

The Collisional and Dynamical Evolution of the Main-Belt, NEA, and TNO Populations

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To model the evolution of the main-belt and near-Earth asteroid (NEA) populations, we have developed an advanced numerical collisional evolution simulation that includes a detailed treatment of collisional outcomes based on the Petit and Farinella (1993) algorithm, which we have substantially modified. In addition to collisional effects, our model also includes the dynamical removal of bodies from the main belt by resonances and size-dependent radiation forces such as the Yarkovsky effect. These dynamical processes continually resupply the NEA population with new asteroids. Collisions amongst main-belt objects, amongst NEAs, and between main-belt asteroids and NEAs, as well as dynamical removal processes, are treated coevally in our simulations.

Our model is able to satisfy six major observational constraints: (1) the observed main-belt size distribution and (2) the observed NEA population; (3) the lifetimes of meter-scale bodies (as inferred from the cosmic ray exposure ages of meteorites); (4) the existence of Vesta's relatively intact basaltic crust; (5) the number of large asteroid families; and (6) the size distribution of craters on asteroids that have been observed by spacecraft. In addition to satisfying these six constraints, the strength law that we find best satisfies these constraints is consistent with estimates of the strength of asteroids from analytical and numerical models and laboratory experiments, and the dynamical removal rates we use are consistent with independent estimates of the removal rates of asteroids from the main belt.

We have applied our model to the collisional evolution of trans-Neptunian objects (TNOs). A recent HST survey of TNOs that extends the size distribution down to ~ 10 km in diameter predicts too few Jupiter-family comet precursors in the TNO population (Bernstein et al. 2003). Using a plausible strength law for icy bodies (Benz and Asphaug 1999), we find that there is likely an upturn in the population below the Bernstein et al. completeness limit that can at least partially explain this discrepancy.

Benz, W. and Asphaug, E. 1999, *Icarus* **142**, pp. 5-20.

Bernstein et al. 2003, astro-ph/0308467 v.1.

Petit, J. and Farinella, P. 1993, *Celest. Mech. and Dyn. Ast.* **57**, pp. 1-28.