CATASTROPHIC DISRUPTION OF ASTEROIDS: LATEST SIMULATIONS INCLUDING POROSITY EFFECTS, EXPLICIT FORMATION OF SPINNING AGGREGATES AND THEIR IMPLICATIONS.

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Introduction: The collisional process plays a major role in all phases of Solar System formation and evolution. Asteroid families are the products of the most energetic events. In recent years, we have been able for the first time to simulate the catastrophic disruption of large asteroids and to reproduce the properties of some asteroid families (e.g. [1], [2]). These simulations not only computed the fragmentation of the asteroid due to the impact of a projectile, but also the subsequent mutual gravitational interaction of the generated fragments. However, the model of fragmentation included in our Smoothed Particle Hydrodynamics (SPH) code or hydrocode ([3]) was only adapted to brittle materials with no porosity at microscales and was then limited to the study of asteroid families of S taxonomic type, believed to be composed of such material. A large fraction of small bodies is also expected to be composed of microporous material, such as dark (C) type asteroids, Kuiper Belt objects and comets.

Effect of Porosity: A body containing microporosity (i.e. porosity on a scale much smaller than the numerical resolution) can be crushable, which will influence the collisional outcome. Various compaction models have been developed recently. We have extended our SPH impact code to include the effect of porosity at a sub-resolution scale by adapting the so-called *P-alpha* model ([4]). A first validation at laboratory scale has been performed ([5]). Our next step, which has just begun, is to investigate this process at large scale and for the first time, to simulate the formation of asteroid families of dark taxonomic classes (e.g. C-type). As a first example, we considered the Batistina family, which is one of the youngest C-type identified families and which may be at the origin of the K/T impactor ([6]). A comparion between our simulations and estimated properties of the real family will be presented. We plan to study the formation of other families, such as EL61 in the Kuiper Belt, and the catastrophic impact energy threshold (called Q^*_D) of porous bodies as a function of their diameter.

Explicit Formation of Spinning Aggregates: When a large asteroid (greater than a few hundreds of meters in diameter) is disrupted, some fragments can reaccumulate which can eventually lead to the formation of large gravitational aggregates. In previous works, all fragments were treated as spheres. We have improved our model by implementing a rigid body approximation ([7]). The shapes and spins (in addition to the masses) of the aggregates are thus recorded as particles are reaccumulating. We started simulating the formation of some families, and our preliminary results look very promising. Fragment spin distributions are consistent with those expected from a disruption, and the shape and surface properties of aggregates resembles those of some observed asteroids, such as Itokawa (see, e.g., Fig. 1). Thus our model can give some clues on the likely physical structure (surface and internal) of small bodies resulting from reaccumulation. We will use this new model in our study of family formation.

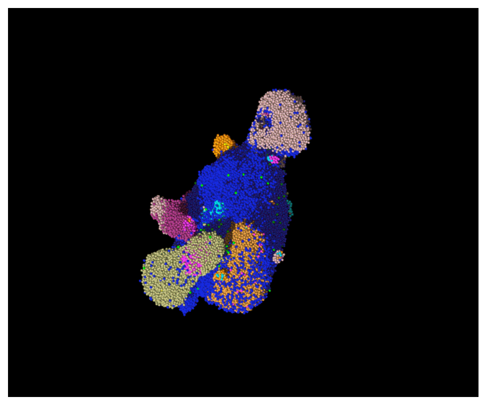

Figure 1: Largest reaccumulated remnant after the disruption of a 25 km diameter pre-fragmented basalt. The different colors correspond to different aggregates that formed before reaccumulating on a single body. Its final mass is about 50% the parent body's mass.

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