EPSC Abstracts
Vol. 10, EPSC2015-133, 2015
European Planetary Science Congress 2015

Catastrophic collisions: structure of the ejecta velocity field and reaccumulation

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1. Introduction

According to hydrodynamic simulations, the outcomes of catastrophic collisions involving asteroids are usually small fragments (below the observability threshold), which are later re-accumulated into larger bodies, leading to the formation of observable dynamical families. The re-accumulation into a large number of bodies is not a trivial outcome of any possible ejecta velocity field. If the field has a regular structure, such as those envisaged by the so-called Semi Empirical Models (SEM) a couple of decades ago [1], the re-accumulation usually involves a few bodies [2].

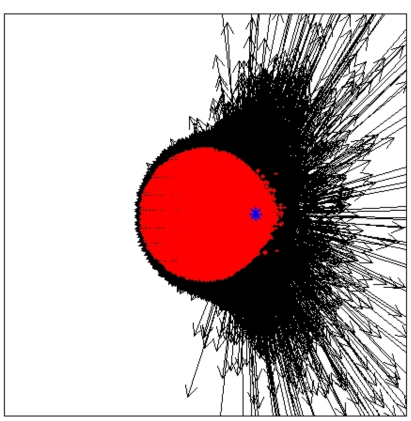

Figure 1: An example of ejection velocity field produced by hydrodynamic simulations. Red dot represents the initial positions of the particles, while black arrows their velocities. The blue star is the irradiation point.

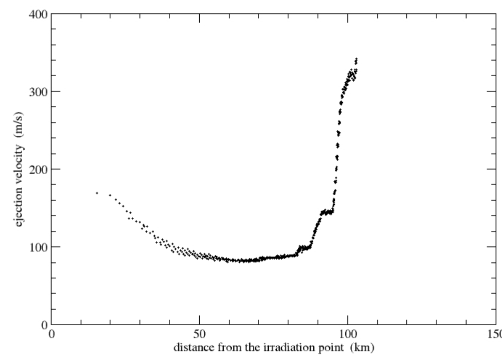

Figure 2: Module of the ejection velocity versus distance from the irradiation point for some particles of a hydrodynamic simulation. The particles are selected such that their initial positions were along a common line passing by the irradiation point.

2. Reconstruction of ejecta velocity fields

In a previous paper [3] we have analyzed the outcomes of a couple of hydrodynamic simulations to infer the kinematical properties of the ejecta velocity field. Like in SEM, hydrodynamic produce ejection velocity fields characterized by the presence of an irradiation point, that is a point (different from the center of the body) from which the trajectories of the fragments seem to emanate (Fig. 1). On the other hand, we have found that the field presents two main "irregularities":

1. a wave in the intensity of the field or, in other terms, bodies ejected along a line have a velocity which is not regularly increasing or decreasing with the distance from the irradiation point (Fig. 2);

2. a systematic misalignment of the velocities, that is the ejection velocities of fragments are not perfectly radial.

The main consequence of this structure is the possibility of early collisions between fragments, involving a significant fraction of them. As opposite, in the typical ejection velocity field modeled by the SEM, the collisions can occur only at a later stage, due to mutual gravity.

3. Preliminary computations

As a natural continuation of the analysis we have created a few new synthetic fields, in such a way to mimic the overall properties of those obtained from the hydrocodes, and we have simulated the evolution of the fragments using the software `pkdgrav` [4], to verify the later reaccumulation properties and to obtain a final mass function, to be compared to those obtained from hydrocodes and to real asteroid families. Preliminary results will be presented.

References

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