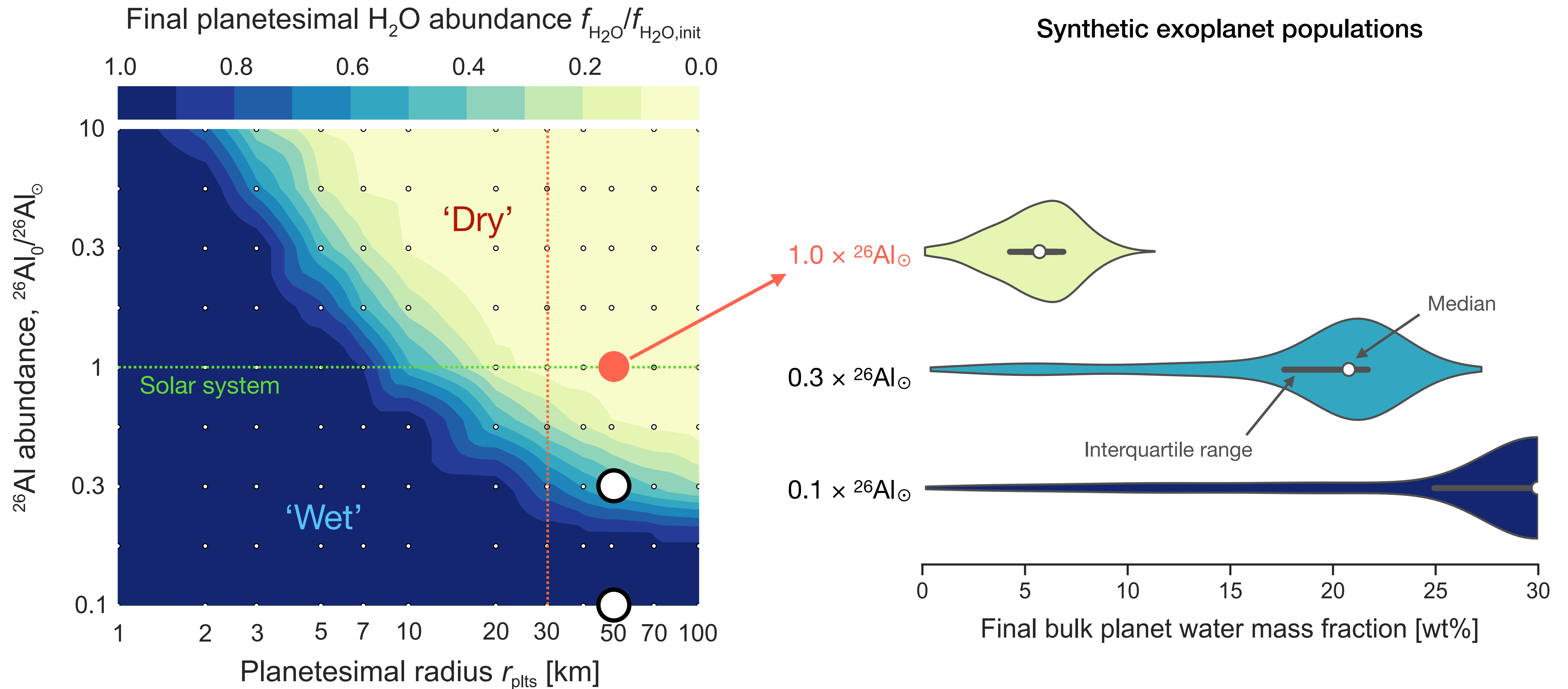
# $^{26}\text{Al}$ controls bulk water content



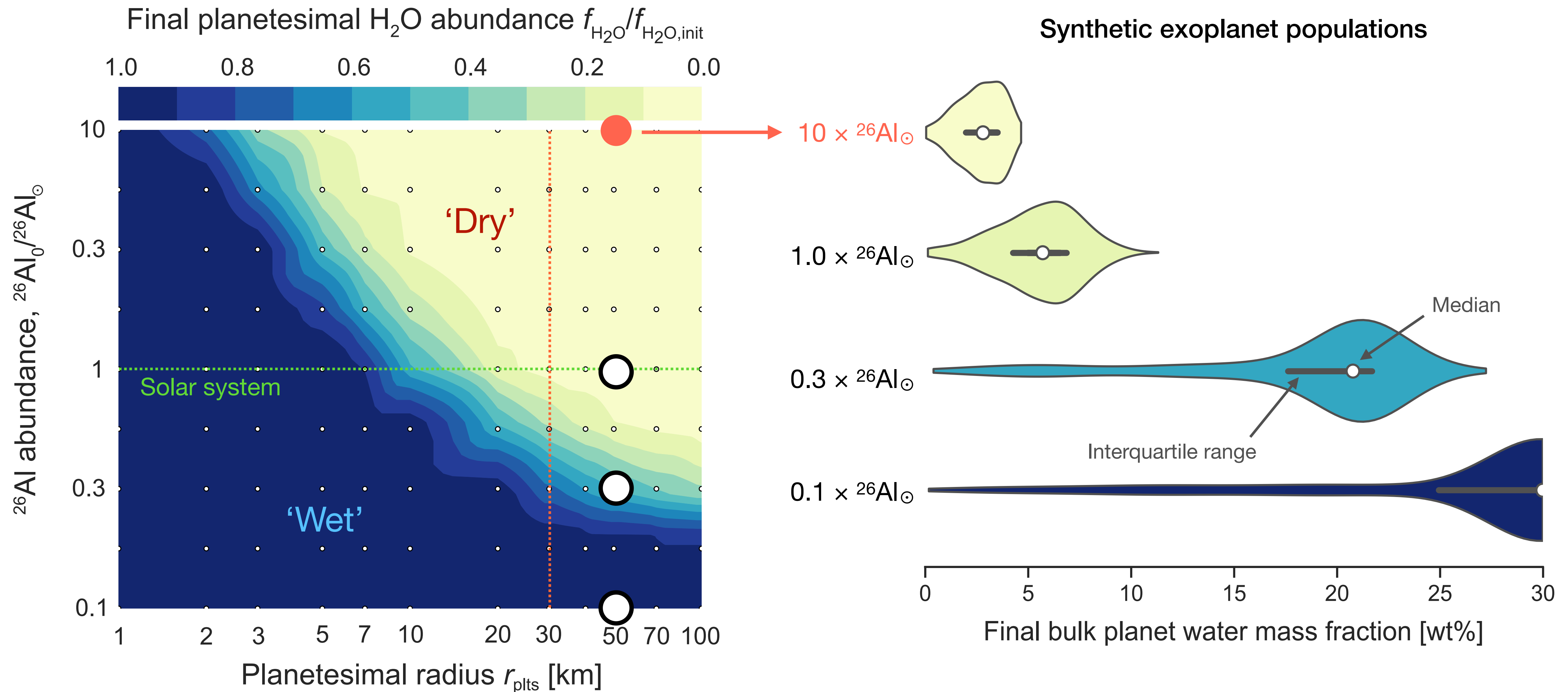
