The Giant Impact and Satellite Accretion of Rubble Pile Bodies

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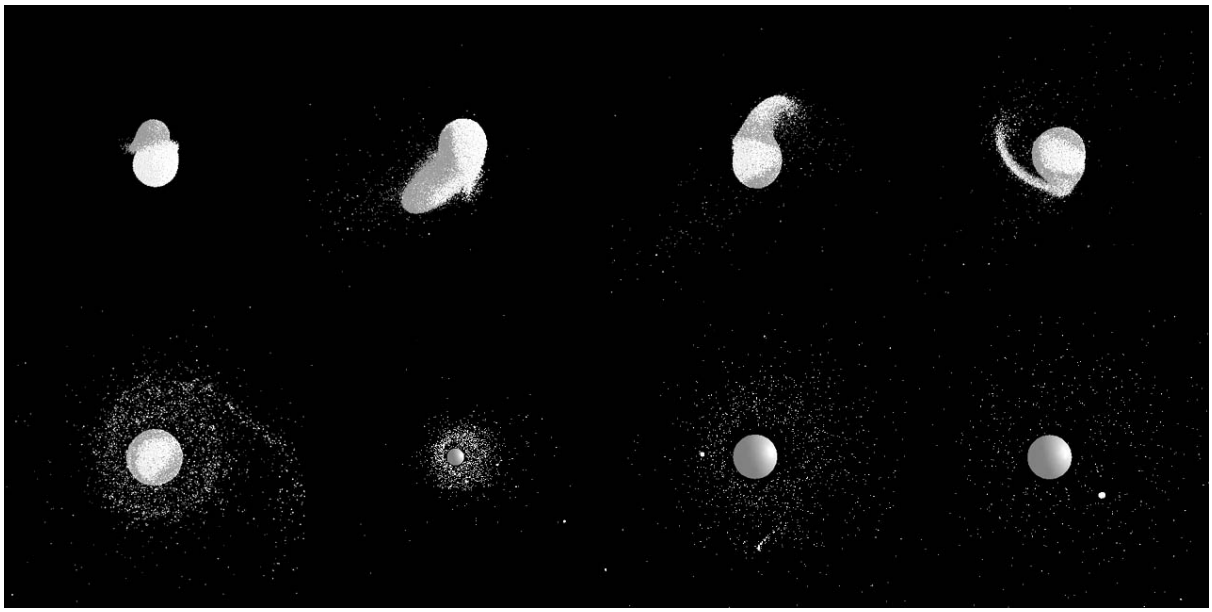
It is considered that satellite systems with small satellite/planet mass ratio, such as Moon/Earth and Charon/Pluto systems, are generated by a giant impact event. SPH simulations had shown that an impact with normalised angular momentum similar to that of the present Earth/Moon system can generate a massive disk.

Pluto/Charon system has smaller satellite/planet mass ratio ($\sim$ 1:10) and larger normalised angular momentum than the Moon/Earth system. Our main interest is in whether a more heavier debris disk is formed from an impact with large amount of angular momentum. We have simulated impacts of two objects by rubble pile N-body simulations. Normal elastic force proportional to the deformation length is adopted as a contact interaction between particles.

We performed simulations of impacts with target-impactor mass ratio 7:3. Parameters are relative velocity at infinite distance v_∞, and distance of closest approach of the initial parabolic or hyperbolic orbit. In our largest N simulation, each body is represented by 65536 particles. Upper panels of the figure show the time-sequence of a typical disk-making impact. The disk with mass up to 3% of the total mass is formed in our simulations. In some simulations, we replace the most massive aggregate to a single large massive particle, and continue the simulation to the phase of satellite accretion from the remaining disk (lower panels). After about 100 orbital period, a single aggregate is formed just outside the Roche limit (the lower rightmost panel).



In high velocity cases ($v_\infty \sim 2v_{\rm esc}$), the most of the impactor escaped from the system, and number of particles which remain in bounded orbits is not large. In the cases with low $v_\infty \sim 0$ and large distance of closest approach, the impactor just grazes the target, and a process like disrupting capture occurs instead of the disk formation. In this case, a binary with mass ratio nearly 1:10 can be formed in our simulation.