



Contribution ID : 40

Type : **Contributed talk**

Can Super-Earths Be Born Rocky? Separating Survey Selection from Formation in the Deficit of Large Rocky Planets at Low Insolation

Wednesday, 28 October 2026 12:45 (10)

Small planets show a radius valley near $1.8 R_{\oplus}$ splitting them into rocky super-Earths and volatile sub-Neptunes, but whether rocky planets can be born rocky, or are all stripped cores of planets that lost an envelope, is still unsettled. We test two planet formation scenarios, Sub-Neptune (no planet born rocky) and Sub-Neptune+Super-Earth (some are), as priors to analyze this question. We build the scenarios by building synthetic planet populations, where we tested two independent generators (occurrence-weighted P-Pop and a flat uniform-parameter control). The two scenarios are then pushed through calibrated Kepler, TESS, and HARPS/NIRPS detection pipelines, and compared against the NASA Exoplanet Archive, filtered with precision control $\leq 25\%$ mass/ $\leq 8\%$ radius uncertainty (125 planets after the filter). The analysis in comparison with NASA include a forward Monte Carlo comparison and a Bayesian posterior-predictive test, during which we used a metric based on the detected population's rocky-to-volatile fraction. As for the result, at low insolation ($S < 50 I_{\oplus}$), the 25 NASA cold super-Earths favor Sub-Neptune under every relation and both generators ($\sqrt{x} = 2.10$ vs 6.25 in the Bayesian test). An important thing to note is that absolute completeness of detection in this cold regime is only $\sim 1\%$, driven almost entirely by the $\sim 2\%$ geometric transit probability of long orbits, rather than photometric sensitivity, so the raw scarcity of cold rocky planets alone says nothing until assessed in detected space. We also find that the result fails when the uncertainty control is relaxed from $\leq 25\%$ mass/ $\leq 8\%$ radius to $\leq 30\%$ mass/ $\leq 10\%$, and only 4 of 25 cold super-Earths are rocky at high confidence. In conclusion, we read the result as most rocky super-Earths coming from atmospheric escape rather than being born rocky. We believe that identifying more precise cold-planet masses, concentrated among K/M dwarfs, where detection efficiency stays near 50%, are needed to settle it.

Did you give a contributed talk at CASCA 2026?

No

If you are selected for a poster, would you be interested in giving a short flash talk on your work?

Yes

What is your career level?

Undergraduate

Which keyword describes the area of focus of this talk?

Exoplanets

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Session Classification : Exoplanets & Stars