Desiccated rocky planet populations from ^{26}Al heating

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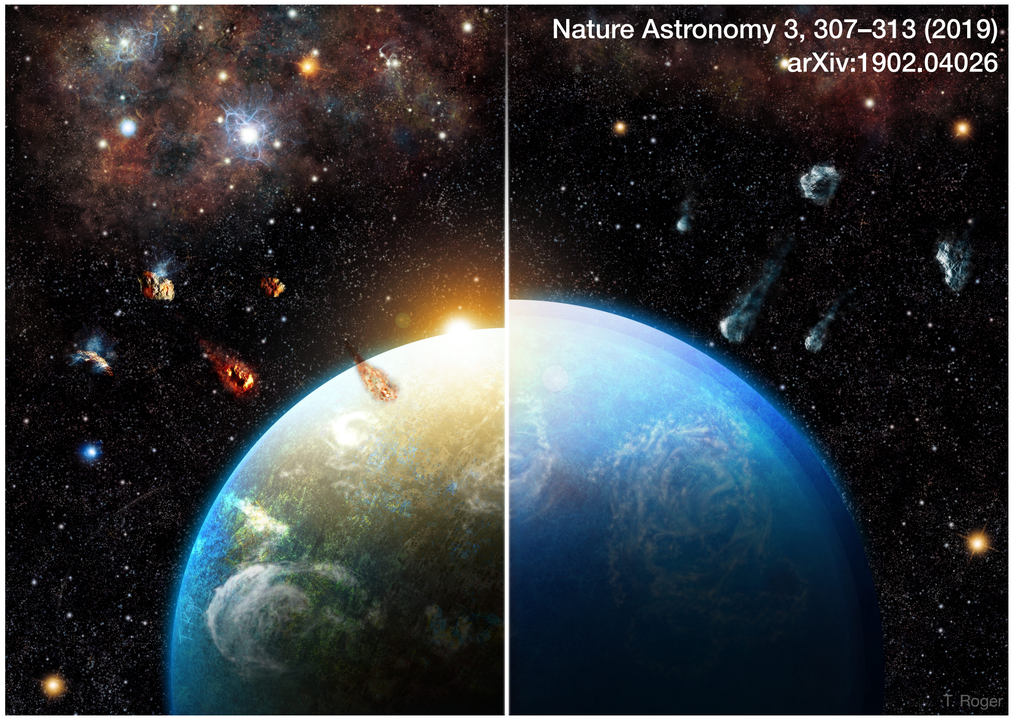
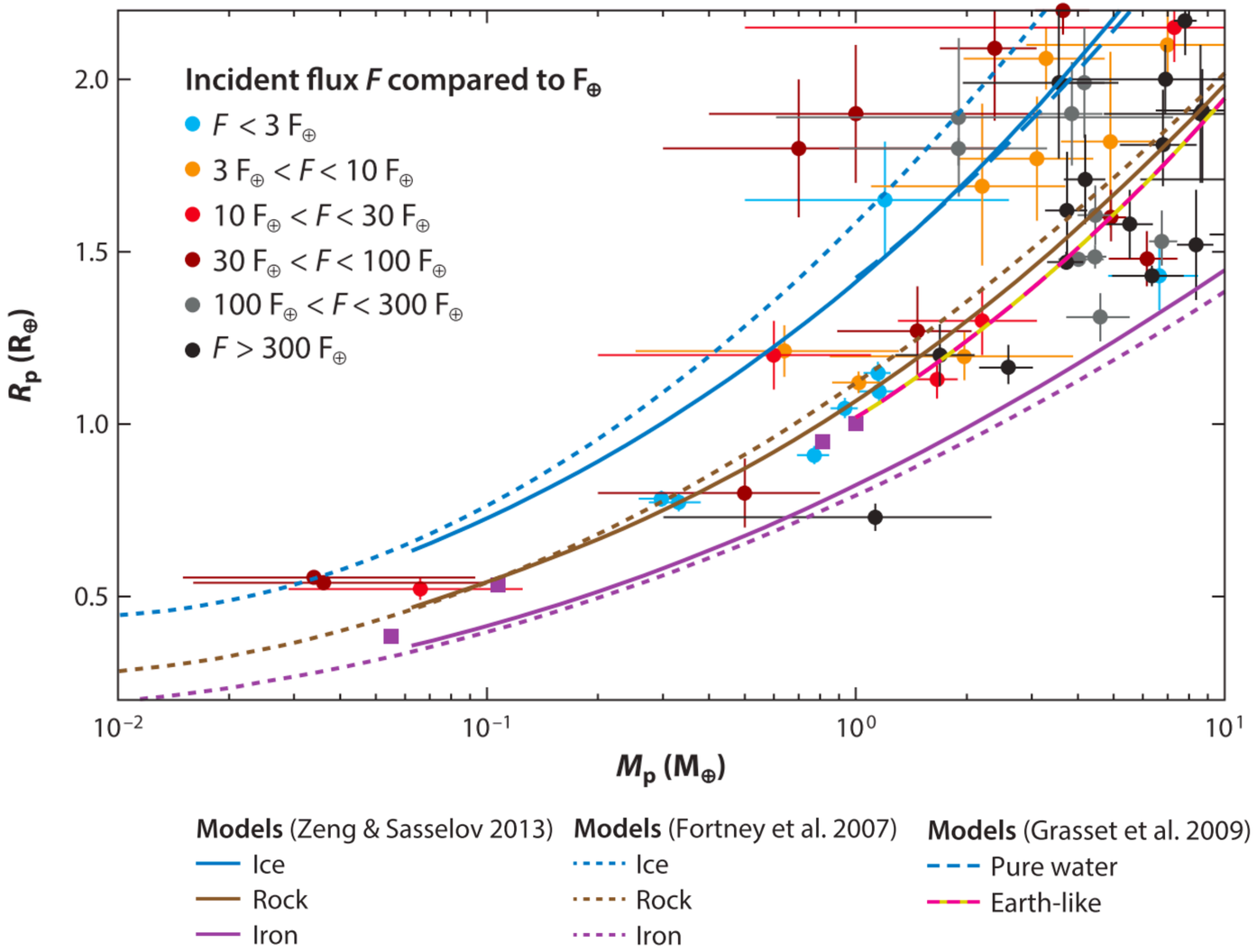
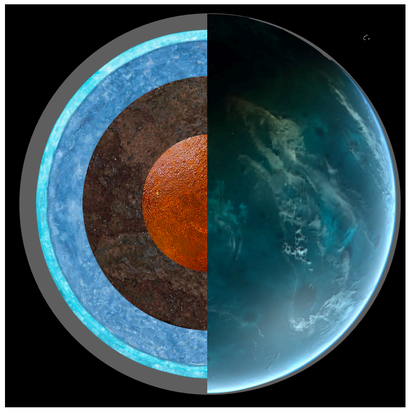
Michael Meyer (U Michigan)
Taras Gerya (ETH Zürich)
Remo Burn (U Bern)
Yann Alibert (U Bern / CSH)
Christoph Mordasini (U Bern / CSH)



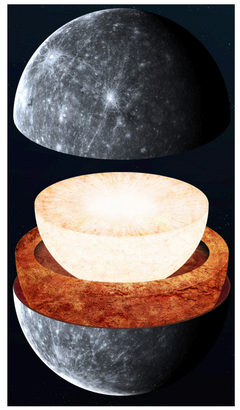
UNIVERSITY OF OXFORD
SIMONS FOUNDATION
FNSNF Swiss National Science Foundation

Ubiquity of water worlds?

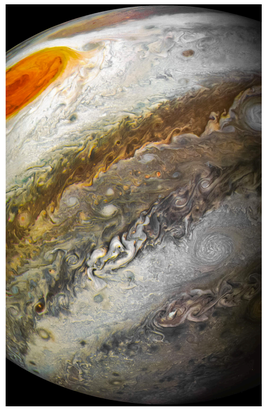




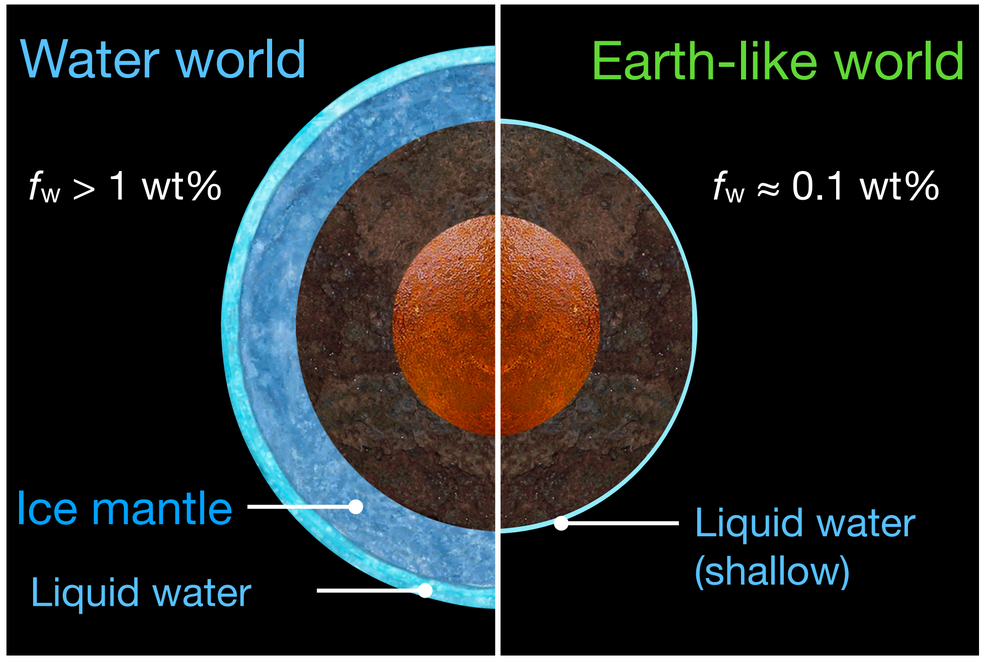
H_2O



Si+Fe



H_2/He

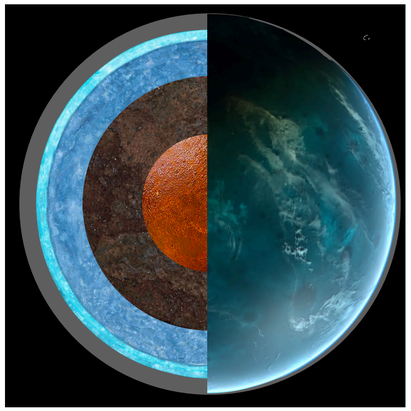


Limited storage in terrestrial core+mantle

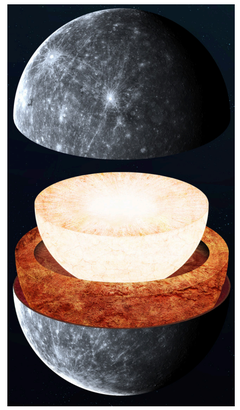
Jontof-Hutter 19

Sotin+ 07; Vadim Sadovski; NASA/JPL-Caltech

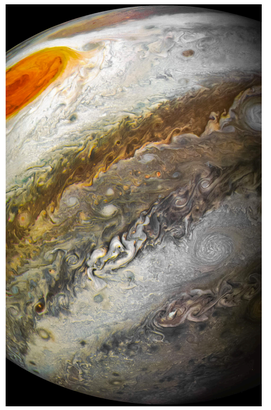
Ubiquity of water worlds?