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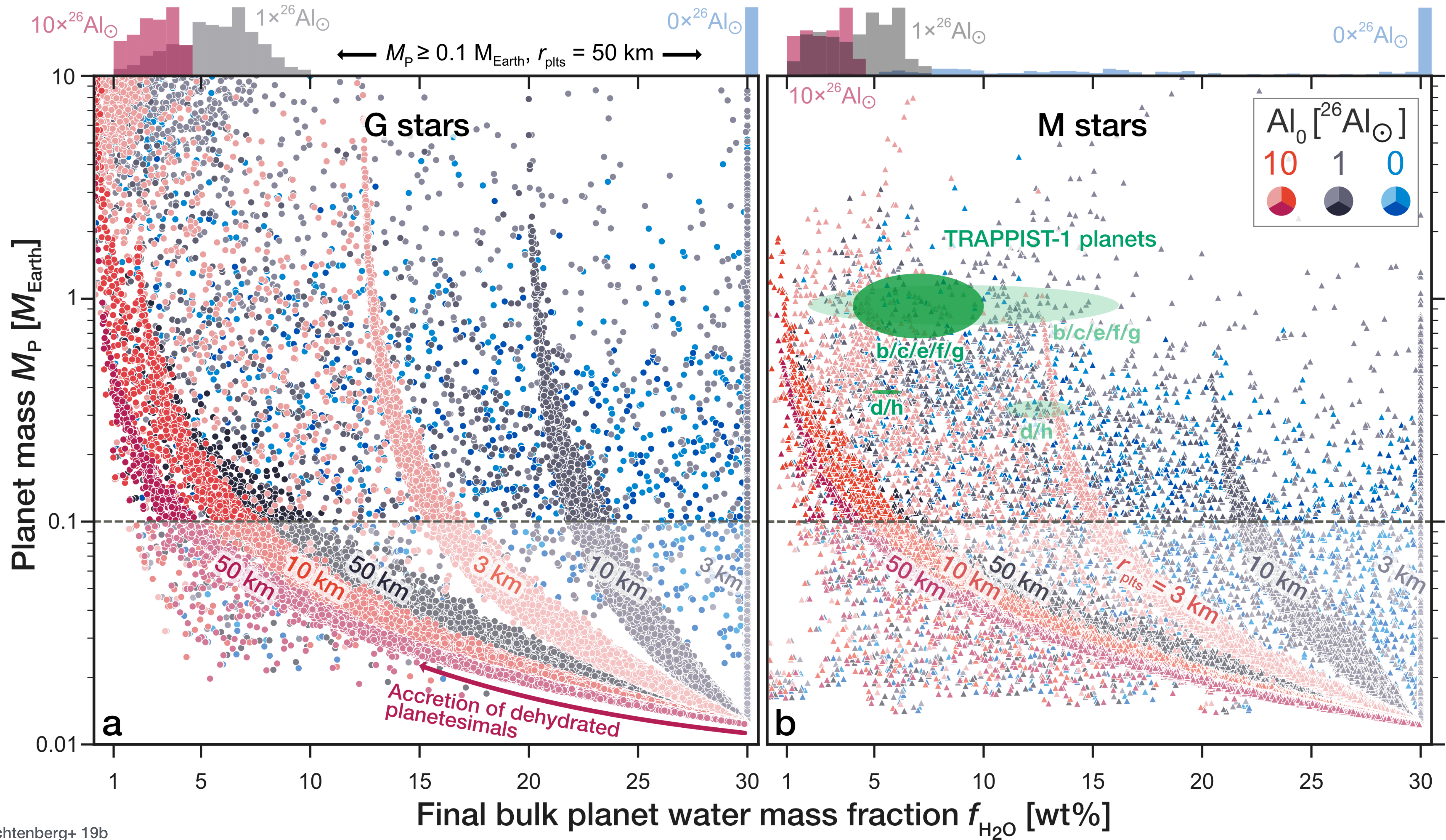
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