EXOPLANETS

Water worlds galore

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Exoplanets with radius R between the Earth and Neptune (~1–4 Earth radii ($R_\oplus$)) might be the most common kind of planets in the Universe, yet they have no analogues in our Solar System, making their interpretation and characterization more difficult. We know the radius distribution of such planets is bimodal, with a minimum around 1.8 $R_\oplus$. If planets below this value are almost surely rocky worlds, it is more complicated to determine the nature of the planets between 2 and 4 $R_\oplus$. Li Zeng and co-authors propose that this regime is dominated by water worlds.

The authors investigate two possible kinds of planets: small gas giants with a rocky core surrounded by a H_2–He atmosphere, or water worlds whose core contains a mixture of rocky material and ices. To create these two populations, Zeng et al. follow the growth of rocky cores of different masses while they accrete either H_2/He gas or H_2O ice. Then, they put these growth curves into a series of Monte Carlo simulations of a solar protoplanetary disk. As a result, they manage to not only reproduce the bimodal distribution of planetary radii and the mass–radius distribution of observed exoplanets but also identify the contribution of the two regimes as a function of radius. They find that the core of most exoplanets with radius between 2 and 4 $R_\oplus$ contains up to 50% ices, identifying them as water worlds.

Extending this model to all exoplanets, Zeng et al. identify four main statistical categories. Planets with $R < 2\ R_\oplus$ are rocky, those with $2\ R_\oplus < R < 4\ R_\oplus$ are water worlds, followed by transitional planets (ice-rich cores with thick atmospheric envelopes) up to 10 $R_\oplus$ and gas giants beyond that limit. The Solar System fits into this structure.

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