H_2O

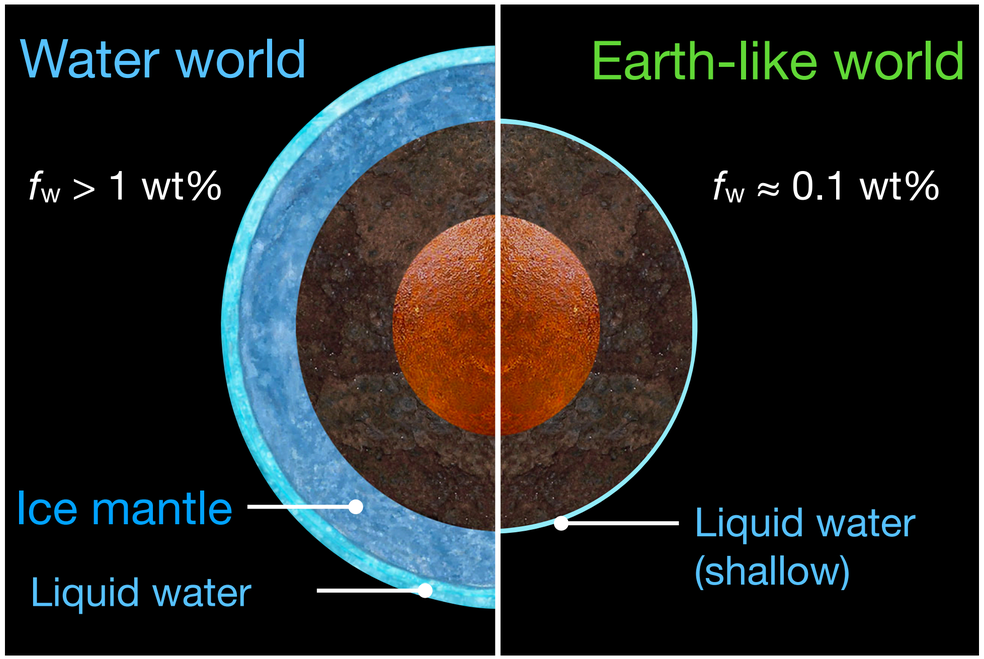


Si+Fe



H_2/He

- Snow line migration
- Collisional water transfer
- Inward-migration of protoplanets
- Inward-scattering of planetesimals

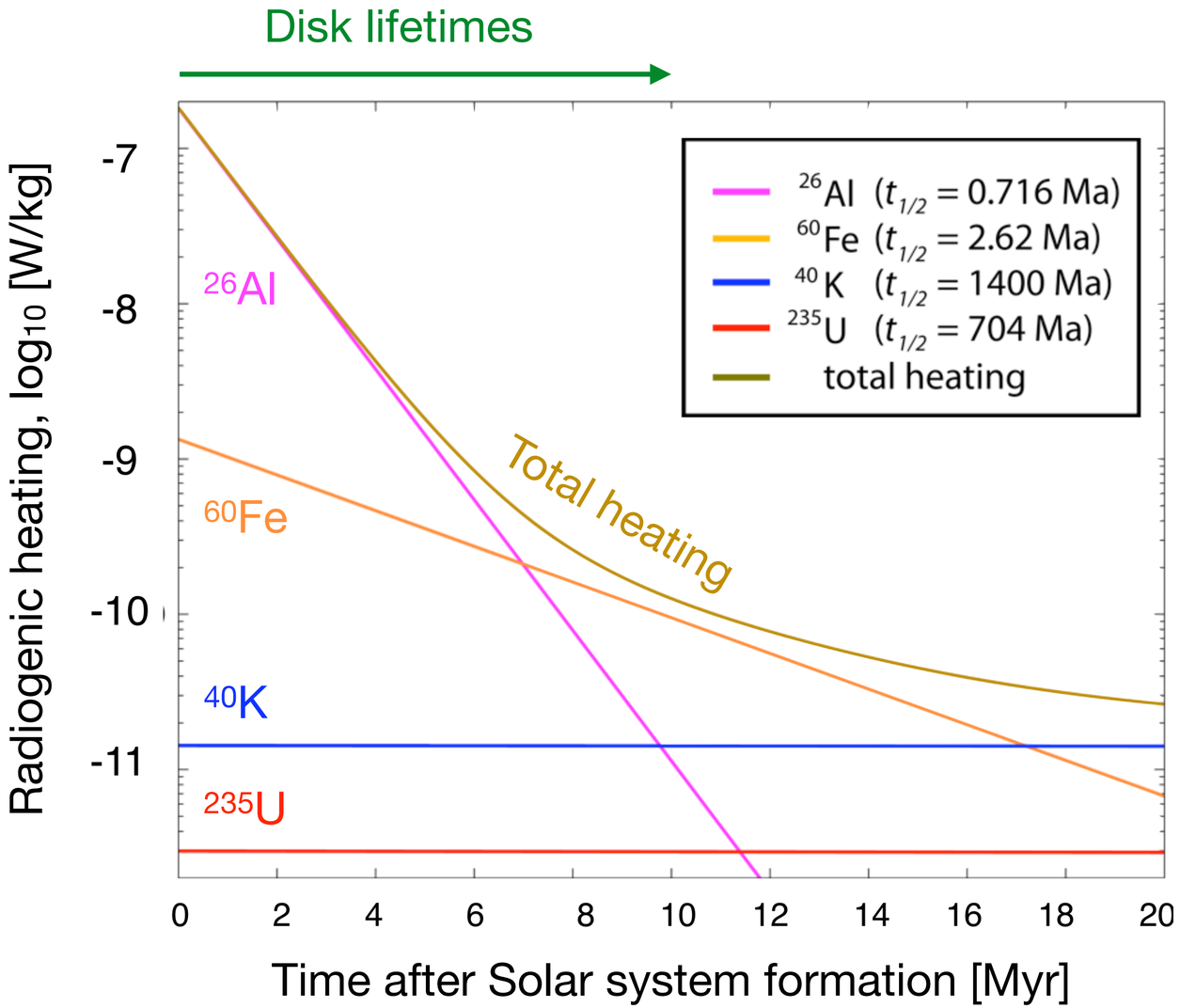


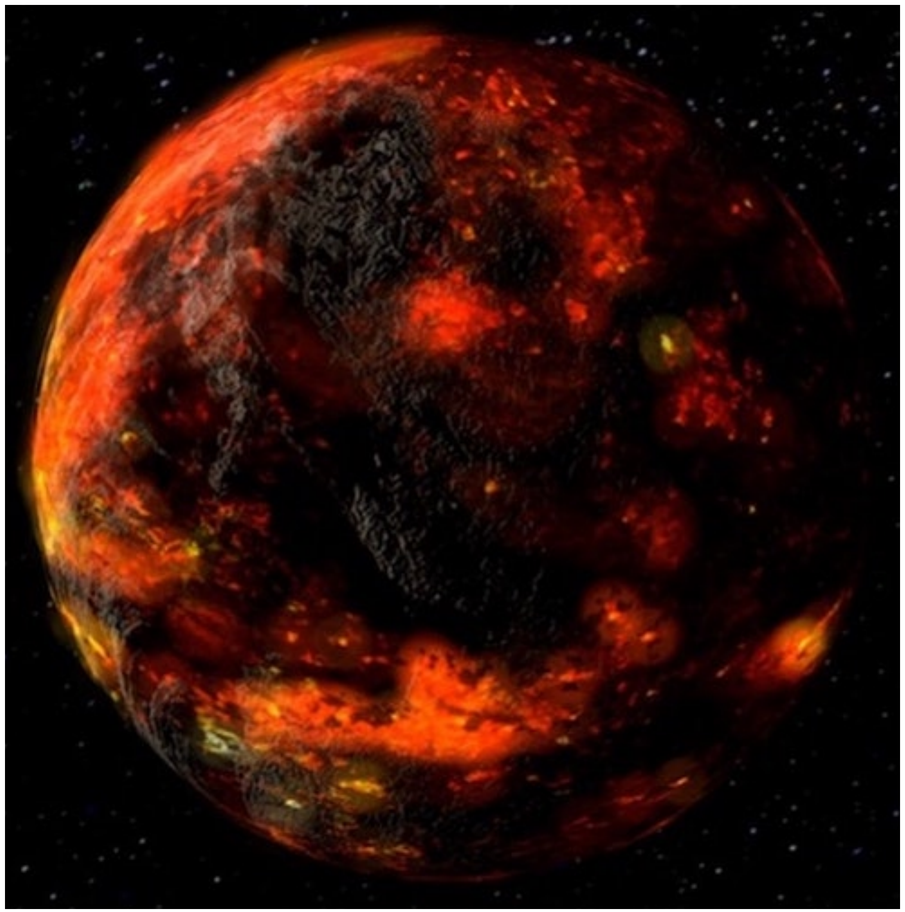
Limited storage in terrestrial core+mantle

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

Sotin+ 07; Vadim Sadovski; NASA/JPL-Caltech

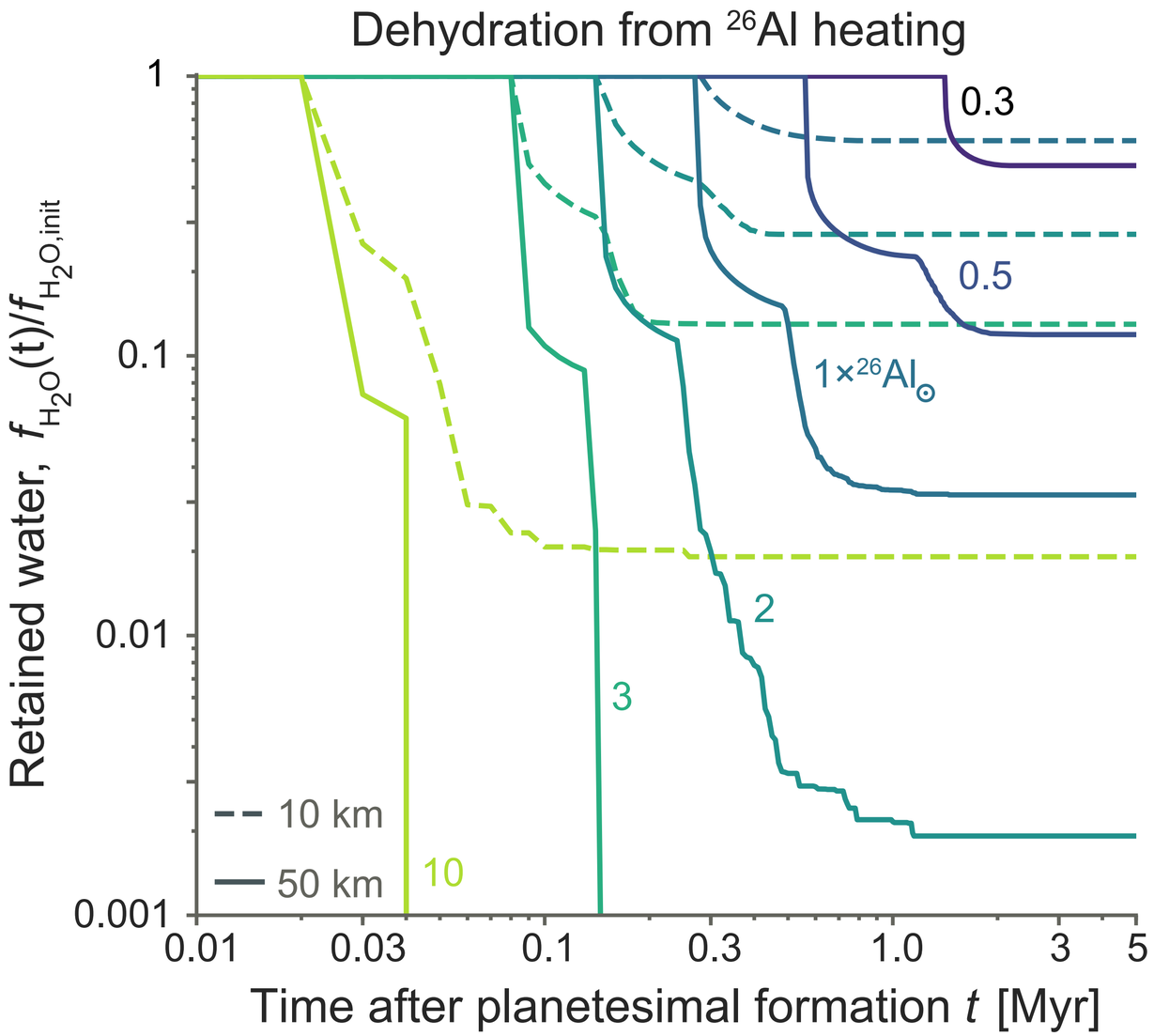
Getting rid of the water: radiogenic heating

