
ABSTRACT ONLY

A DENSITY VALLEY ACROSS STELLAR TYPES

Julia Venturini¹, María Paula Ronco², Octavio Guilera², Jonas Haldemann³, Christoph Mordasini³
and Marcelo Miller Bertolami²

The radius valley separating super-Earths from mini-Neptunes is a fundamental benchmark for theories of planet formation and evolution. Observations show that the location of the radius valley decreases with decreasing stellar mass and with increasing orbital period. Here, we build on our previous pebble-based formation model. Combined with photoevaporation after disc dispersal, it has allowed us to unveil the radius valley as a separator between rocky and water-worlds. In this study, we expand our model for a range of stellar masses spanning from 0.1 to 1.5 $M_{\odot}$. We find that the location of the radius valley is well described by a power-law in stellar mass as $R_{\text{valley}} = 1.8197 M_{\star}^{0.14(+0.02/-0.01)}$, which is in excellent agreement with observations. Additionally, we note that the radius valley gets filled towards low stellar masses, particularly at 0.1 – 0.4 $M_{\odot}$. This is the result of orbital migration occurring at lower planet mass for less massive stars, which allows for low-mass water-worlds to reach the inner regions of the system, blurring the separation in mass (and size) between rocky and water-worlds. Furthermore, we find that for planetary equilibrium temperatures above 400 K, the water in the volatile layer exists fully in the form of steam, puffing the planet radius up (as compared to the radii of condensed-water worlds). As with Sun-like stars, we find that pebble accretion leaves its imprint on the overall exoplanet population as a depletion of planets with intermediate compositions (i.e. water mass fractions of ~ 0 –20%), carving an planet-depleted diagonal band in the mass-radius diagrams.

¹ Department of Astronomy, University of Geneva, Chemin Pegasi 51, 1290 Versoix, Switzerland.

² Instituto de Astrofísica de La Plata, CCT La Plata-CONICET-UNLP, Paseo del Bosque S/N (1900), La Plata, Argentina.

³ Department of Space Research & Planetary Sciences, University of Bern, Gesellschaftsstrasse 6, CH-3012 Bern, Switzerland.