Microgravity Testing and Deployment of a Pico-Scale Satellite Dust Detector

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Summary

We report on the progress of our current project to place a dust detector on a pico-scale satellite (0.1 - 1 kg) in Earth orbit. We are building a 10 cm^2 dust detector that will mount to the face of a 1-U cubesat or can be mounted adjacent on the long side of a 3-U unit for continuous measurements of the dust environment around the Earth. For launch into orbit a formation of cubesats may be a secondary payload on any rockets that are delivering the primary payloads into Earth orbit. This requires coordination with primary payload objectives in order to place a formation of pico-scale satellites into the desired orbital configuration.

Introduction

Dust and micrometeorites are important in the study of planetary science. For example, the exosphere of the Moon is sustained in part by micrometeorite impact followed by ejection of atoms from the surface [1]. Mercury is subject to the same process, and although much further away from the Earth-Moon system, models for the micrometeorite impacts at Mercury are based on extrapolations from measurements of this population at Earth [2,3]. Another example is that dust and micrometeoroids in the inner solar system consist of contributions from asteroid collisions, comets, and interstellar material [4]. Constraining the abundance of dust and micrometeoroids at Earth's orbit helps to constrain models of these populations and provides insight into inner solar system dynamical processes. An additional benefit to flying dust detectors is to help mitigate micrometeoroid hazards to other satellites by guiding proper design criteria to deal with impacts.

Experiment

The dust detector consists of a polyvinylidene fluoride (PVDF) film that produces charges when impacted, which are then amplified and recorded. Construction and initial calibration of the dust detector are being done in the Center for Microgravity Research at the University of Central Florida. The attitude control system operates by circulating current through magnetic torque coils mounted on the sides of the satellite (Figure 1) in order to interact with the Earth's magnetic field. We plan to use parabolic airplane flights and suborbital rockets to test the associated attitude control system of the pico-scale satellite. We need to test this system on parabolic airplane flights in order to characterize the angular velocity and control strategies in a simulated zero or near zero gravity environment. We are presently considering an autonomous experimental configuration that may be tested in the payload compartment of a suborbital rocket.

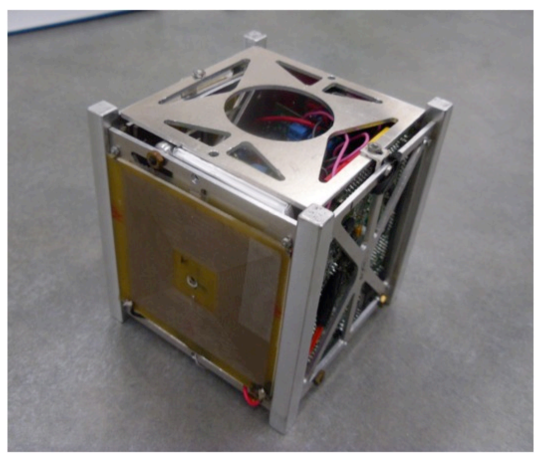

Figure 1: Cubesat showing a magnetic torque coil.

[1] Berezhnoy A. A. 2007. Meteorite Bombardment as a Source of Lunar Atmosphere. LPSC XXXVIII, 1047.
[2] Cintala, M. J. 1992, J. Geophys. Res., 97.
[3] Borin, P., G. Cremonese, F. Marzari, M. Bruno, and S. Marchi, 2009. Statistical analysis of micrometeoroids flux on Mercury. Astronomy and Astrophysics, 503, 259-264.
[4] Divine, N., 1993. Five populations of interplanetary meteoroids. Journal of Geophysical Research, 98, Issue E9, 17029-17048.