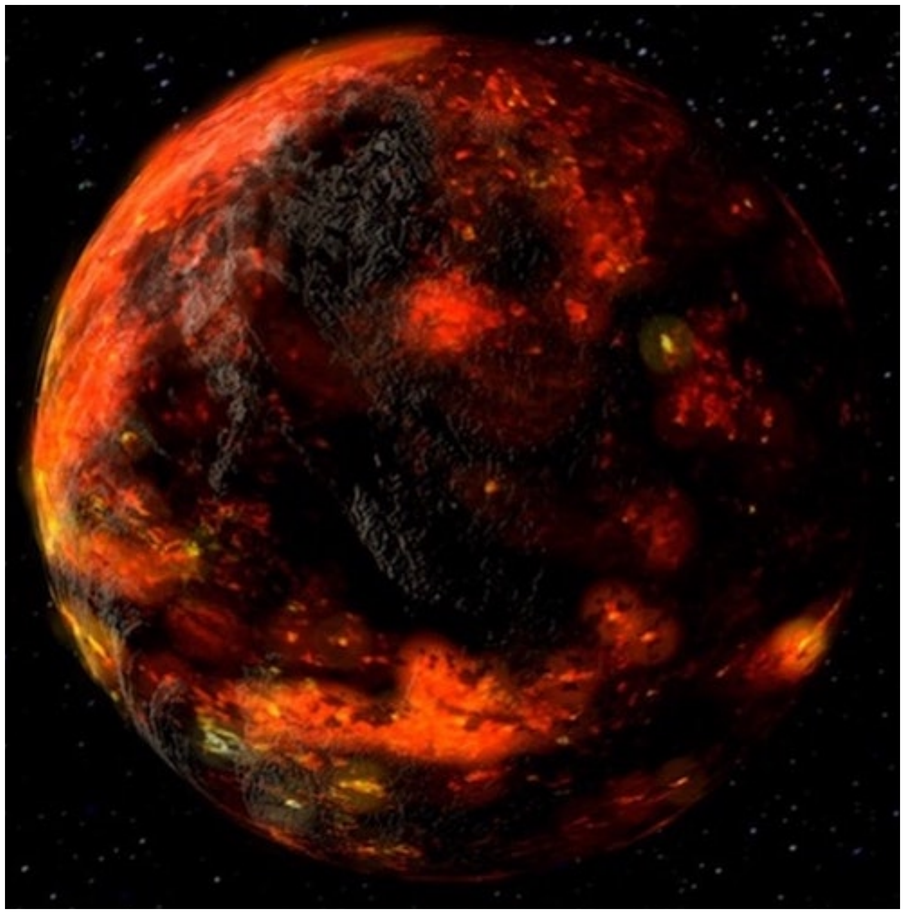




Lichtenberg+ 16a,18,19a,b

Getting rid of the water: radiogenic heating

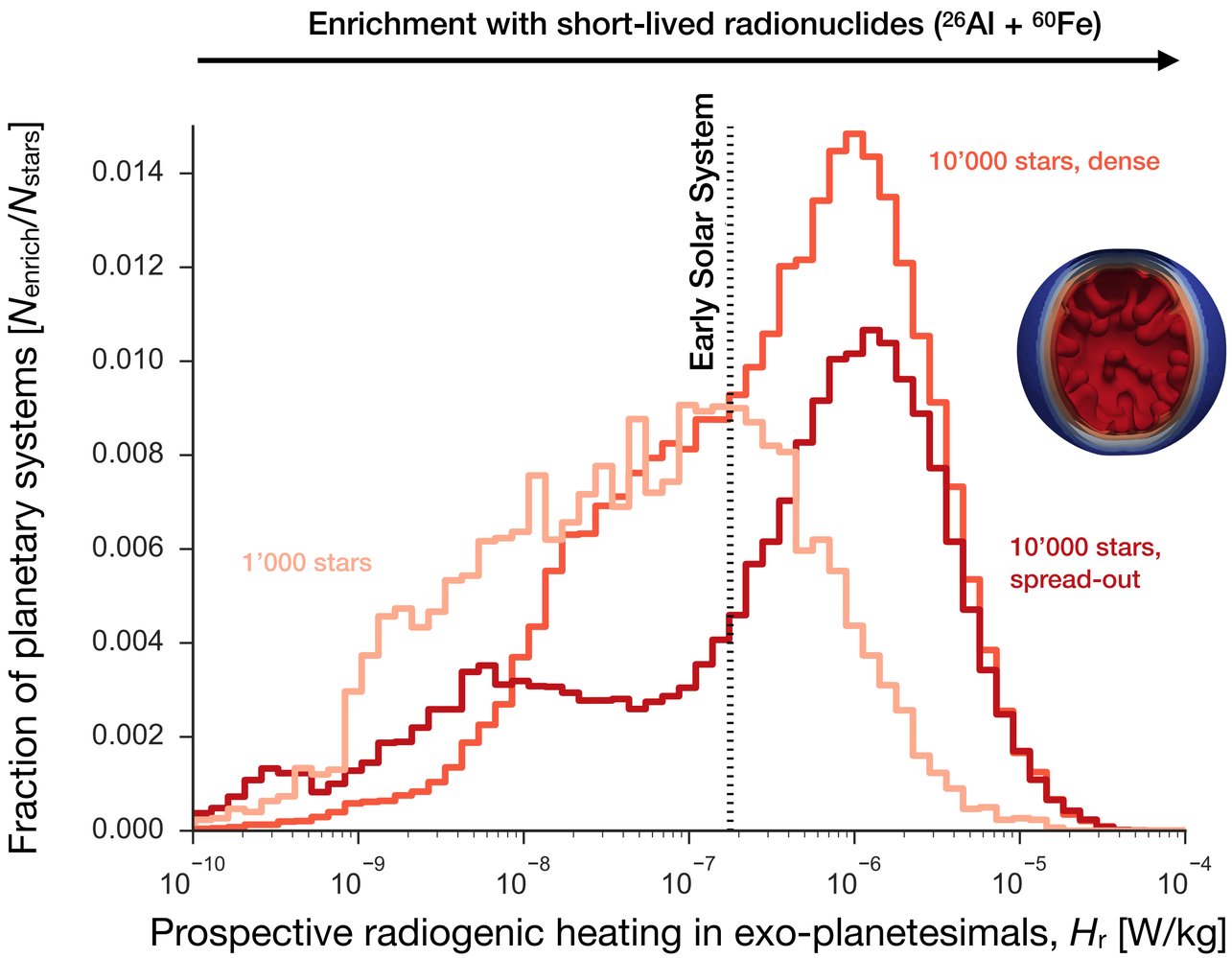




Lichtenberg+ 19b

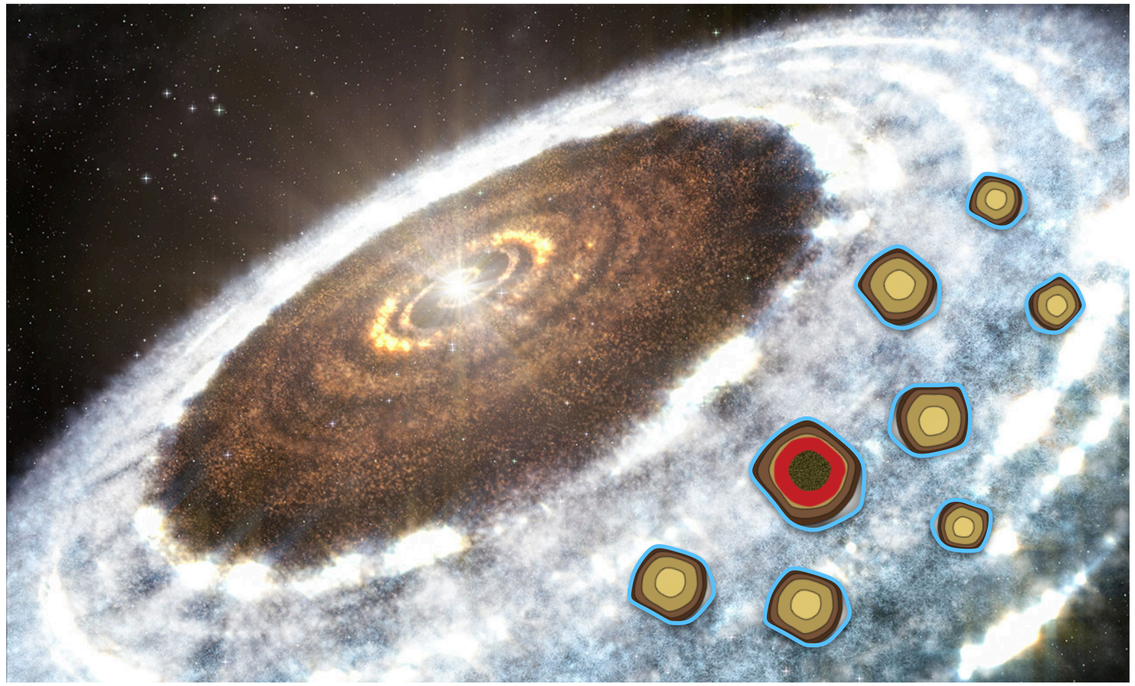
Lichtenberg+ 16a,18,19a

^{26}Al variability across planetary systems



≈ 10^2—10^8 × Earth's present-day interior radiogenic heating

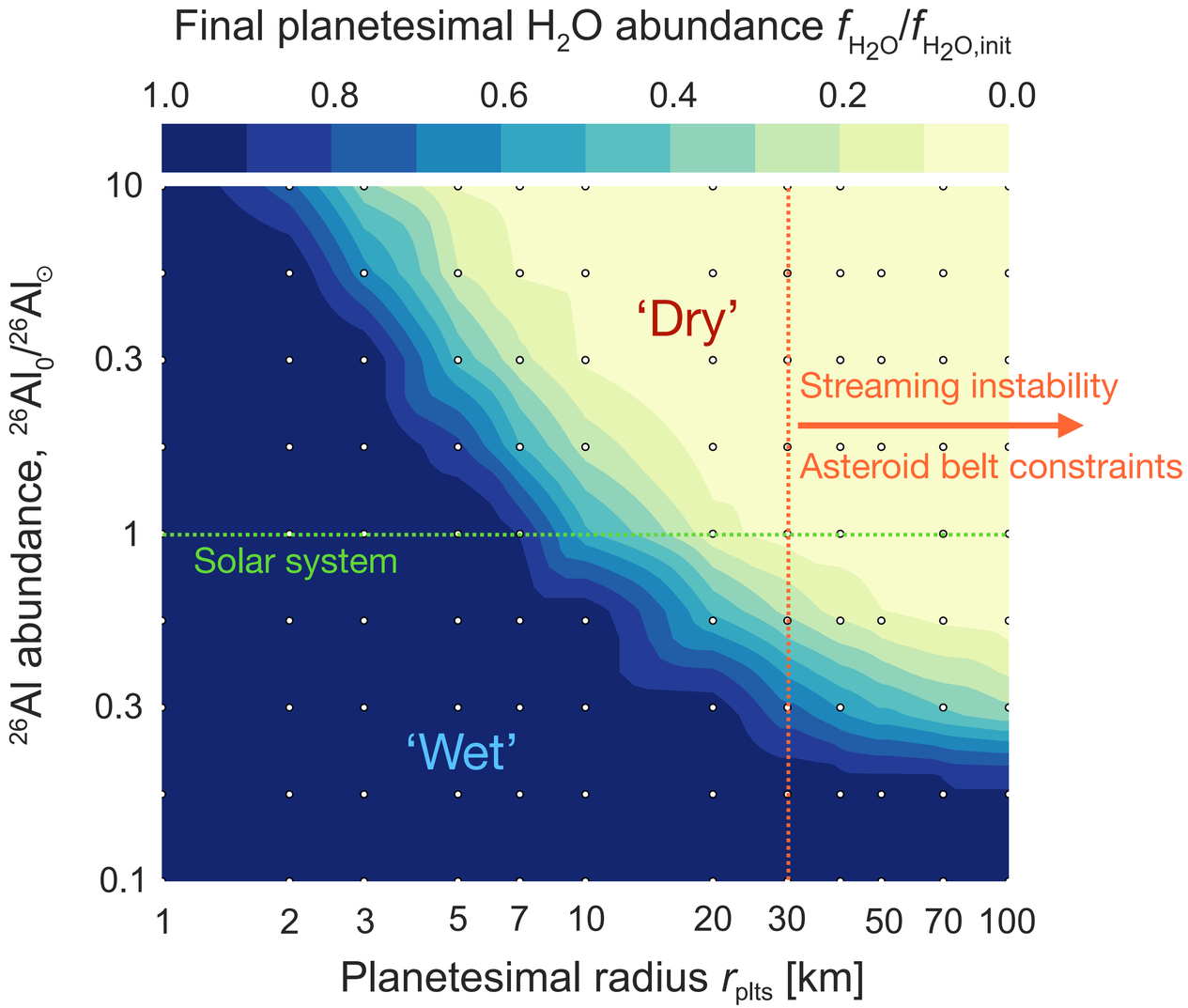
^{26}Al-heated icy planetesimals forming planets



