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Free-floating and wide orbit planets from breaking the chains of cold Neptunes

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Multiplanet systems are expected to form in resonance chains as a consequence of disk-driven migration. We investigate the dynamical evolution of cold Neptune systems initially assembled in resonance chains that later interact with planetesimals leftover from planet formation. We find that planetesimal masses comprising only 1–2% of the total planetary mass are sufficient not only to break the resonance chains but also to trigger a global dynamical instability, producing a mixture of planetary collisions, tidal disruptions/captures, and ejections. Unlike systems with Jovian-mass planets, which have frequently been studied in the past, our simulations show that Neptunes are remarkably efficient at inducing tidal disruptions and/or captures (˜0.7 per system), a rate comparable to that of ejections. After more than a billion years in a substantial fraction of systems, configurations containing wide-orbit Neptunes (average separation ⊠ 30–50 au) are retained, largely assisted by the dynamics of the disrupted planets. Such planets may represent an important contribution to the observed population of inferred free-floating planets.

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