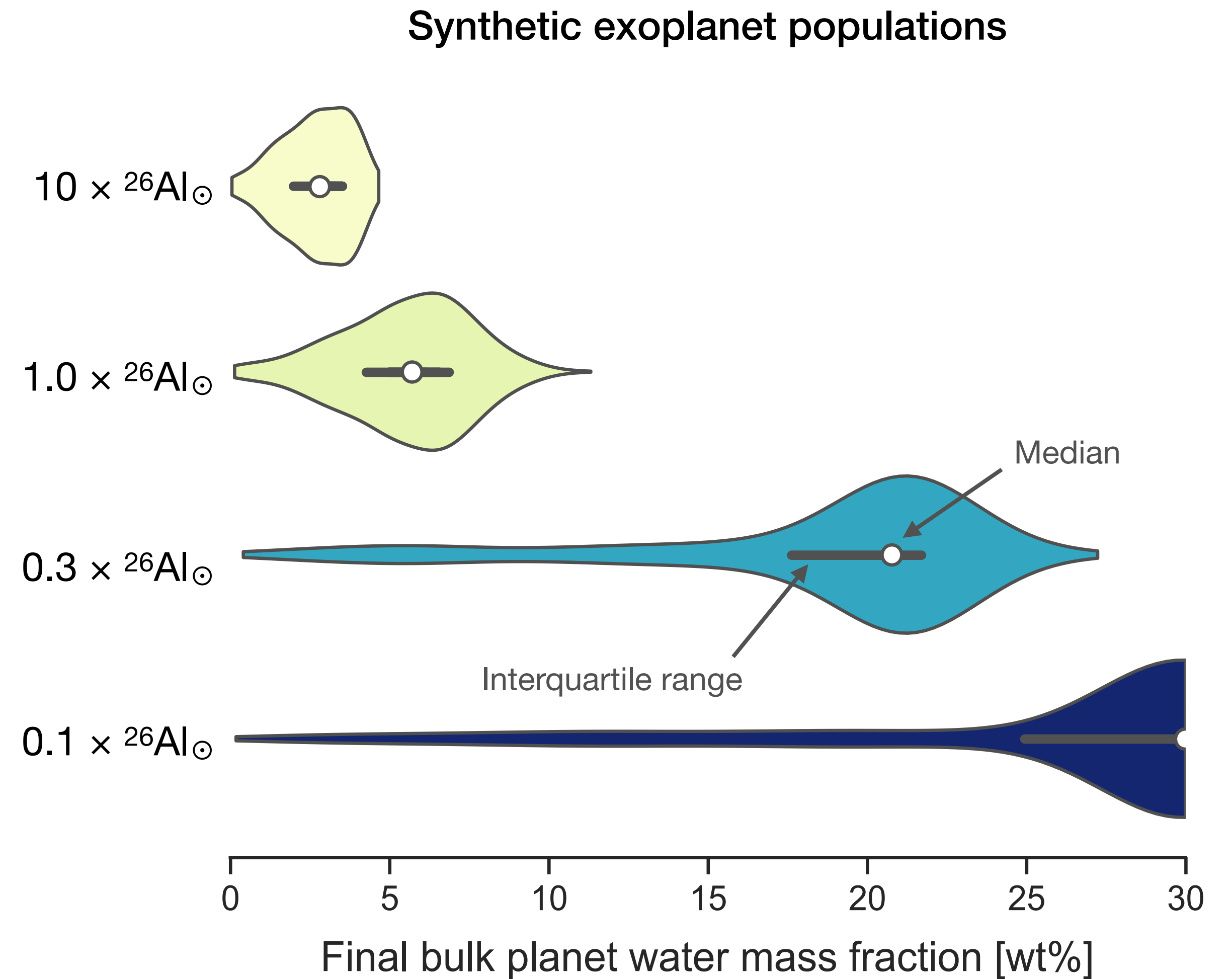
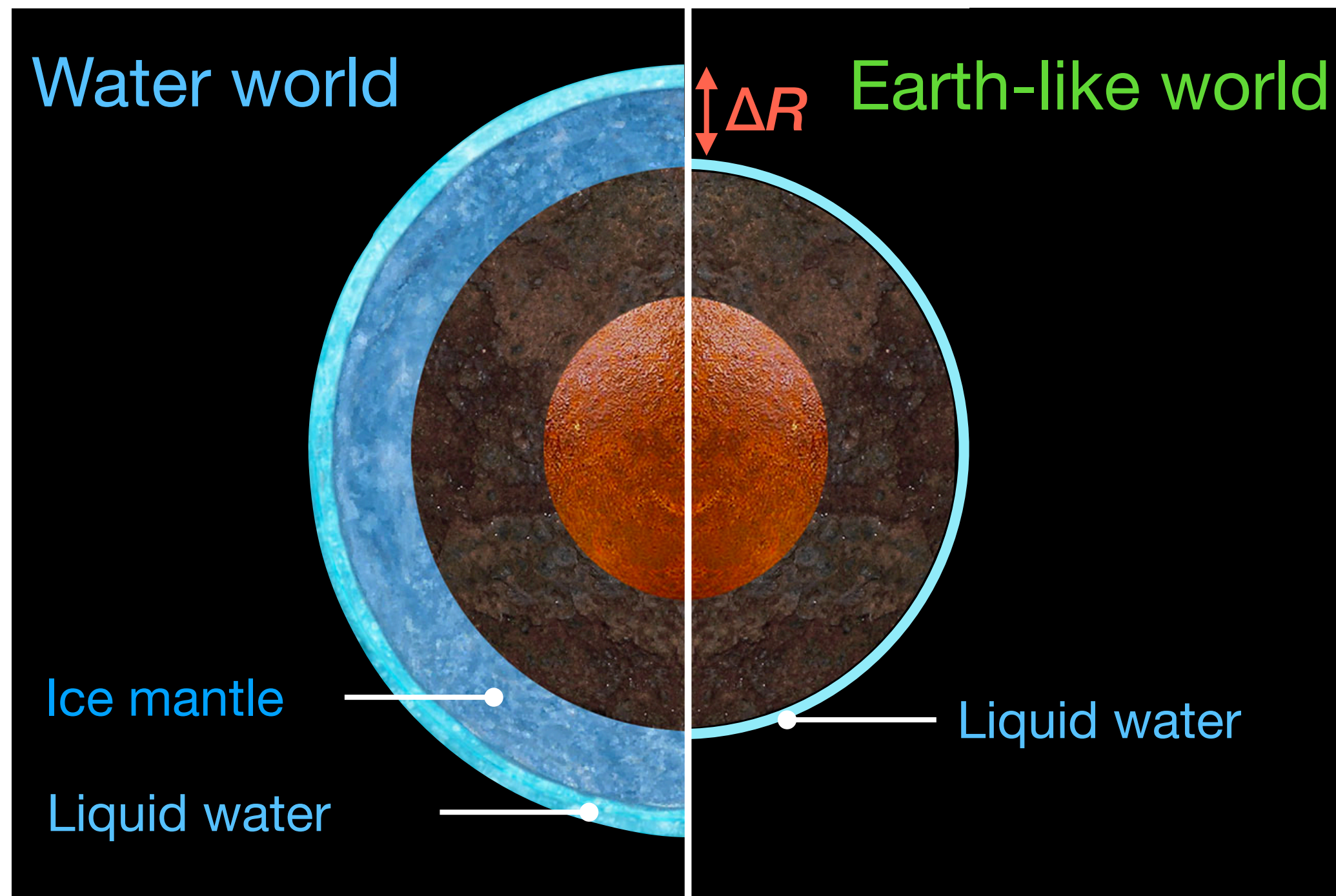
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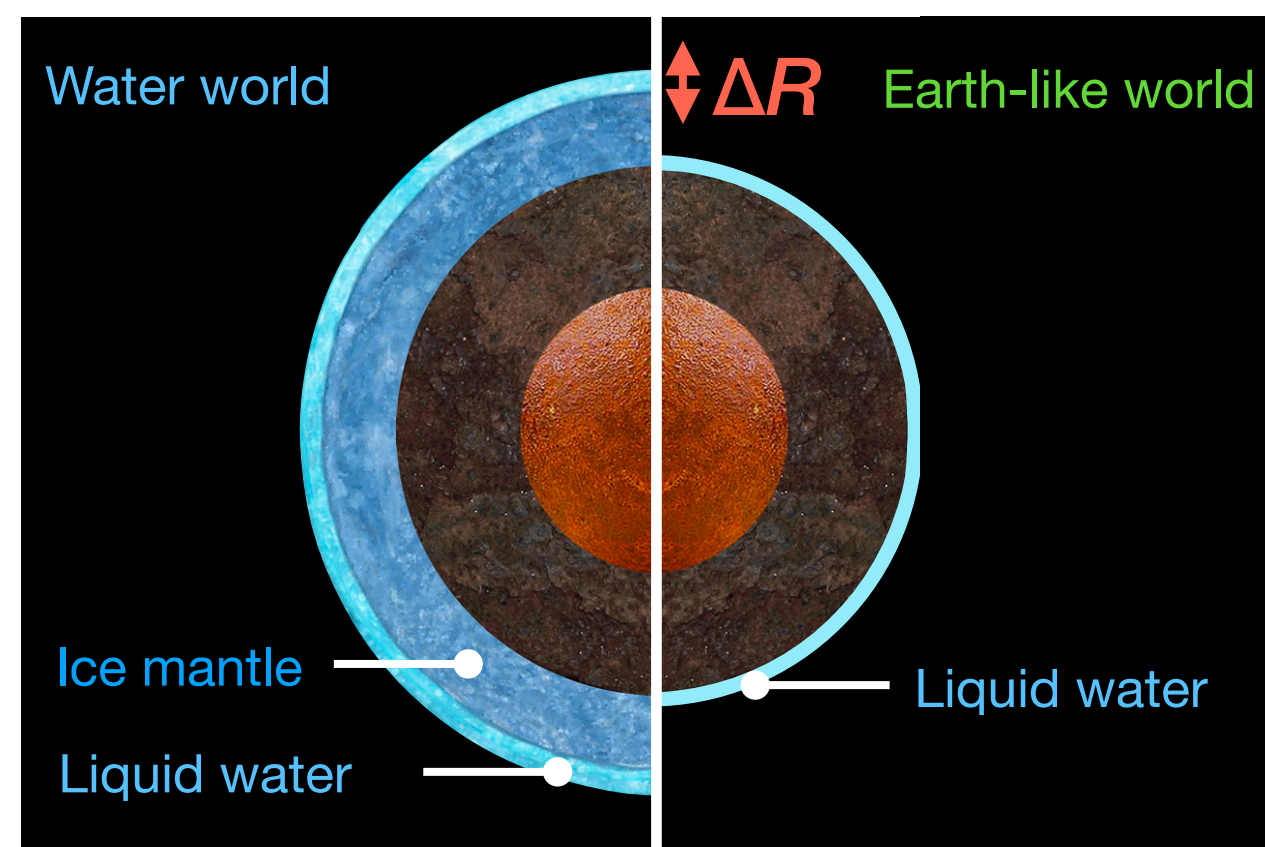