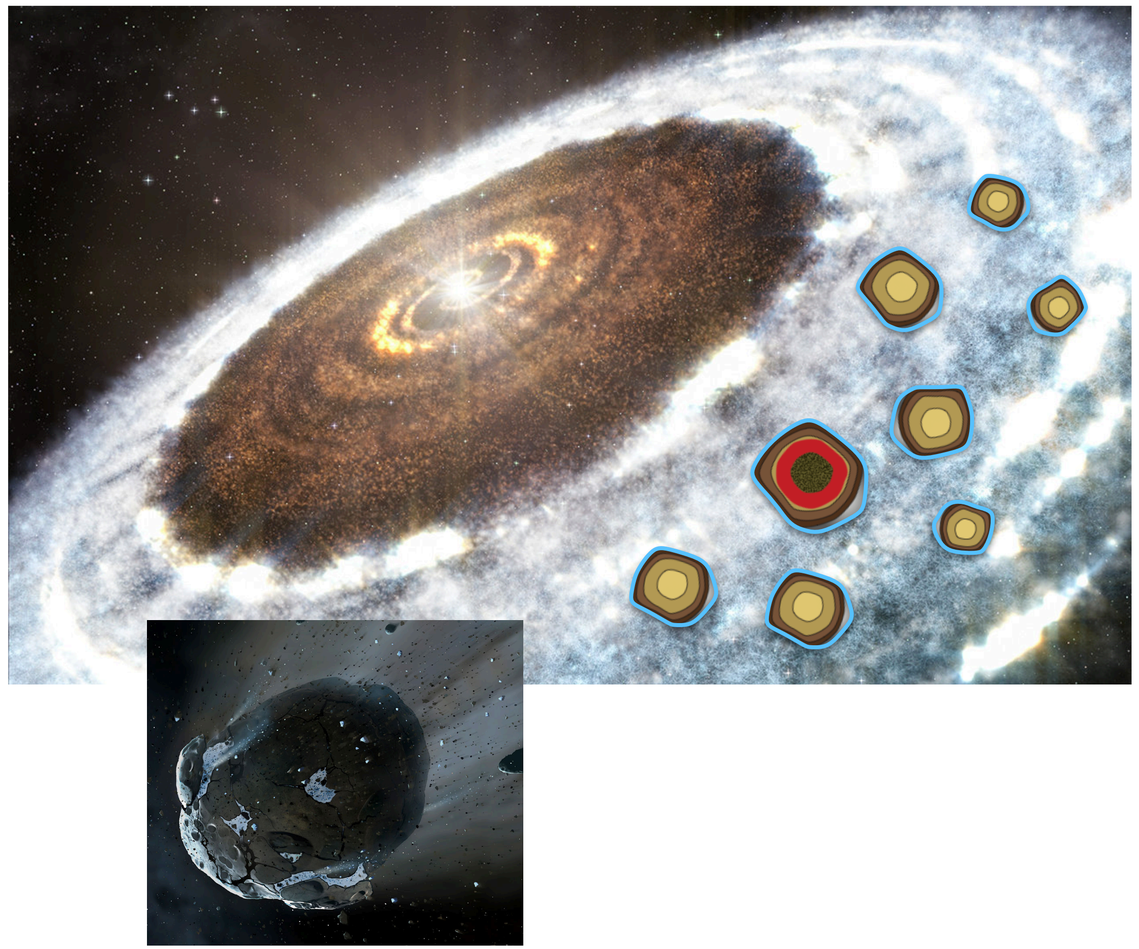
Lichtenberg+ 16b, Parker+ 14,15,17, Gaidos+ 09, Pfalzner+ 15, Kuffmeier+ 16, Lugaro+ 18

A. Angelich (NRAO/AUI/NSF)/ALMA (ESO/NAOJ/NRAO)

Rapid dehydration of water-rich planetesimals



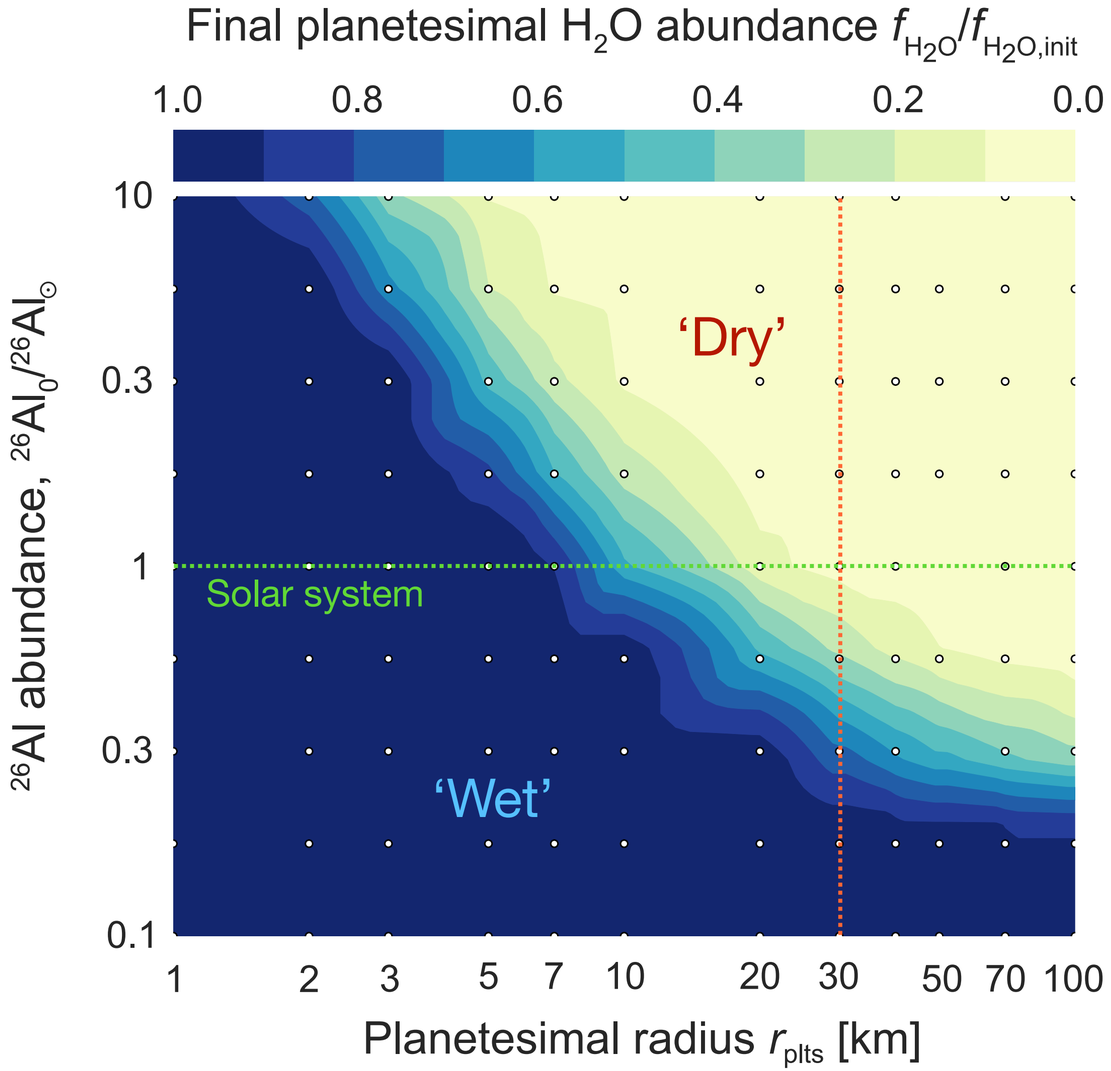
^{26}Al-heated icy planetesimals forming planets



