Density, not radius, separates rocky and water-rich small planets orbiting M dwarf stars

Authors:
Rafael Luque & Enric Pallé

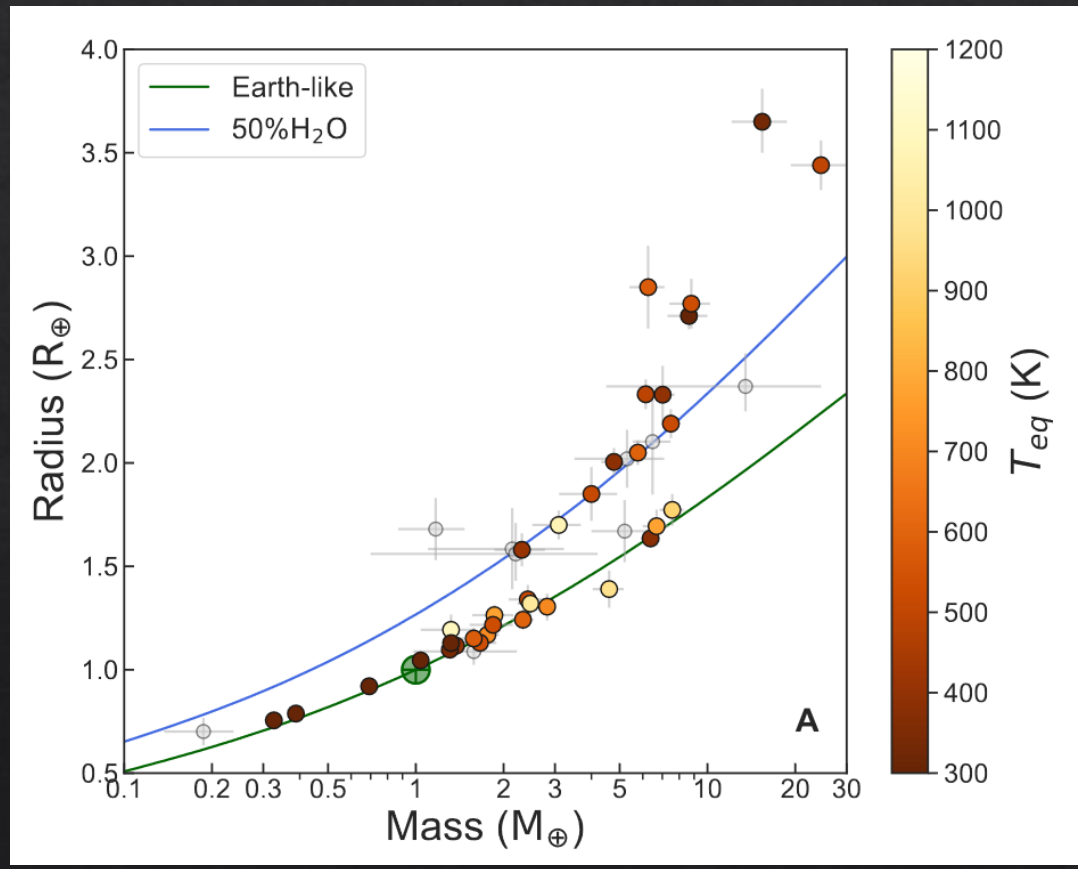
Presenter:
Ryan Cosgrove

Overview:

- Advancement in the characterization of small exoplanets around M dwarf stars
- Composition of exoplanets previously thought to have bimodal radius distribution
- Proposal that examining density of planet offers a better method of characterization than radius