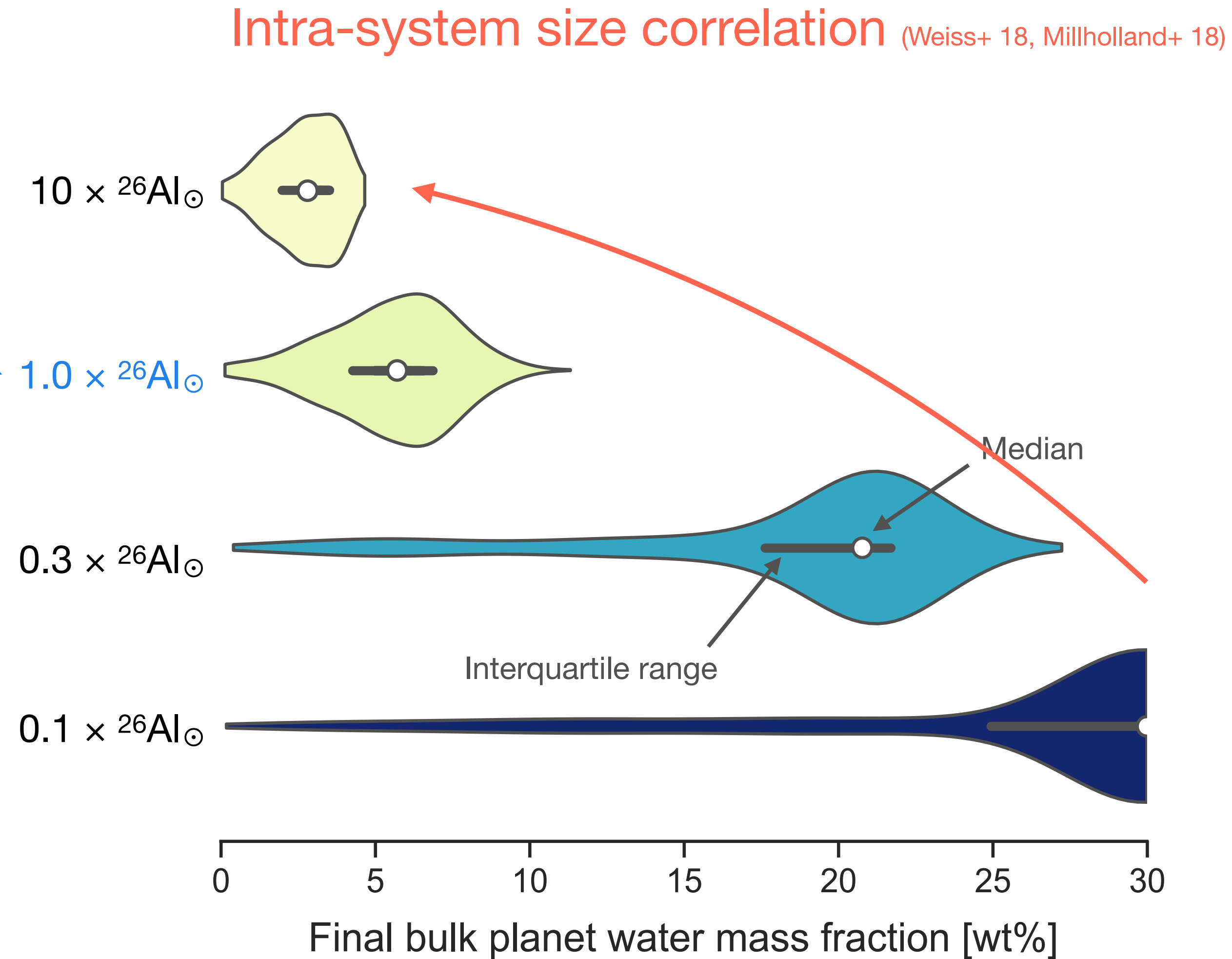
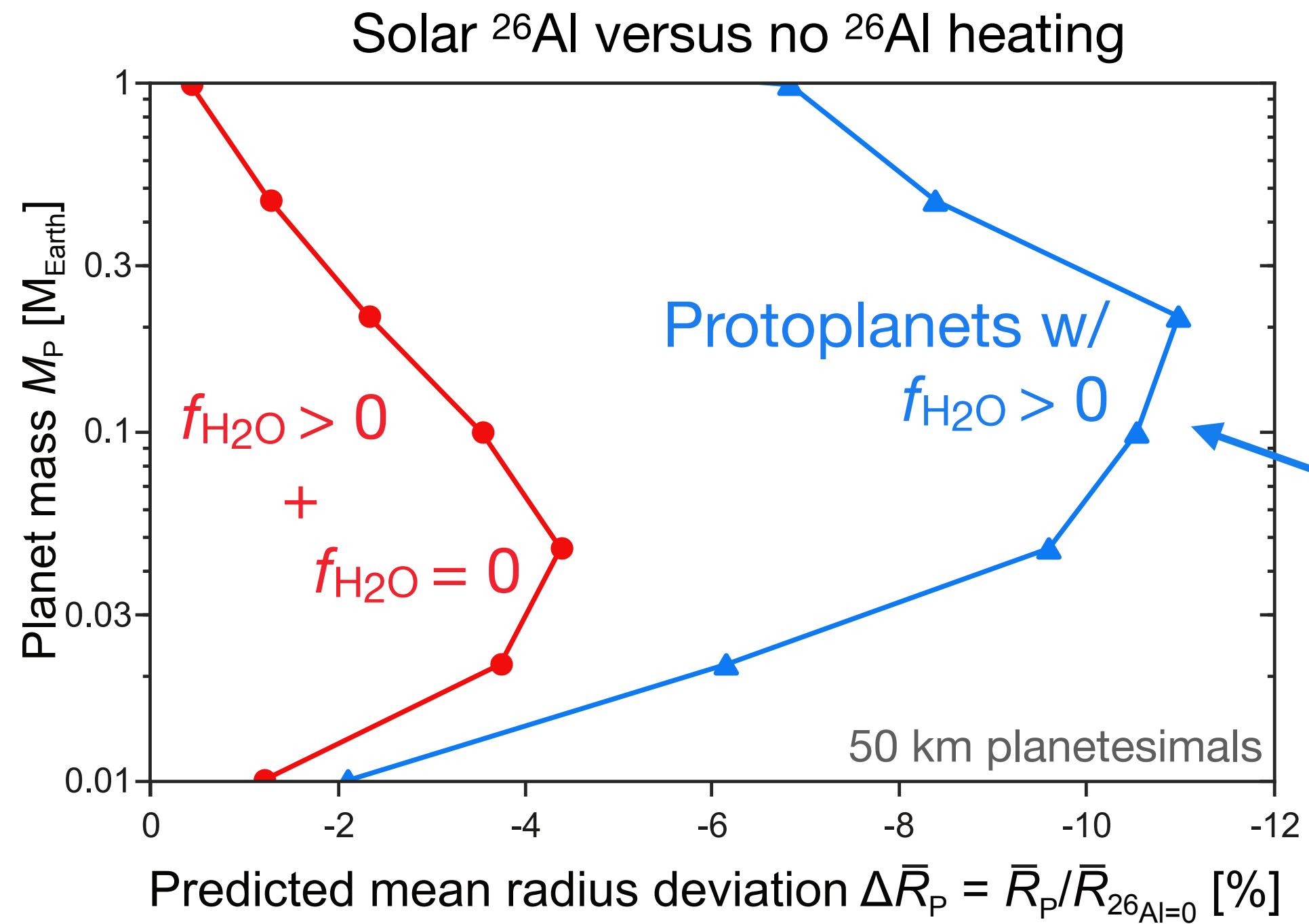




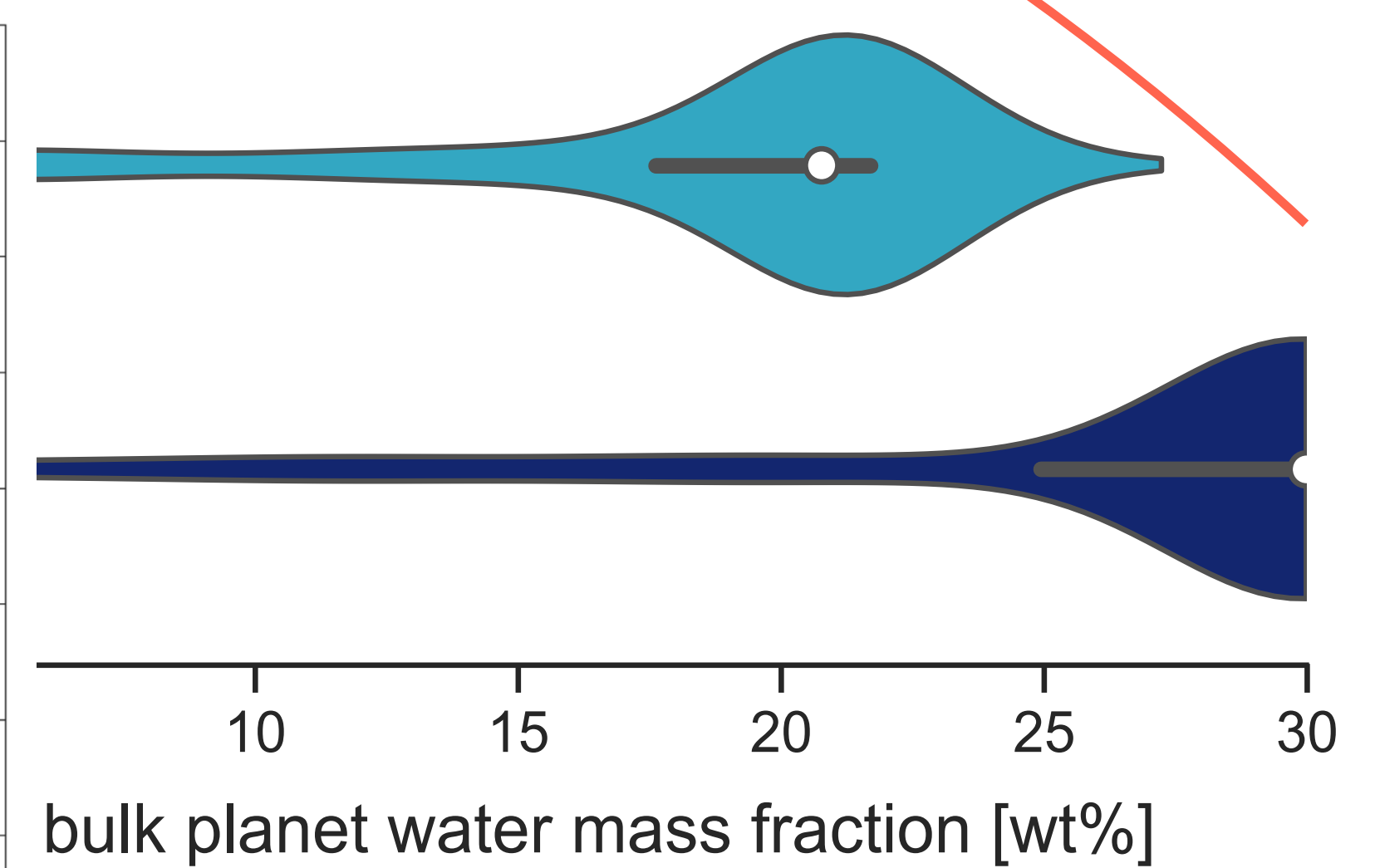
