Growth Model Interpretation of Planet Size Distribution

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The radii of over 4000 exoplanet candidates have been precisely measured by the NASA *Kepler* Mission, along with their orbital periods and other parameters [1]. Their radii show a bi-modal distribution, with the main and secondary peaks likely corresponding to Earth-like rocky planets and larger intermediate-sized planets, respectively [2–4]. The masses of planets can be determined by ground-based spectroscopic observations, but only for planets orbiting the brightest stars. These observations, allow calculations of average densities and, thus, constraining their bulk compositions and internal structures. Hence, an important question about the compositions of the planets ranging from 2 to 4 Earth radii ($R_\oplus$) still remain [5,6]. They may either have a rocky core enveloped in a massive H_2-He gas (gas dwarfs) [3,7–9] or contain a significant amount of multi-component, H_2O-dominated ices/fluids (water worlds). The growth model tracks how mass and radius change when a planet population grow from rocky core and subsequently accrete either O-H-C-N-ices or H_2-He gas. The observational radius and mass-radius distribution can be reproduced by the growth model with a Monte Carlo simulation. Because their composition cannot be uniquely constrained, we use growth model and Monte Carlo simulation for these planets to argue that many intermediate-sized planets are “water worlds”.

[1] Akeson *et al*. (2013) *Publ. Astron. Soc. Pacific* **125**, 989. [2] Zeng *et al*. (2017) *LPSC* abstract **1576**. [3] Fulton *et al*. (2017) *Astron. J.* **154**, 109. [4] Zeng *et al*. (2017) *RNAAS* **1**, 32. [5] Rogers & Seager (2010) *Astrophys. J.* **712**, 974–991. [6] Adams *et al*. (2008) *Astrophys. J.* **673**, 1160–1164. [7] Buchhave *et al*. (2014) *Nature* **509**, 593–595. [8] Lehmer & Catling (2017) *Astrophys. J.* **845**, 130. [9] Owen & Wu (2017) *ApJ* **847**, 29.