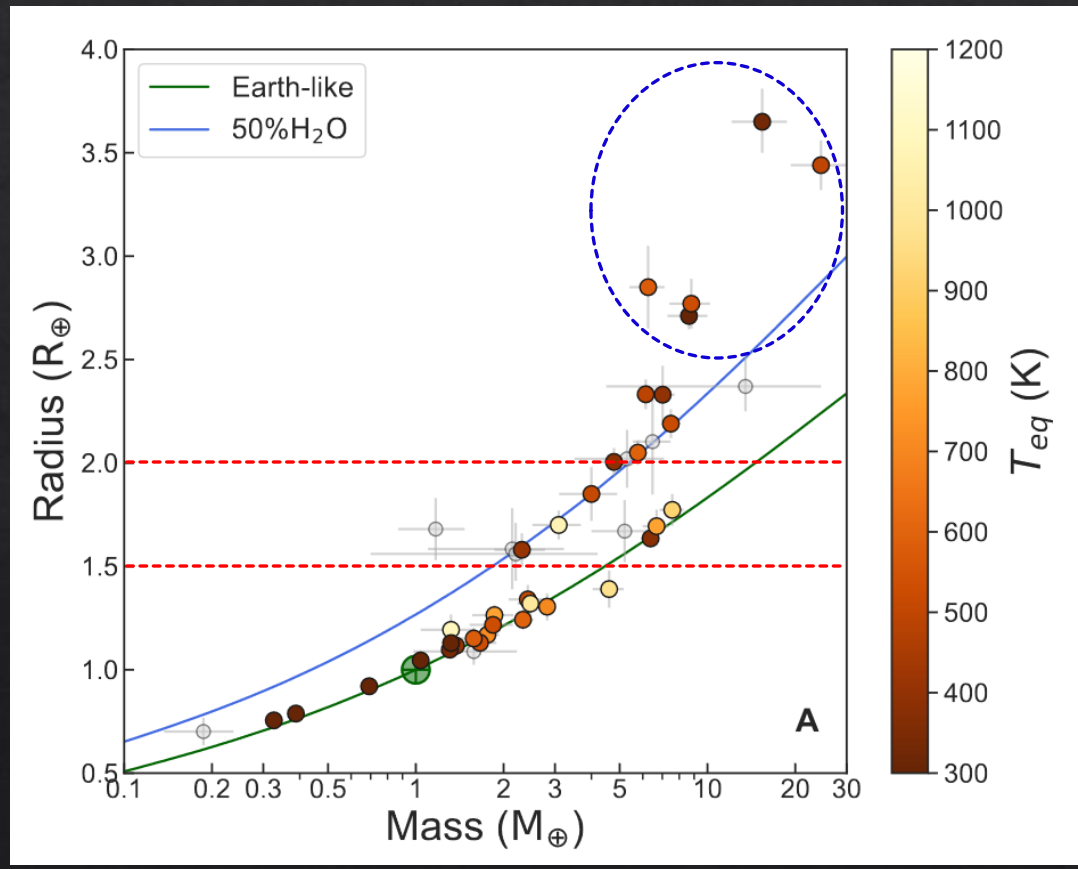
Previous Accepted Literature

- Small exoplanets categorized as "rocky" or "water world" based on composition
- Composition affects range of possible masses and radii
- Radius gap between rocky planets and water worlds