A. Angelich (NRAO/AUI/NSF)/ALMA (ESO/NAOJ/NRAO); ESA/NASA/M.A.Garlick

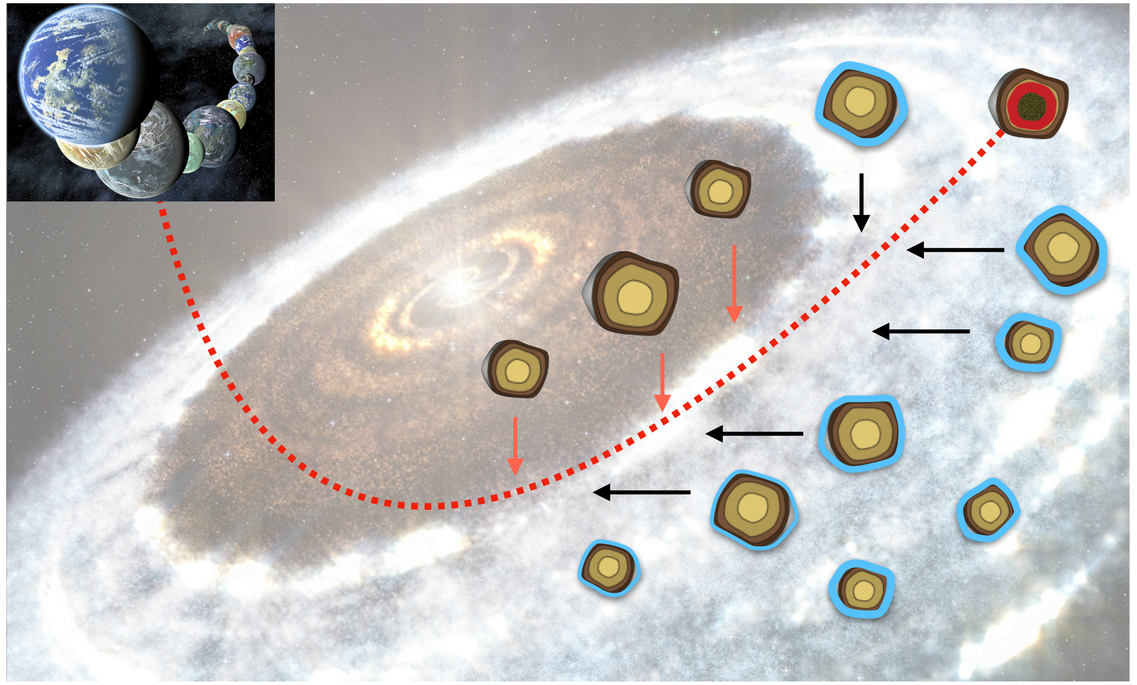
Lichtenberg+ 19b

^{26}Al controls bulk water content



Lichtenberg+ 19b

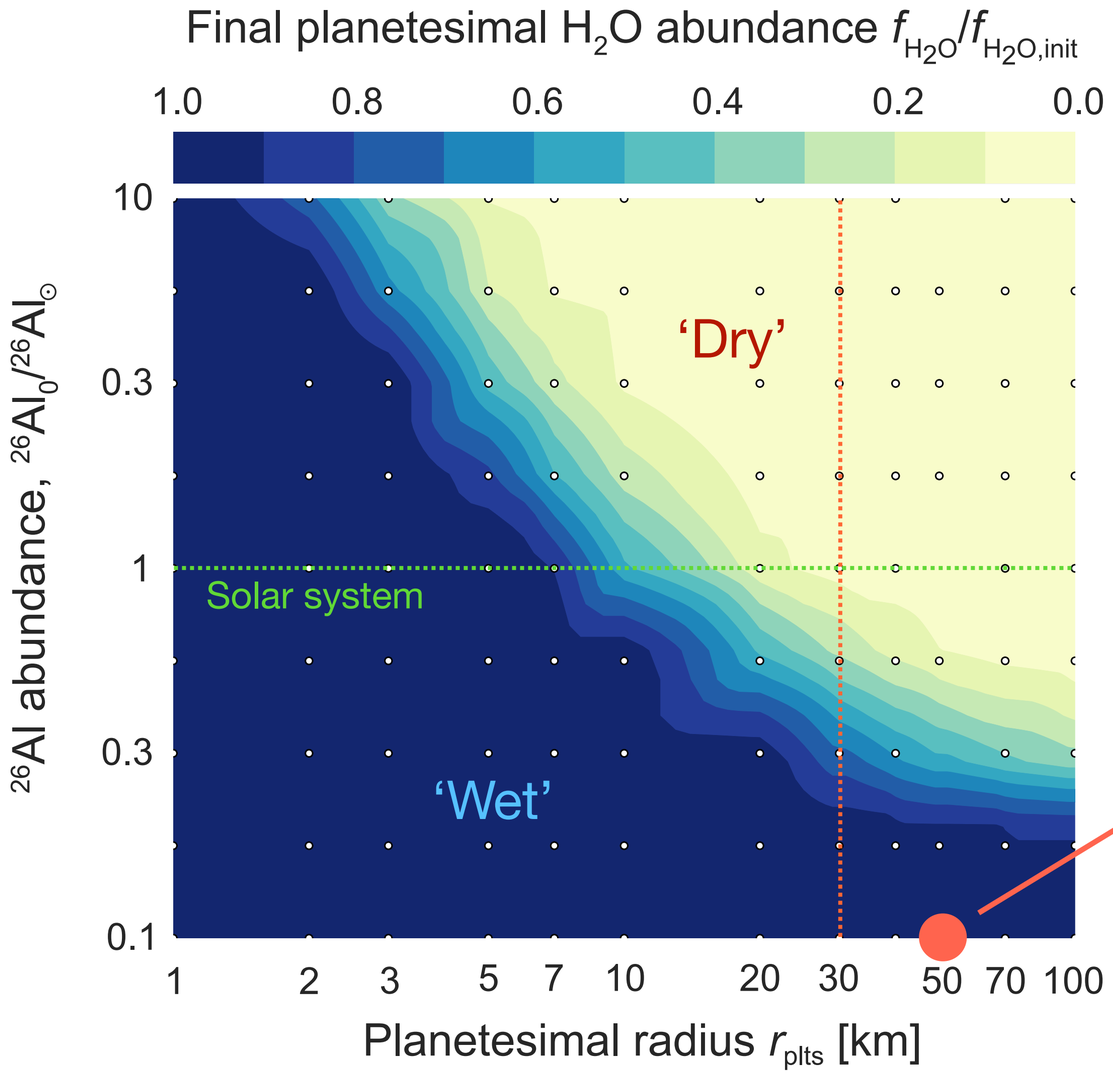
Synthetic exoplanet populations

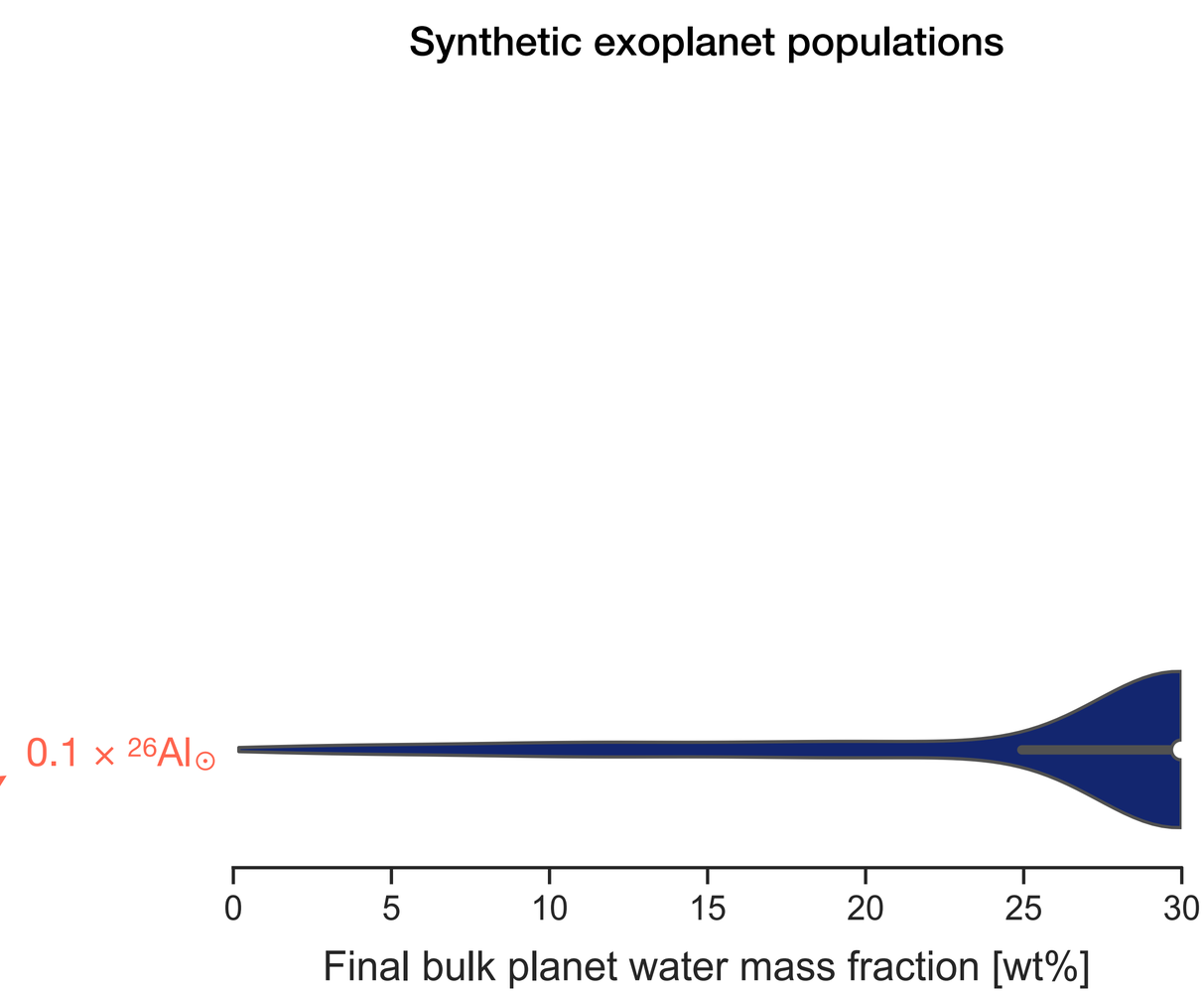


Accretion & decreasing water abundance in planetesimals

Benz+14, PPVI

^{26}Al controls bulk water content