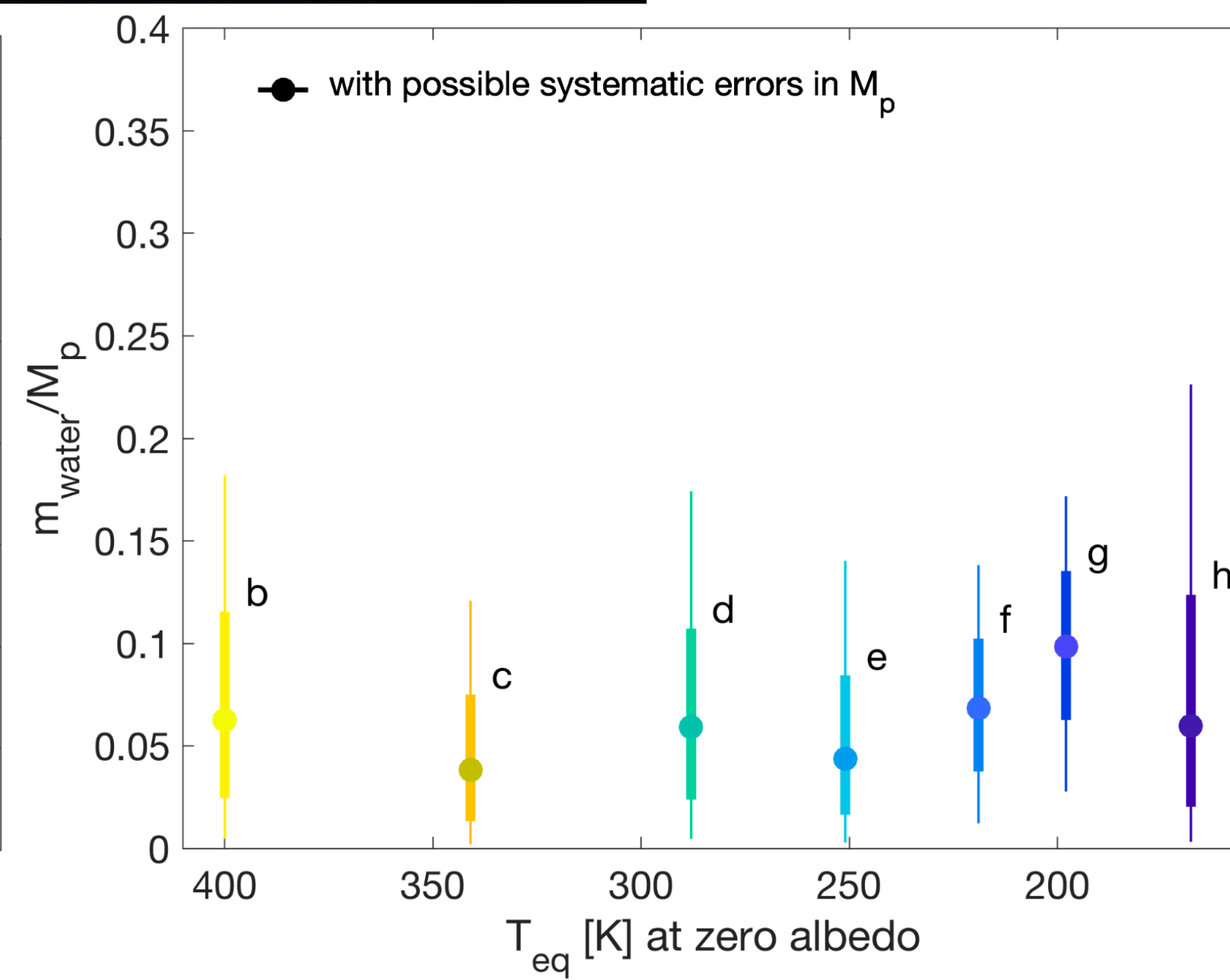
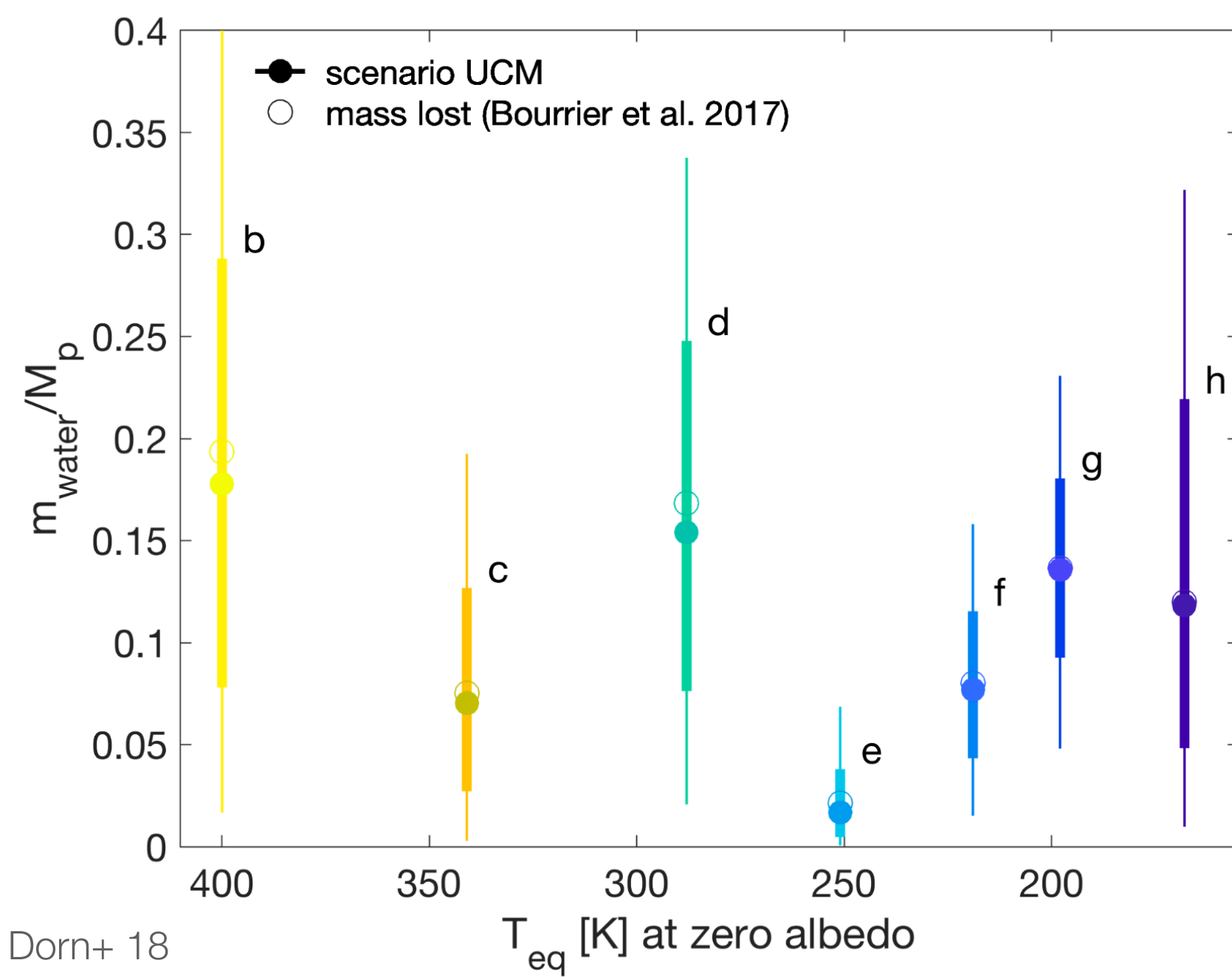
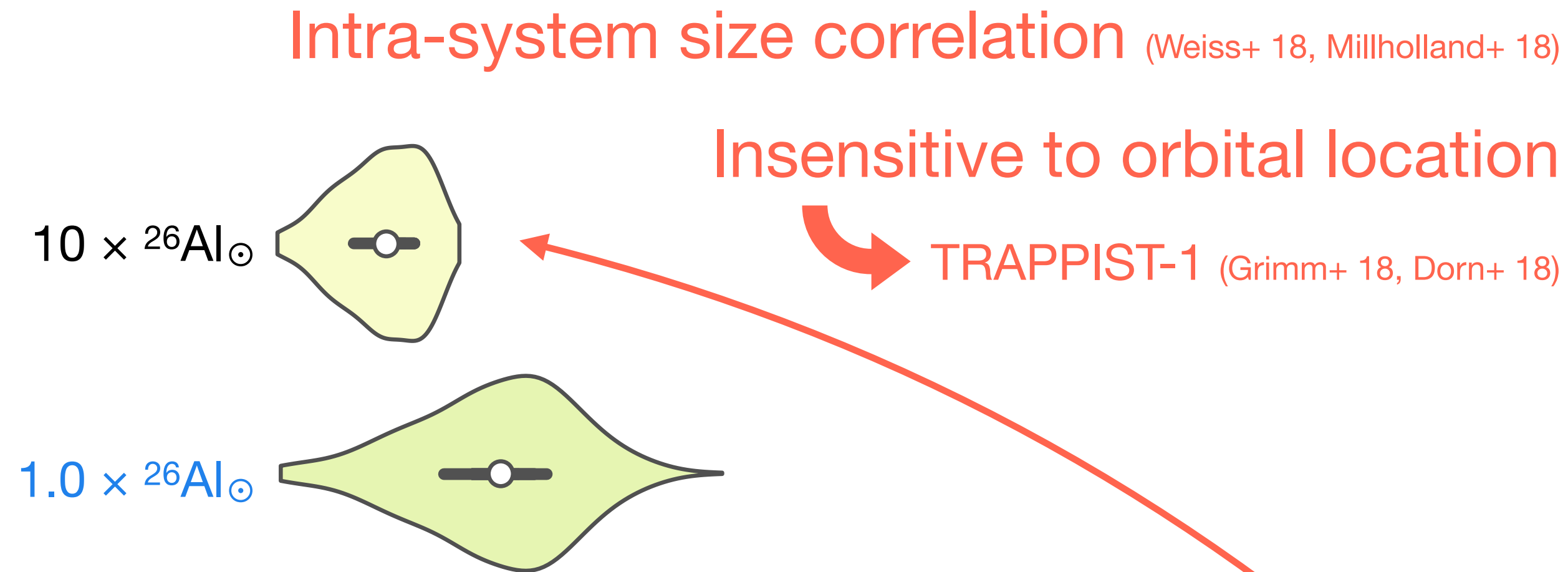
# $^{26}\text{Al}$ controls bulk water