The Origin of Asteroid Geometries: Dependence on Conditions of Planetesimal Collisions

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Recent observations by space probes or light curves clarify that most of asteroids in present solar system have irregular shapes distinctly different from a sphere, such as asteroid Itokawa. These irregular shapes are supposed to be created by collisional destruction and coalescence of planetesimals. We expect that we can clarify the past environment of the solar system if we clarify the relationship between impact condition, such as impact angle or velocity, and resultant irregular shape of planetesimal, and compare with the asteroid shapes in present solar system.
For relatively small objects like planetesimals, effect of material strength or friction is also important other than effect of the self-gravity. To investigate the resultant shape of planetesimals made by collisional destruction and re-accumulation, we developed numerical simulation code of Smoothed Particle Elastic Dynamics (Sugiura and Inutsuka 2016, 2017). Moreover, we included fracture model (Benz and Asphaug 1995) and friction model (Jutzi 2015) to describe realistic property of rocks. Owing to friction model, we can represent the irregular shape of rubble pile formed by re-accumulation of fragments. Our simulation code also calculates the self-gravity, and thus we can treat collisional destruction and subsequent gravitational re-accumulation consistently.We simulate the collision between rocky planetesimals with the radius of about 50 km while varying the impact velocity, impact angle and mass ratio, and we measure the axis ratios of fragments with sufficiently high resolution. In this talk, we will discuss the relationship between resultant shape of planetesimals and impact condition, and mechanism to produce irregular shapes.

Keywords: asteroid geometry, planetesimal collision, SPH, elastic dynamics