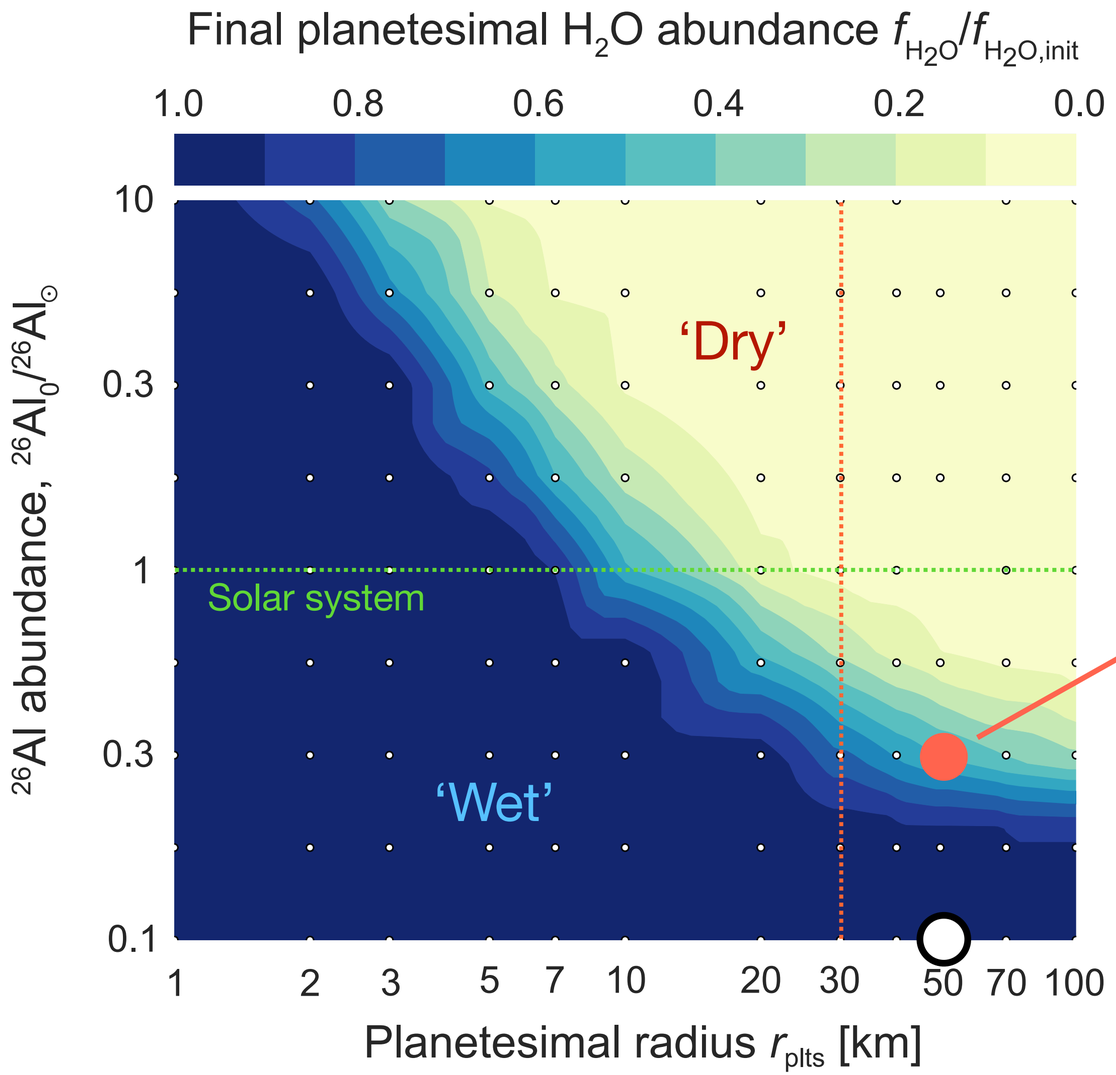


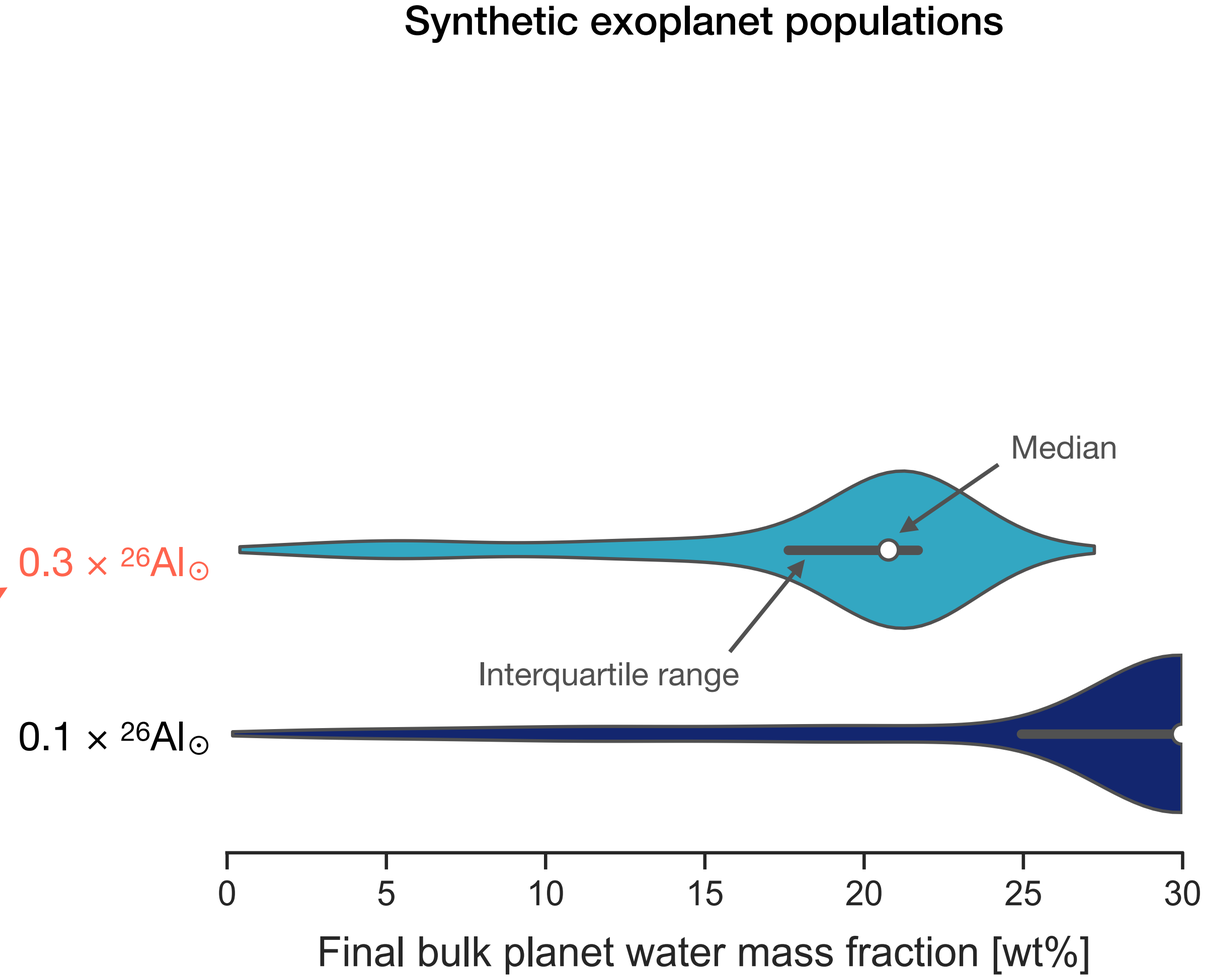


$f_w > 0$, $M_P < 10$ M_{Earth}, G stars

Lichtenberg+ 19b

^{26}Al controls bulk water content





Lichtenberg+ 19b

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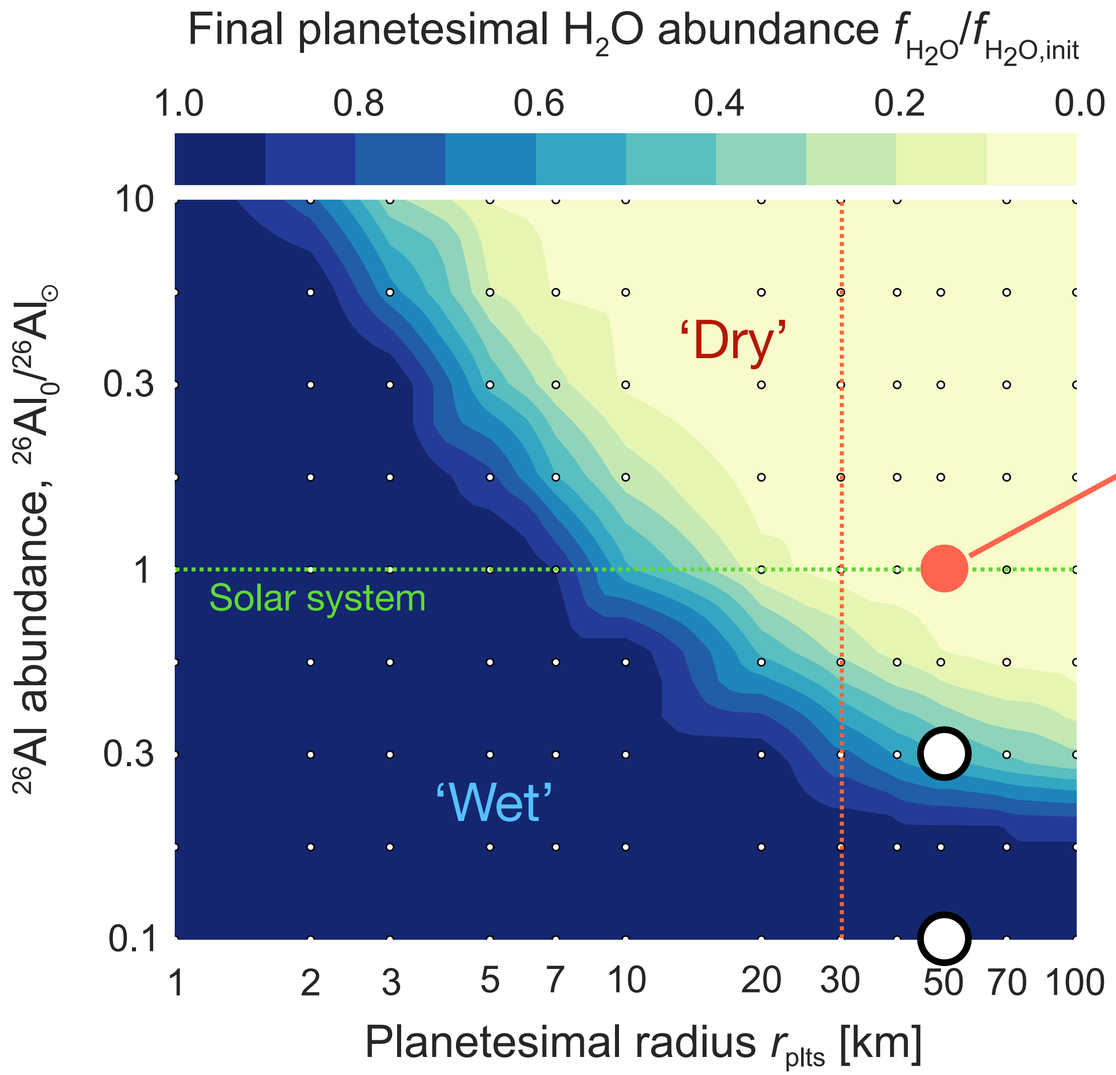
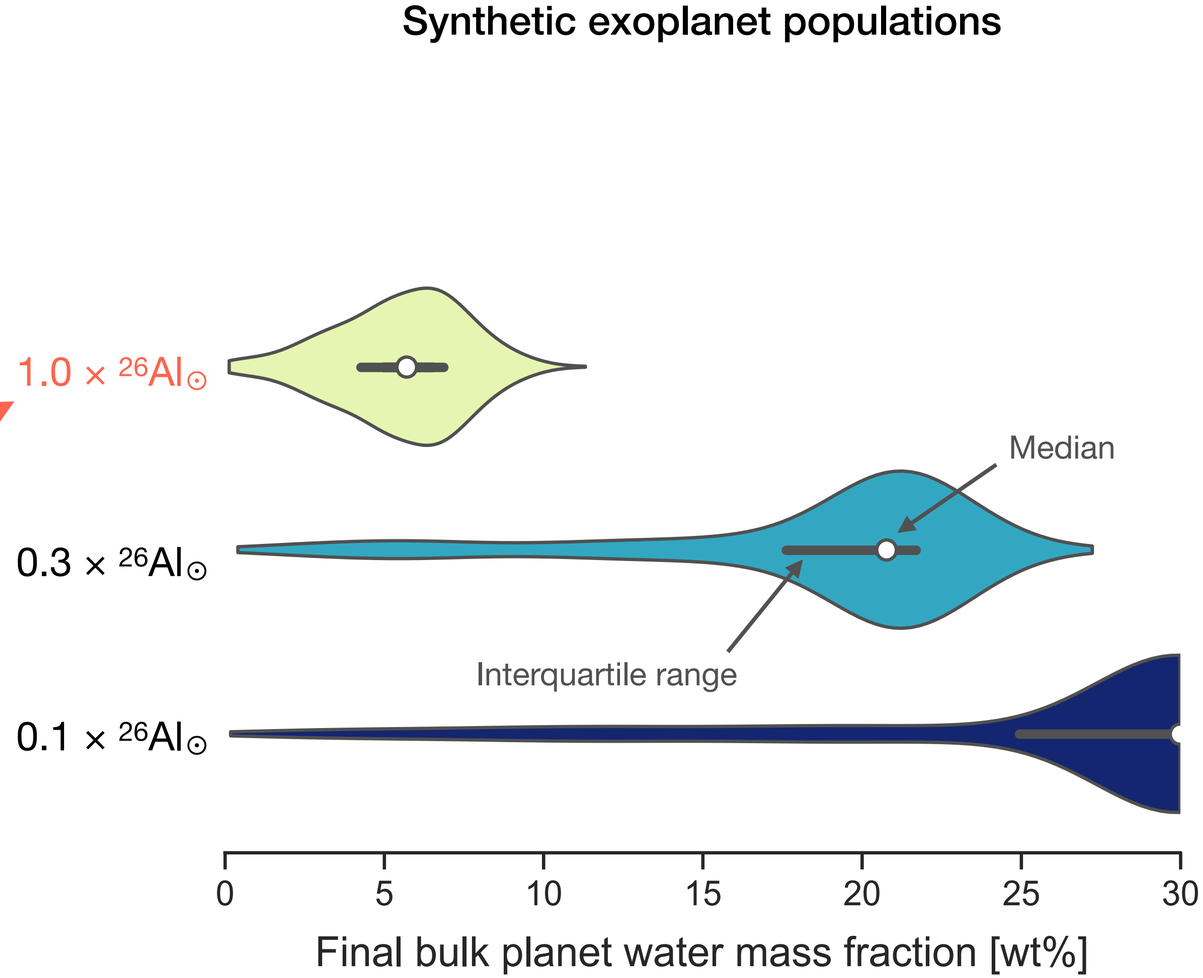
^{26}Al controls bulk water content

