**ASTEROID ORIGINS SATELLITE (AOSAT): SCIENCE IN A CUBESAT CENTRIFUGE.** V. Perera[1], D. Cotto-Figueroa[1], J. Noviello[1], E. Asphaug[1], and M. Morris[2]. [1]Arizona State University (School of Earth and Space Exploration, PO Box 876004, Tempe, AZ 85287-6004. viranga@asu.edu), [2]State University of New York at Cortland (Physics Department, PO Box 2000, Cortland, NY 13045-0900).

**Introduction:** It is vital to study asteroids for two reasons. First, since asteroids are remnant bodies from the early solar system, by understanding their origin we can characterize the early planet formation epoch. This important first step called primary accretion [1], where dust in the protoplanetary disk coagulated into planetesimals (~1 km sized objects), is not well understood due to the difficulty of having a representative long-duration (~days to months) zero-gravity laboratory. Earth-based laboratories are only able to conduct zero-gravity experiments lasting for about ten seconds [2]. Second, regolith on the surface of asteroids have a unique behavior due to the low-gravity environment [3] and thus understanding this behavior is a necessary first step for future sample return or mining missions. Therefore, we propose a CubeSat mission called the Asteroid Origins Satellite (AOSAT) as a low-cost laboratory to study primary accretion and asteroid surface properties. In addition, AOSAT will serve as a precursor to future missions and help test techniques for the exploration of asteroids.

**CubeSat Layout:** AOSAT will be a 3U CubeSat with the dimensions of 10 cm x 10 cm x 34 cm and with a mass of less than 4 kg (see Figure 1).

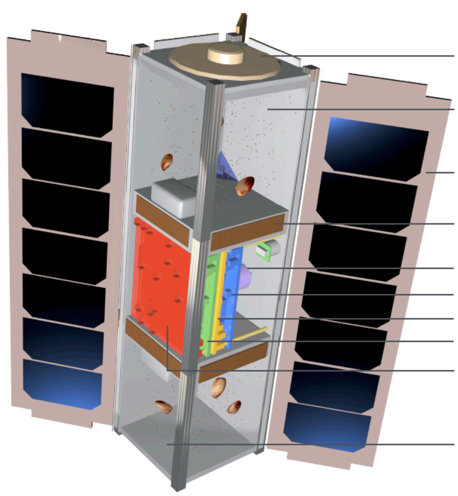


**Figure 1:** CAD model cutout of AOSAT with notable components identified.

The central chamber will house the spacecraft electronics (e.g. main computer, attitude control system, communications system, etc.) while the two outer chambers will contain ground up meteorite regolith and a number of cameras to capture high-resolution images and video of the regolith. Having two chambers will allow us to have regolith of different grain sizes in each chamber such that one of the chambers could be specialized to study the primary accretion process and the other one to study the asteroid-like regolith behavior. The attitude control system will be able to keep the CubeSat stable with minimal oscillations as well as be able to stably spin the CubeSat along its maximum moment of inertia axis.

**Flight Experiments:** In a stable zero-spin spacecraft state, regolith inside the CubeSat will be free to interact in a manner similar to that of the early solar system. AOSAT will pioneer realistic primary accretion experiments due to the long-duration zero-gravity environment and the use of material similar to that of the early solar system and present day asteroids (i.e. ordinary chondrite meteorite material). Since AOSAT will be able to stably spin about its axis of maximum moment of inertia, it will be able to create a patch of regolith that will be representative of regolith on an asteroid surface. In the spinning state, artificial gravity will push the regolith inside the end chambers outwards and once it is against the end wall, it will behave similar to regolith on an asteroid (e.g. a spin rate of one revolution per minute will create artificial gravity of $10^{-4}$ g which is the average surface acceleration due to gravity of a 1 km size asteroid). Since it is important to understand the angle of repose in low gravity environments [3], we will be able to measure the angle for varying g-levels. Also, we will use a mechanism to induce a “seismic shock” to stimulate regolith motion to test the concept of photoseismology [4]. We will then quantify the differences in the surface morphology before and after the shock using methods that have been refined in previous asteroid studies [5, 6]. The high-resolution images and video will significantly contribute to the understanding of both primary accretion and the regolith behavior on asteroids.

**References:** [1] Chiang, E. and Youdin, A. N. (2010) *Annu. Rev. Earth Planet. Sci., 38,* 493–522. [2] Blum, J. (2010) *Microgravity Sci. Technol., 22,* 517-527. [3] Kleinhans, M. G. et al. (2011) *JGR, 116,* 1-13. [4] Noviello, J. and Asphaug, E. (2014), *AIDA Int. Conf.*, 37-38. [5] Mazrouei et al. (2014), *Icarus, 229,* 181-189. [6] Noviello et al. (2014), *LPS XLV,* Abstract #1587.