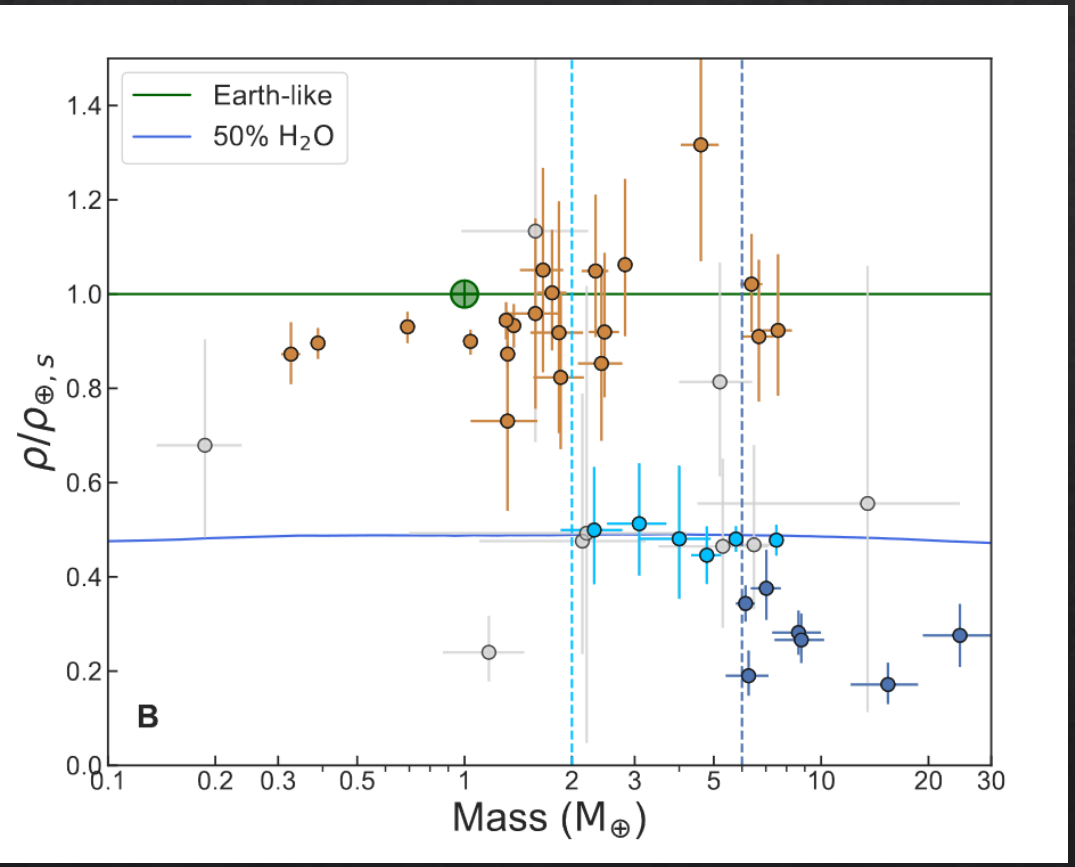


Issues With Previous Accepted Literature

- From 1.5 $R_\odot$ < R < 2.0 $R_\odot$, no clear radius gap is present
- Group of high-radius, high-mass planets unaccounted for