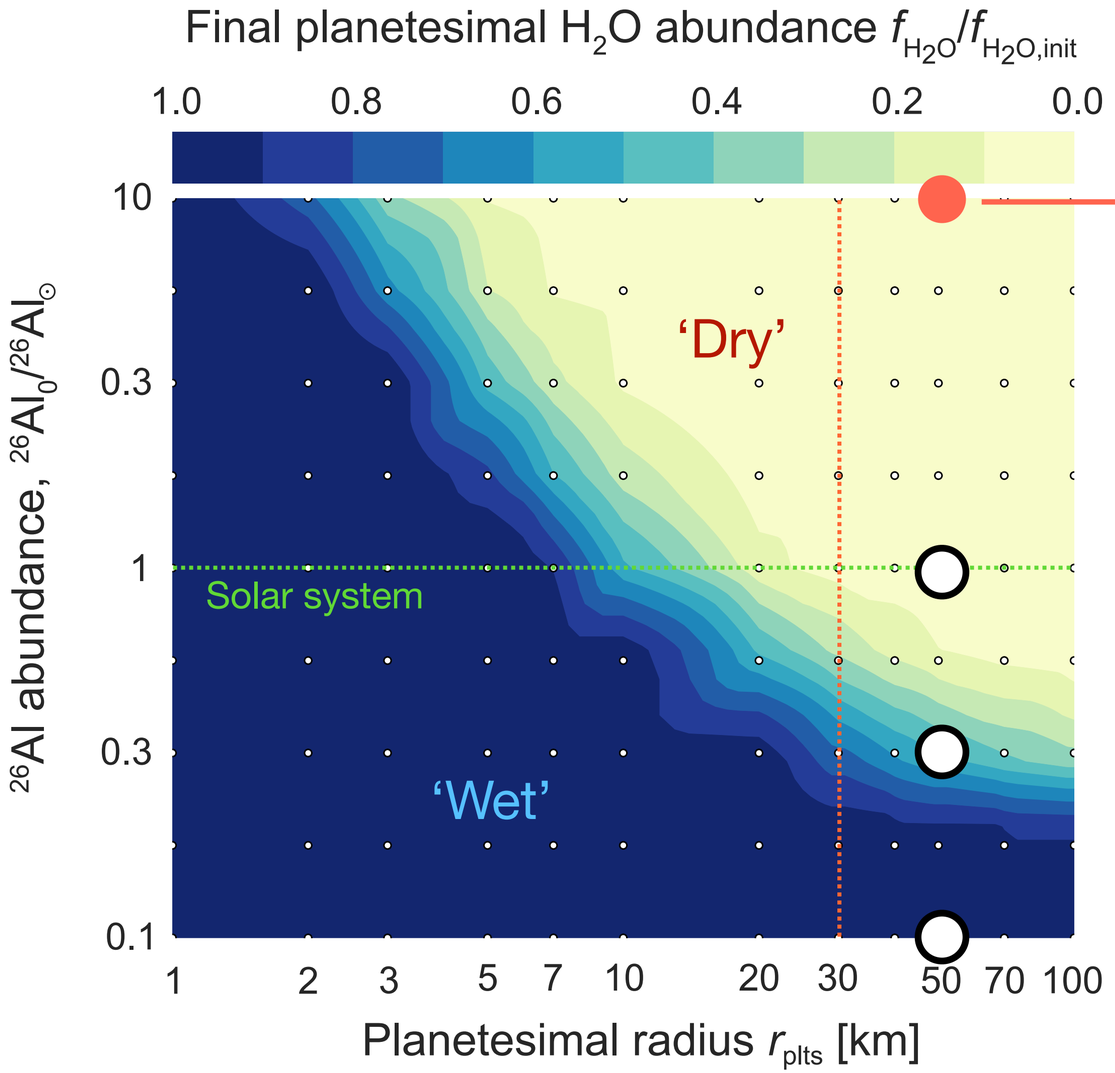


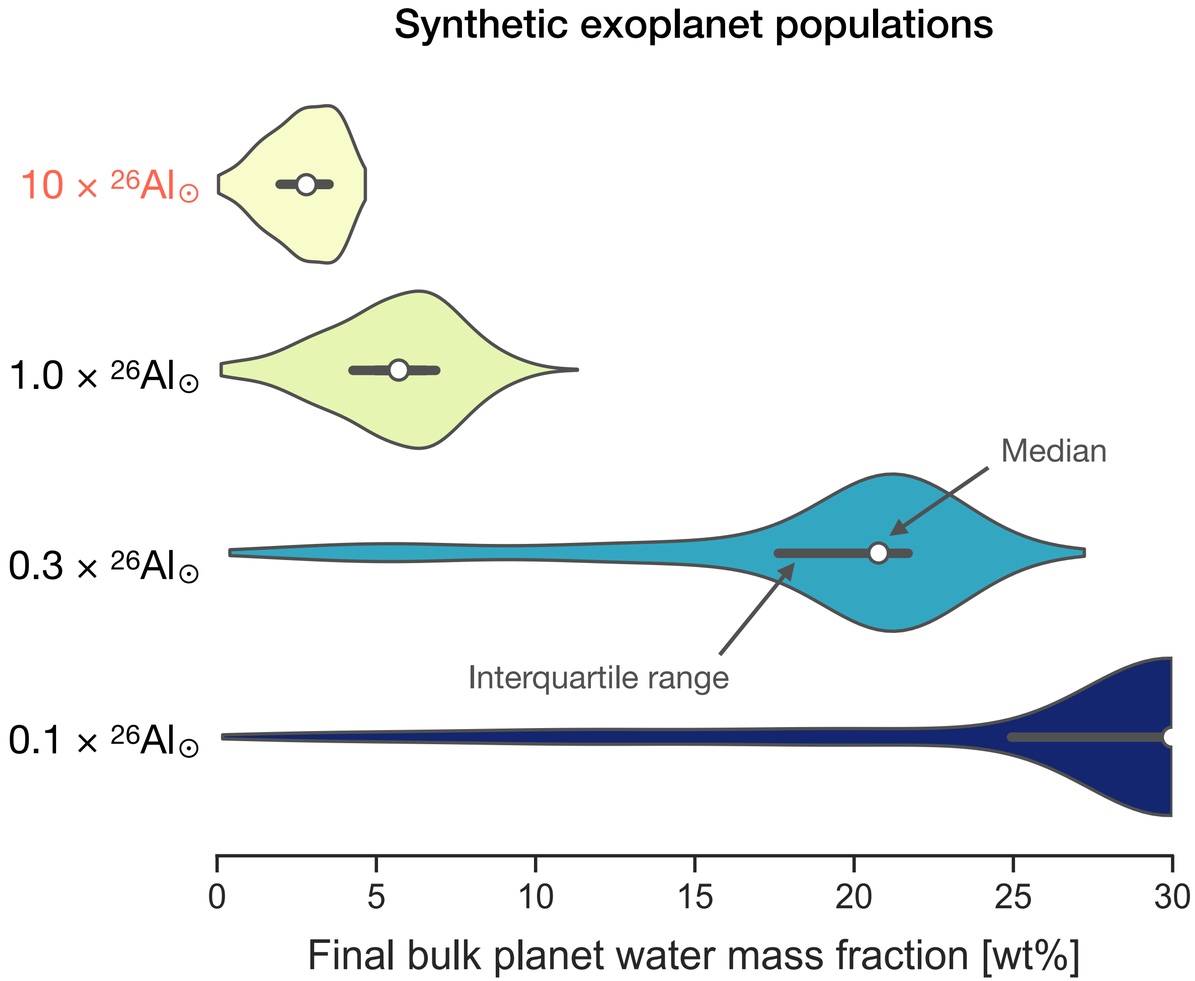


$f_w > 0$, $M_P < 10$ M_{Earth}, G stars

Lichtenberg+ 19b

^{26}Al controls bulk water content





Lichtenberg+ 19b

$f_w > 0$, $M_P < 10$ M_{Earth}, G stars

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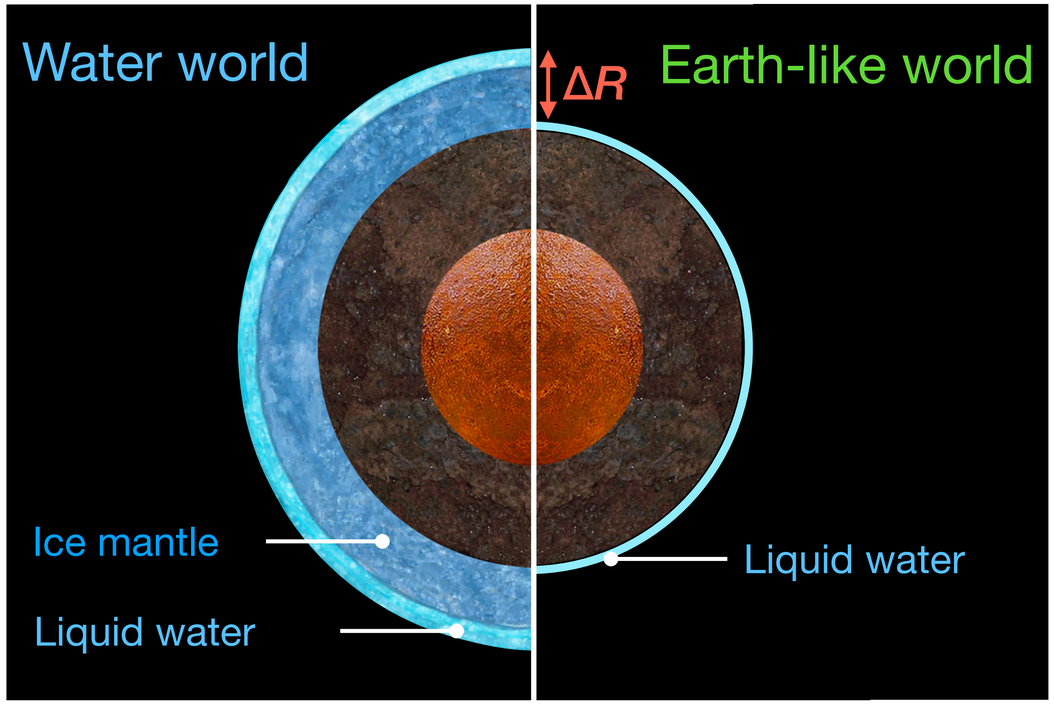
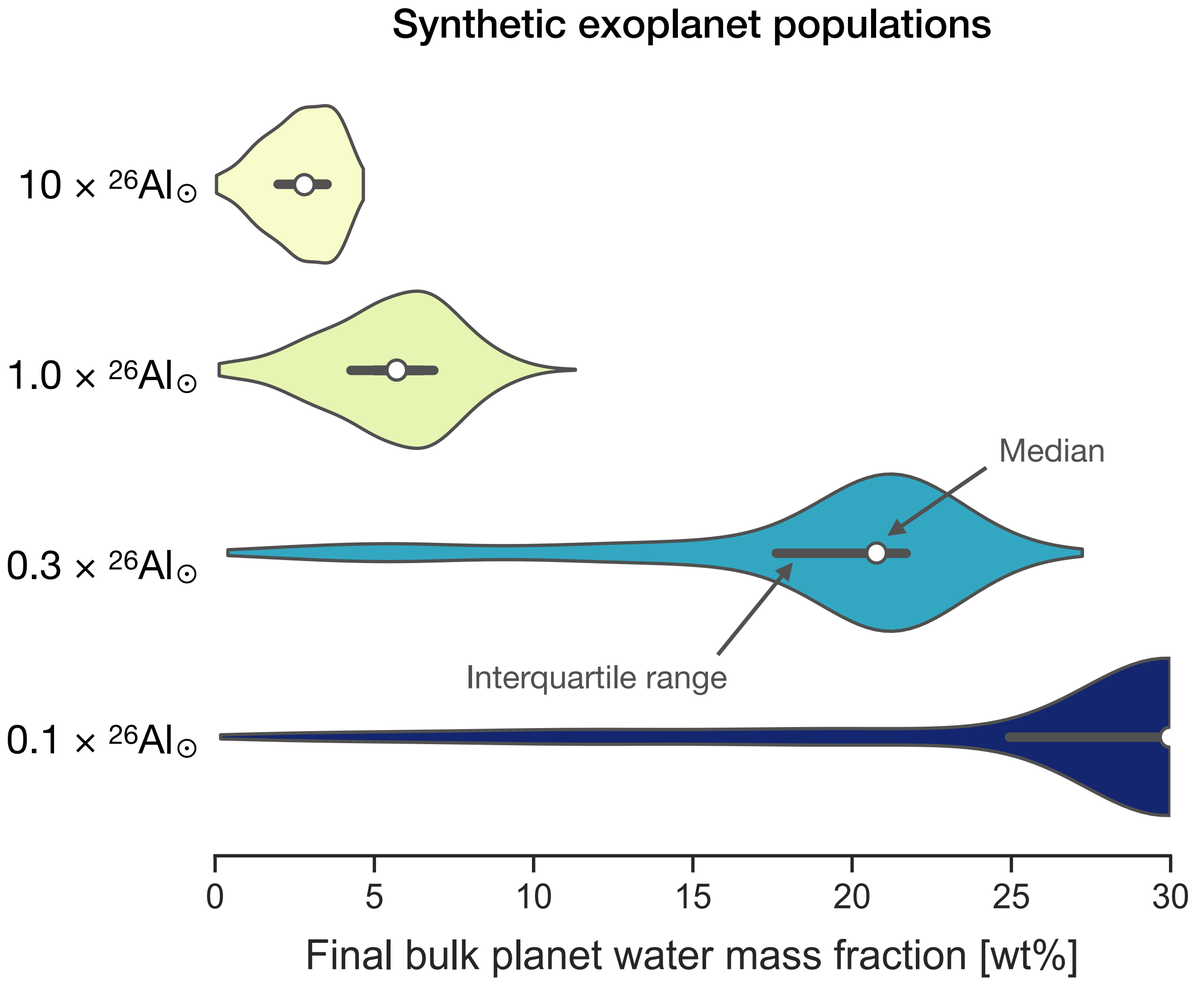
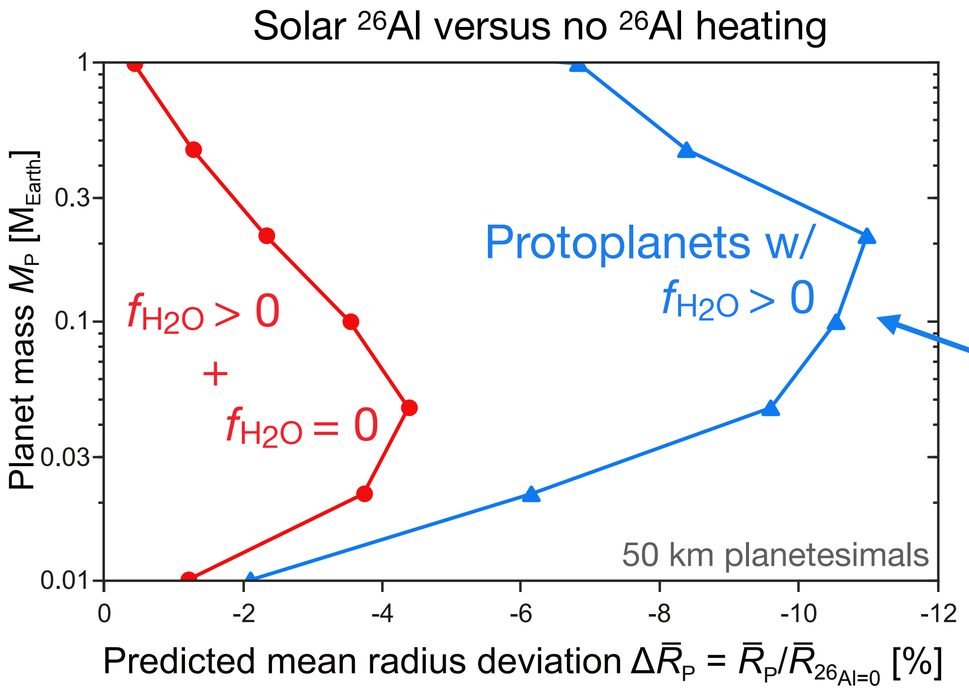
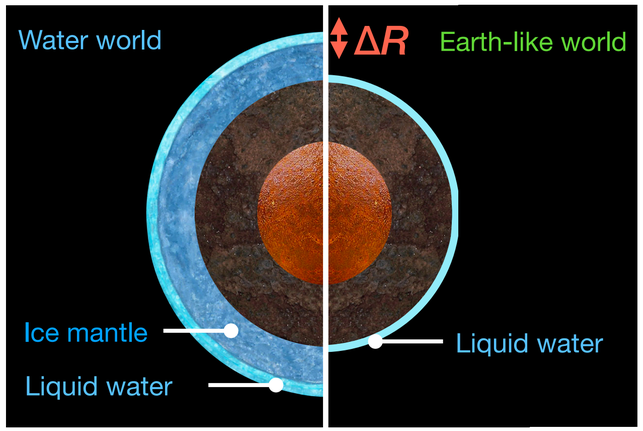