content



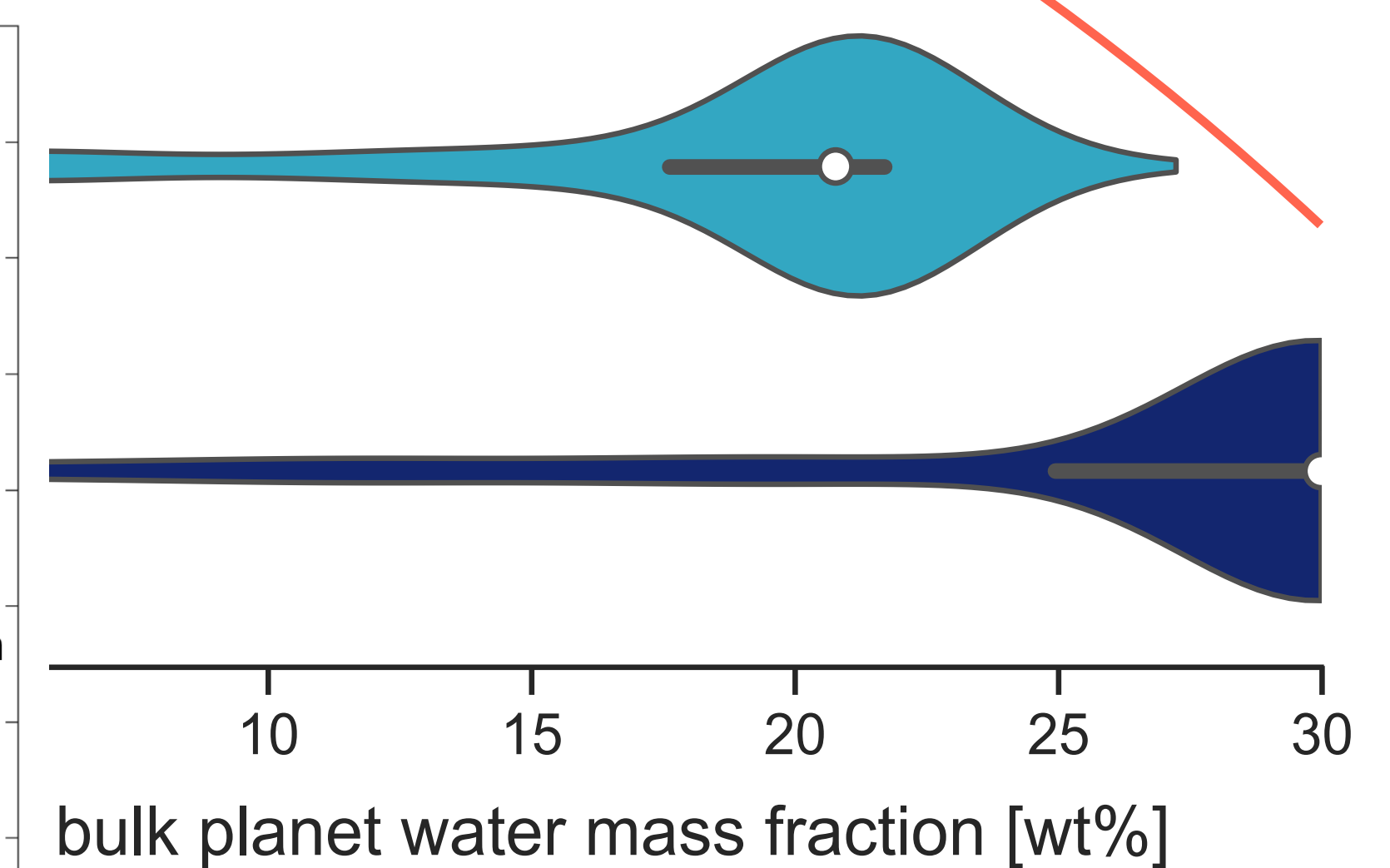
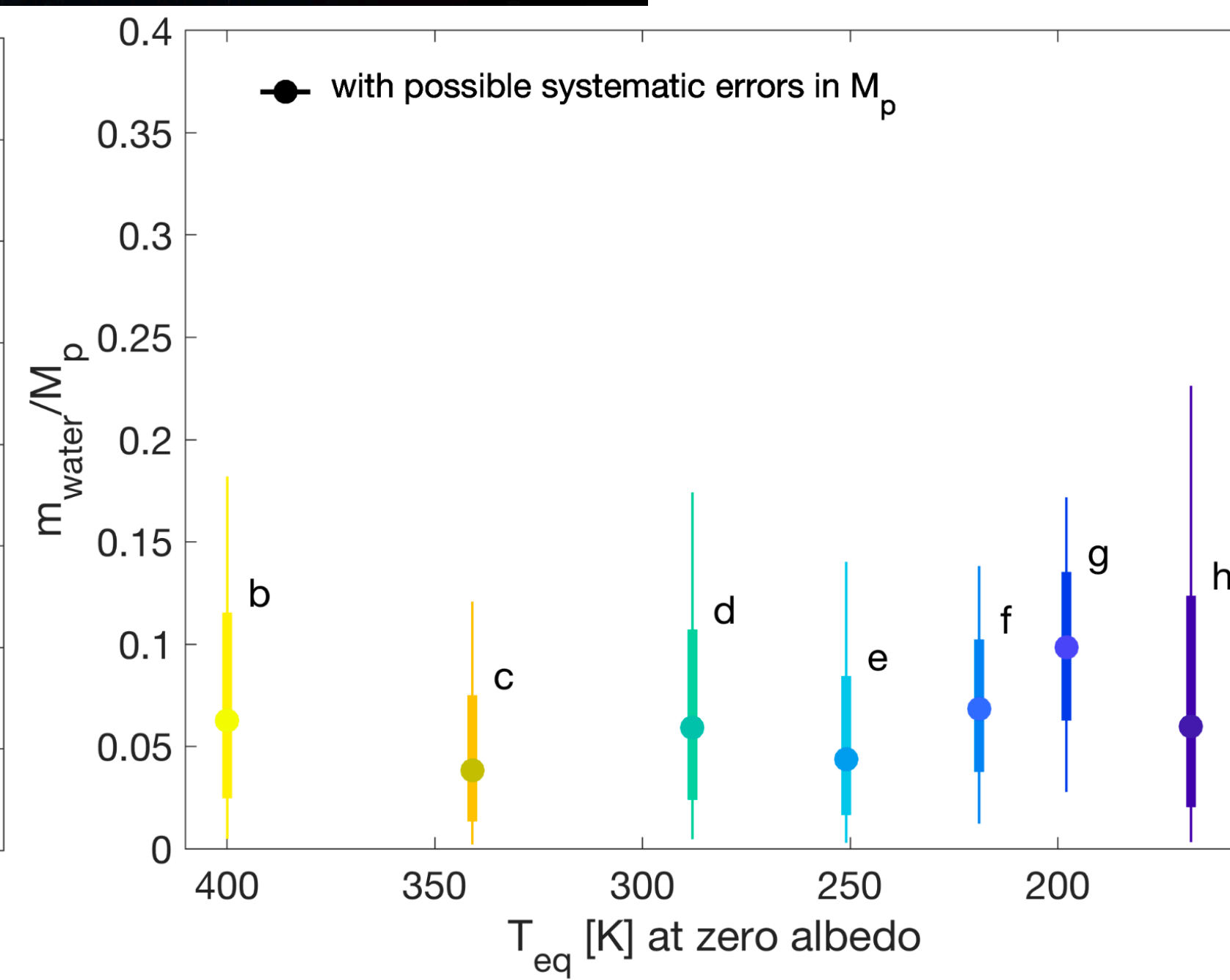
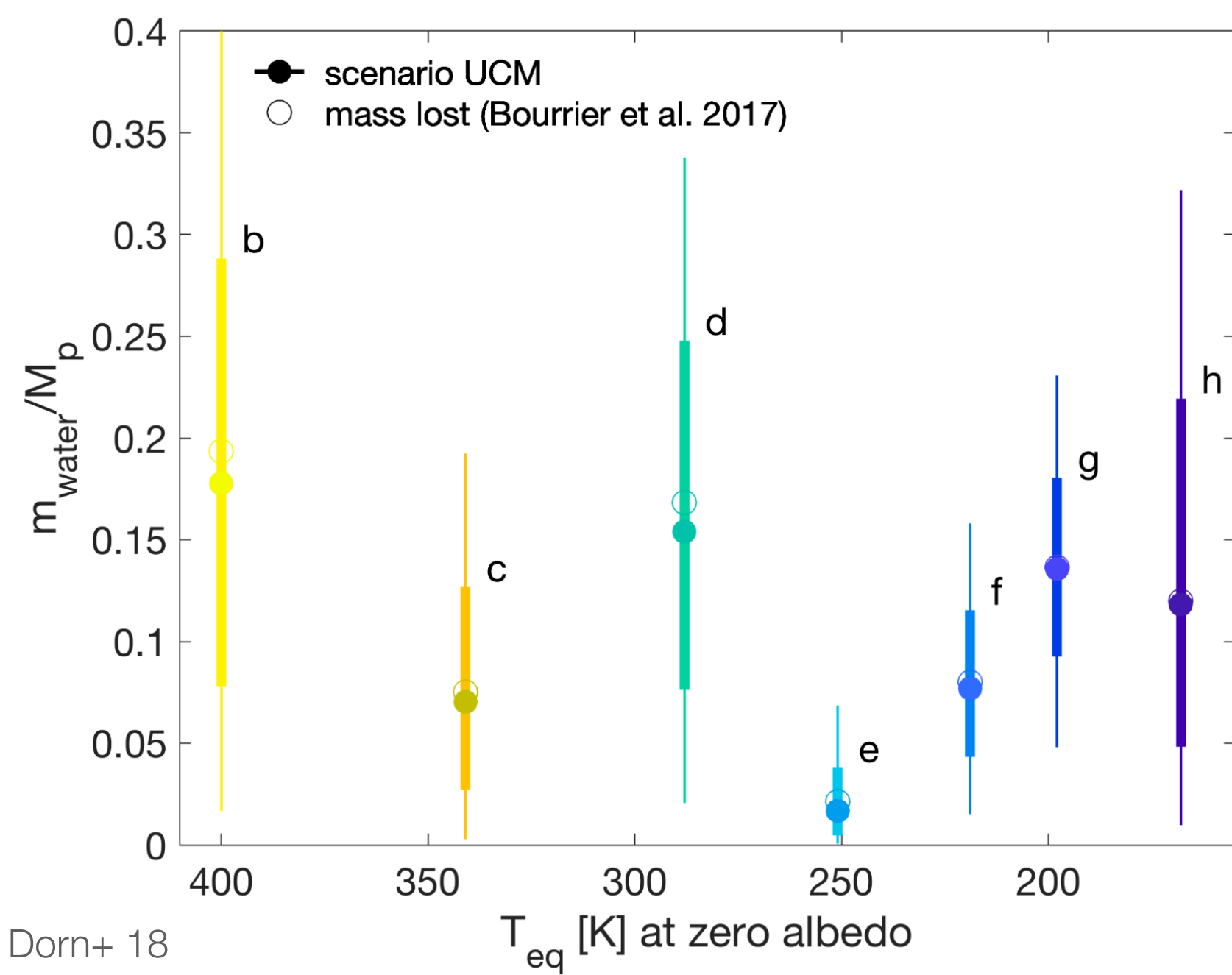
