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GRAINS: A NEW NUMERICAL METHOD FOR THE STUDY OF GRAVITATIONAL AGGREGATES

Fabio Ferrari, fabio1.ferrari@polimi.it
Politecnico di Milano, 20156, Italy
Michèle Roberta Lavagna, michelle.lavagna@polimi.it
Politecnico di Milano, Milano, Italy

The study of small bodies addresses a number of questions relevant for space engineers, planetary scientists and physicists. Near Earth Asteroids (NEA) are a great opportunity for technological and human exploration missions. NEAs can also represent a threat for the planet. The scientific and technological exploitation and the implementation of mitigation actions for hazardous asteroids rely upon our knowledge of their properties. Remote surveys play a fundamental role to estimate asteroid properties, but they can provide very limited information about their internal structure. GRAINS addresses such problem through N-body numerical simulations of gravitational aggregation. This method is suitable to estimate the internal properties of rubble-pile asteroids: gravitational aggregates with very low tensile strength and high level of porosity. The study of aggregation phenomena currently relies on codes optimized for a large number of mutually interacting particles, regardless of their individual shape and rigid body motion. Although not relevant for many applications, this limitation could be relevant for the case of asteroids, as suggested by results of granular dynamics in terrestrial engineering applications. The latter are commonly studied using multi-body codes, able to simulate contact interactions between a large number of complex-shaped bodies, but not suitable for gravitational dynamics. GRAINS is able to joint the advantages of both classes of codes into a single implementation, to reproduce N-body gravitational dynamics between a large number of complex-shaped rigid bodies. In this work, aggregation simulations are presented: favorable conditions leading to the formation of an asteroid are investigated, when starting from a cloud of boulders. The analysis is performed under many degrees of freedom, to include different geometries, physical and dynamical properties of the boulders and final aggregate. The problem to be investigated is twofold: (a) the study of gravitational aggregation dynamics, and (b) the study of the physical and dynamical properties of the final aggregate. The first aspect includes the analysis and numerical simulation of typical scenarios, for small and medium sized (hundreds of meters) asteroid aggregation, to identify the conditions that lead to the formation of a single or multiple aggregate, or to the dispersion of the particle cloud. The second aspect analyzes the properties of the final aggregate, as a result of the dynamical simulation, which are then studied and classified depending on the initial parameters and simulation scenario. Preliminary results show good agreement between theory and observation, and confirm the capability of the numerical code to predict natural aggregation phenomena.