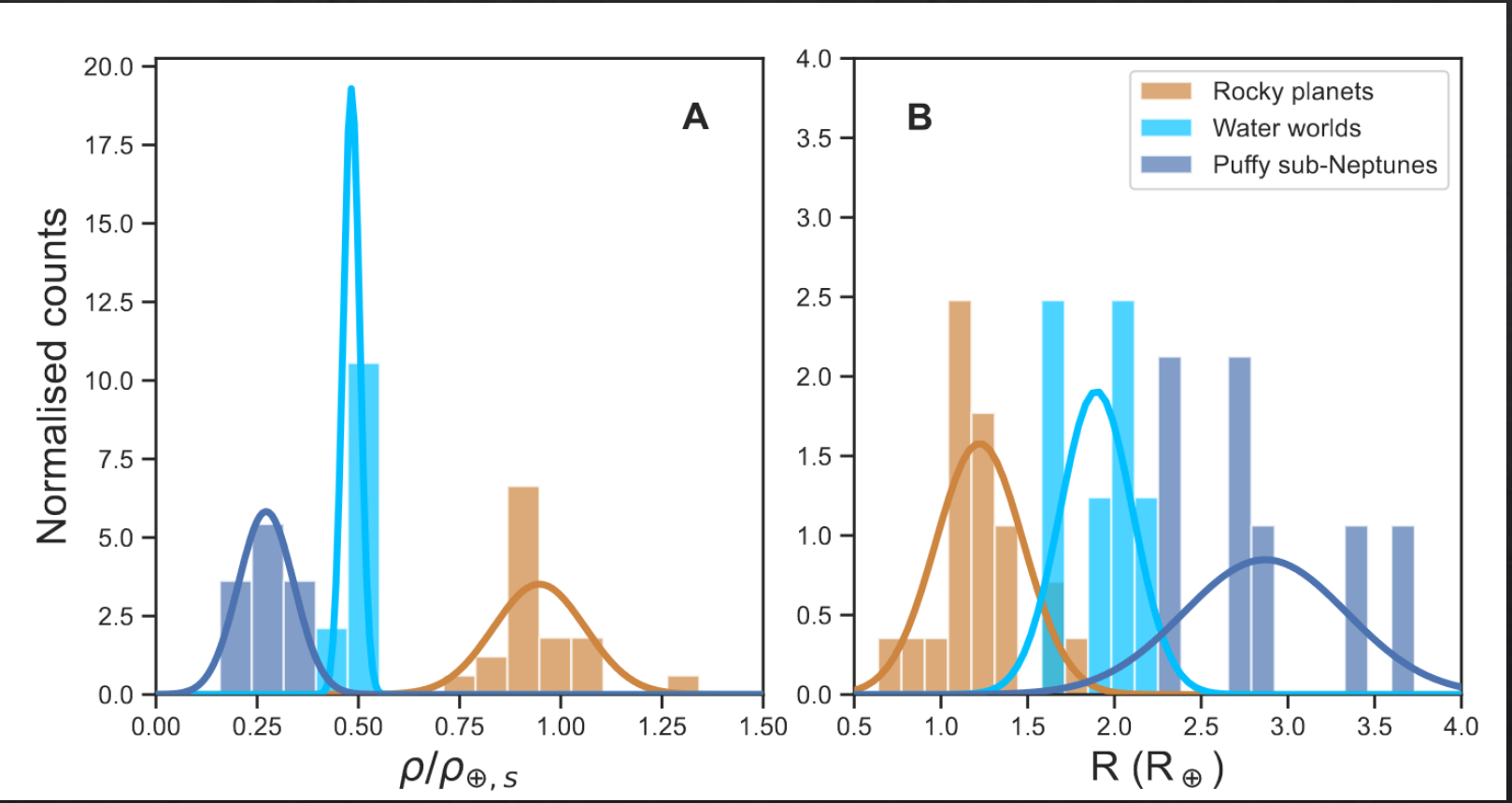


Density Proposal



- Much clearer separation between rocky planets and water worlds
- Both groups of planets better-characterized
- Third population: “puffy sub-Neptunes”

Radius vs. Density



Implications For Planetary Evolution

- Planetesimal accretion vs. pebble accretion:

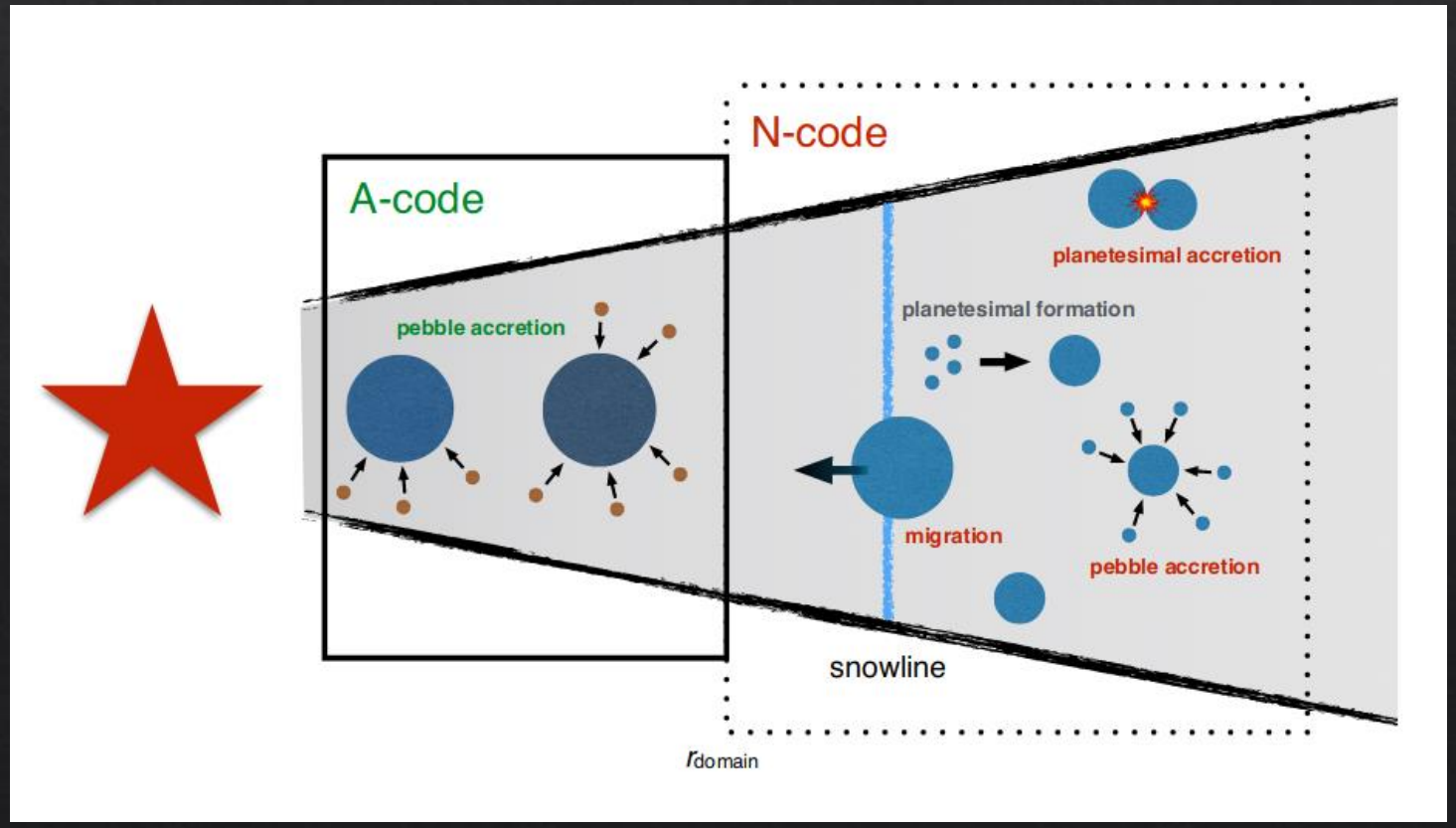


image credit: https://staff.fnwi.uva.nl/c.w.ormel/science.html

Implications For Planetary Evolution

- Planetesimal accretion would result in intermediate water-rock compositions
- Pebble accretion does not
  - Favoured by data for small planets around M dwarfs

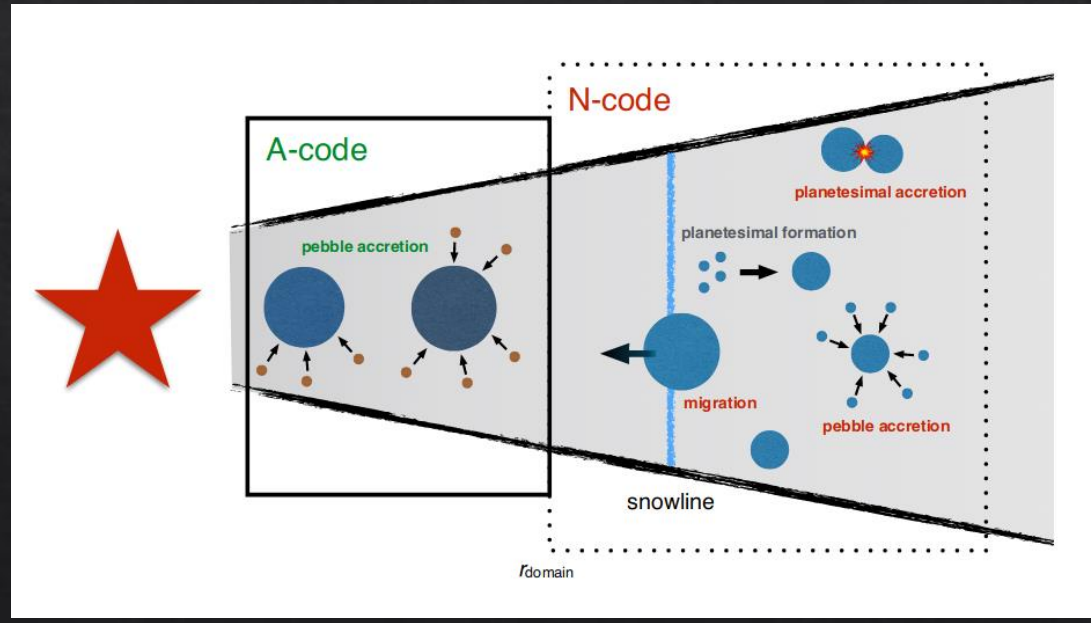


image credit: https://staff.fnwi.uva.nl/c.w.ormel/science.html

Implications For Planetary Evolution

- Icy planets form beyond ice line and migrate inwards to become water worlds
  - Minimum mass for water worlds better understood, relates to host star mass
  - Water worlds more common around lower mass stars
- Rocky planets form within ice line
  - In multi-planet systems, rocky planets closer to host than water worlds

Conclusions

- Density-approach superior to radius-approach for characterizing small exoplanets around M dwarfs
- Three main classes: rocky planets, water worlds, and sub-Neptunes
- Formation, evolution, and position of each class in multi-planet systems better understood