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MATERIAL STUDIES OF ASTEROID REGOLITH AND ACCRETION USING A LOW-COST CUBESAT LABORATORY

Abstract

The origin of asteroids remains a mystery. Did the most primitive bodies accrete directly from fine particles in the early solar system? To what extent were turbulent and electrical effects involved in their coagulation, or was the mechanism primarily gravitational? What is the equilibrium balance between accretion, and rotational and collisional disruption? The study of fine particles in close to zero gravity is a problem of cosmogonic scope, vital to the science of planet and star formation. But laboratory studies of dust coagulation and microgravity regolith behavior are limited to tens of seconds on parabolic flights, much shorter than the onset of gravitational effects, and requiring a centrifuge to obtain asteroid-like gravity. We are developing a low cost mode of experimental study to access this problem, the Asteroid Origins Satellite (AOSAT). The central chamber of AOSAT will house the spacecraft electronics and attitude-control systems. The experimental chambers will be equipped using off-the-shelf components to measure fundamental regolith and coagulation properties, including stereo cameras, accelerometers, gyros, force sensors and acoustic velocity sensors. AOSAT will carry fine fragments of native asteroid material (i.e. pulverized meteorite) into orbit, building two 'patches of asteroid' that will survive for months or years inside of each experimental chamber onboard the spun-up 3U CubeSat. By mimicking the native environments in sufficient detail, AOSAT will be a laboratory for direct research into asteroid and primary accretion, enabling scaling studies of fundamental processes in their microgravity environments (0 to 10-4 g). Scaled experiments will validate engineering approaches for next-generation asteroid landers and robotics systems. We will present computational simulations of AOSAT in various spin states, using the Astrophysical Rubble piles Simulation Software (ARSS) to conduct regolith modeling simulations as a point design.