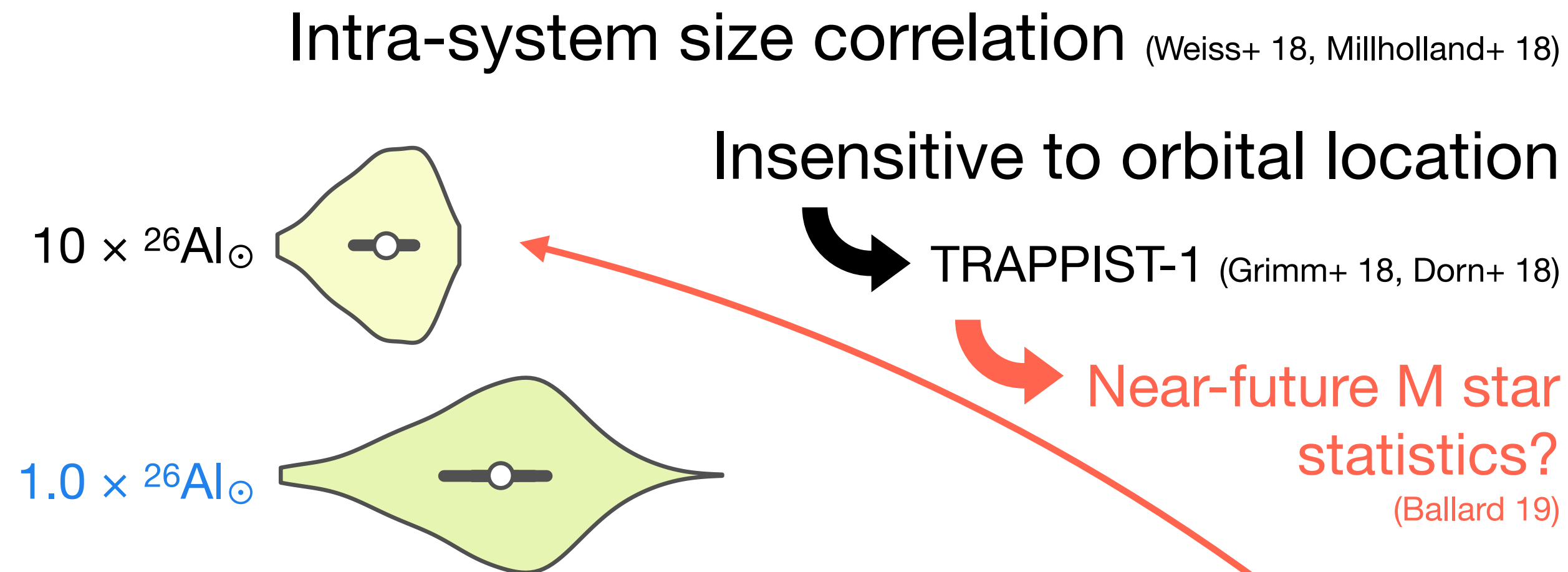
# $^{26}\text{Al}$ shapes exoplanet structure



# $^{26}\text{Al}$ shapes distribution systematics



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# $^{26}\text{Al}$ key control on rocky planet composition



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