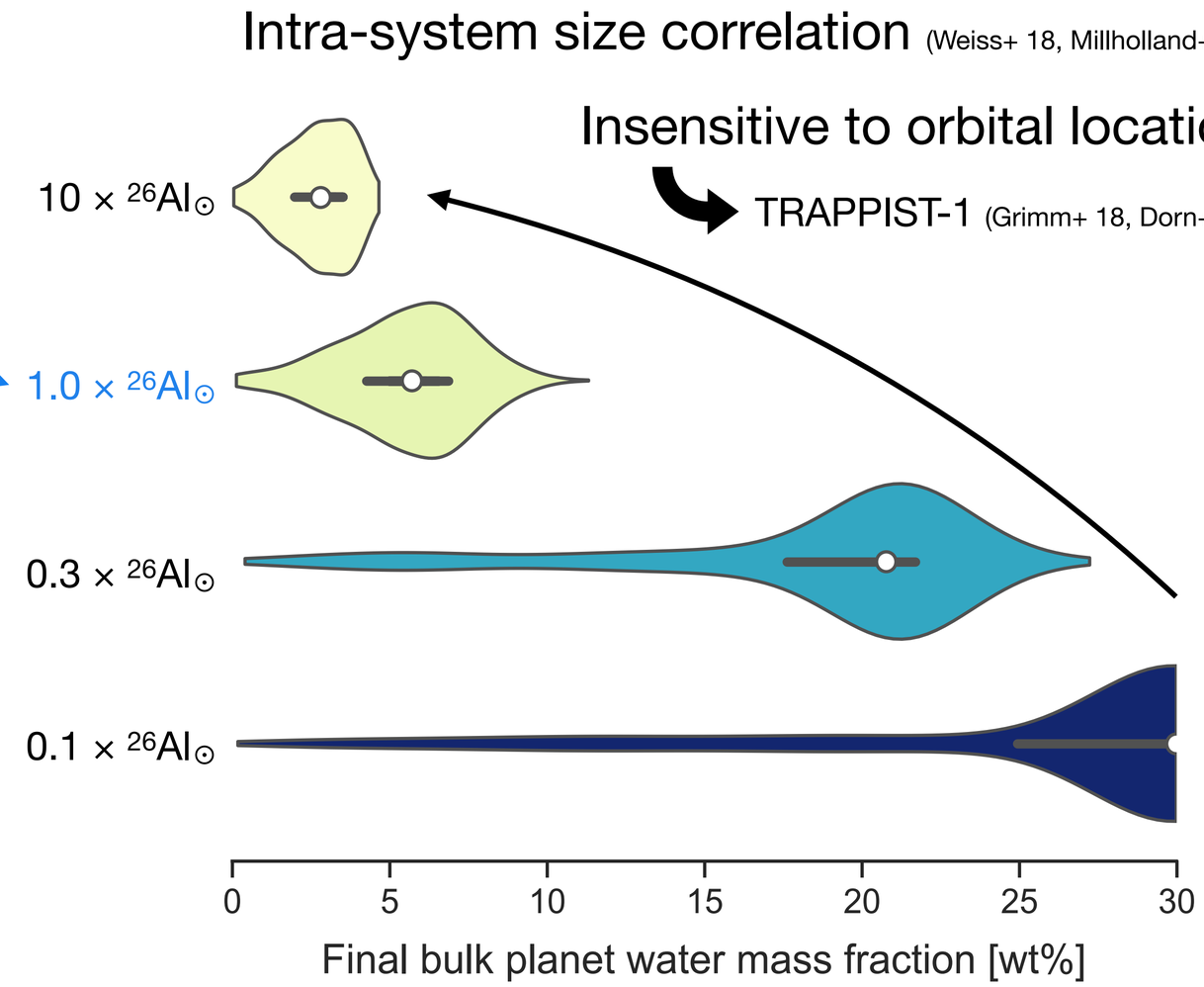


Leger+ 04, Sotin+ 07, Alibert 14, Noack+ 16/17

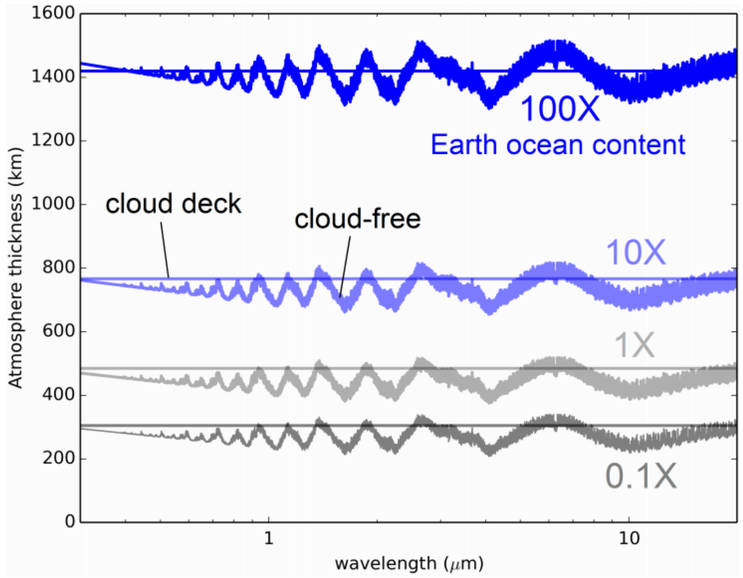
^{26}Al shapes exoplanet structure

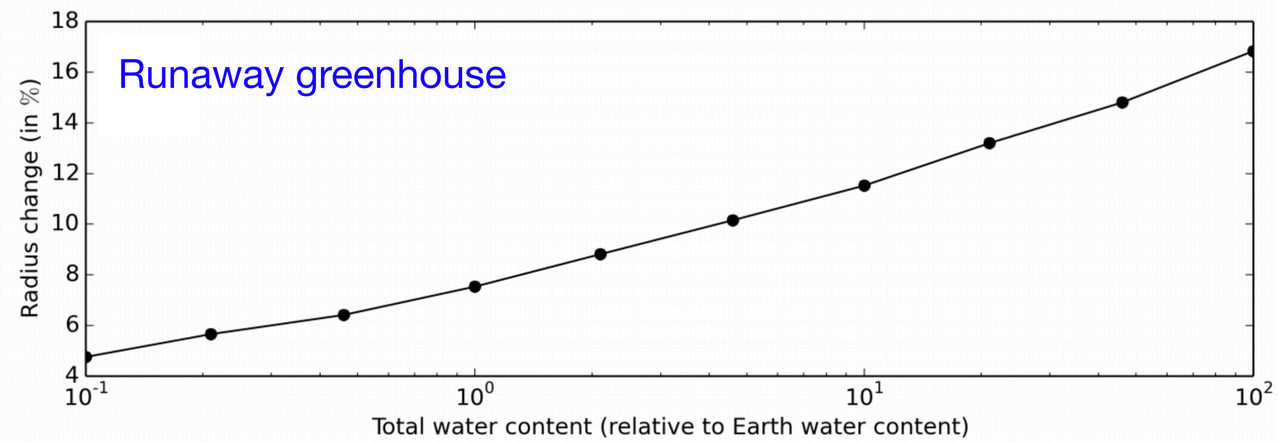


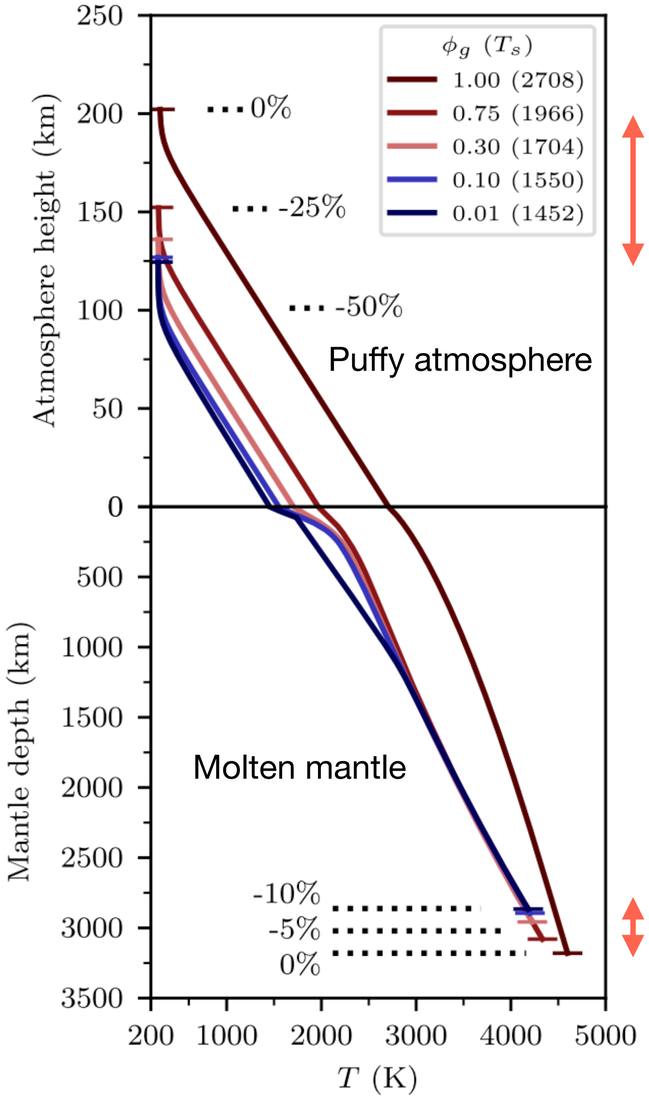




Water shapes exoplanet structure







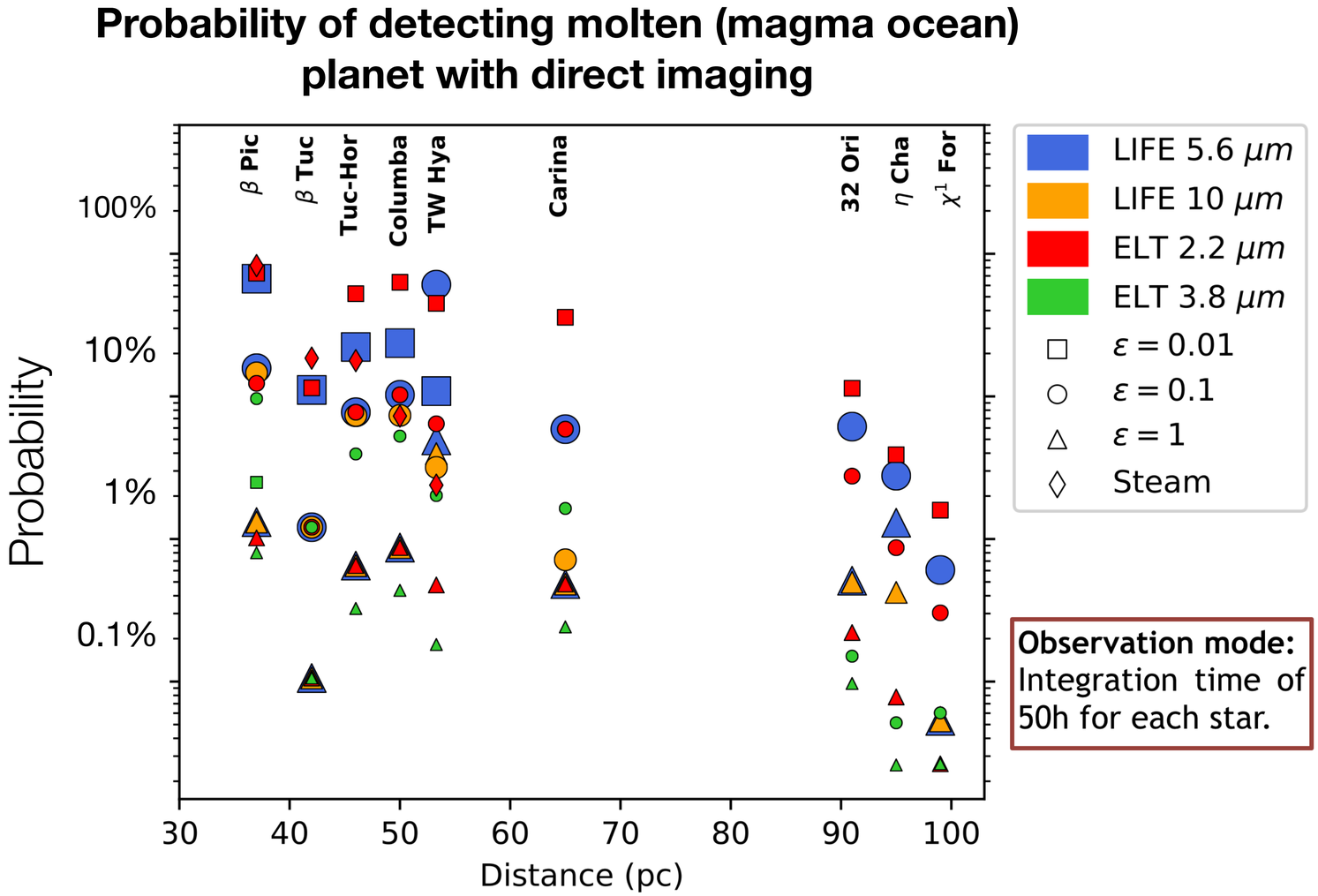
Radius change due to puffy atmosphere

Radius change due to magma ocean

Turbet+ 19

Bower+ 19

Detectability with direct imaging?



Direct imaging of molten protoplanets in nearby young stellar associations

➡ Poster 234 (EXO4/TP10/OPS14)

➡ Thu, 19 Sep, 17:15–18:45 | L2.84

➡ Presented by Dan Bower

Irene Bonati
ELSI, Tokyo Tech

Bonati, Lichtenberg, Bower, Timpe, Quanz (A&A, 2019)

^{26}Al key control on rocky planet composition

- Fraction of planetary systems enriched with ^{26}Al

  ➡ Volatile loss & differentiation in planetesimals

- Systemic dichotomy:

  ➡ Enriched: water-poor (proto-)planets

  ➡ Not-enriched: ocean worlds

◉ Statistically traceable w/ near-future observations?

  ➡ Discernible by *transit radius* alone

A water budget dichotomy of rocky protoplanets from ^{26}Al-heating
Lichtenberg, Golabek, Burn, Meyer, Alibert, Gerya, Mordasini
Nature Astronomy 3, 307–313 (2019) | arXiv:1902.04026