Paper ID: 44037
oral

25th IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Small Spacecraft for Deep-Space Exploration (8)

Author: Dr. Kieran Carroll
Gedex Inc., Canada, kieran.carroll@gedex.com

Dr. Robert E. Zee
University of Toronto, Canada, rzee@utias-sfl.net
Mr. Henry Spencer
Space Flight Laboratory, University of Toronto, Canada, hspencer@utias-sfl.net
Dr. Martin Connors
Canada, martinc@athabascau.ca

GEOPHYSICAL RECONNAISSANCE ASTEROID SURFACE PROBE

Abstract

Here we describe a small (12U cubesat) sized spacecraft designed to make geophysical measurements on the surface of an asteroid, and the science objectives which can be addressed using those measurements. Gedex and Space Flight Laboratory (SFL) are developing the "Geophysical Reconnaissance Asteroid Surface Probe" (GRASP) spacecraft to be a low-cost means for conducting fundamental asteroid science, as well as for exploring for possible natural resource deposits in asteroids. To that end, GRASP's design is based on the "Microspace" approach that SFL has used on many successful, very low-cost and high-capability nanosats and microsats in low Earth orbit (LEO). In particular, by following this design approach, GRASP is by design robust against operational failures seen in some previous small deep-space missions.

Previous and current asteroid exploration missions have carried primarily instruments (such as cameras and imaging spectrometers) which measure the surface properties of the asteroid target. In geosciences terms, these can be categorized as determining *geomorphology* and *surface geochemistry*. These have told us a great deal about the bodies that have been visited, but leave important questions unanswered regarding the composition and structure of the interiors of asteroids and comets. Answering these would shed further light on the evolution of the Solar system, and help with future asteroid resource-prospecting endeavours.

Geophysics is the branch of geoscience that employs instruments that are sensitive to subsurface properties, and analyzes data from them to infer subsurface composition and structure. GRASP employs two geophysical techniques, surface gravimetry and magnetometry. The former makes use of the "Vector Gravimeter/Accelerometer" (VEGA) instrument to make measurements of the gravity vector on the asteroid's surface. The latter employs magnetometers mounted at the ends of the legs that hold GRASP's body off the asteroid surface, in close proximity to any magnetized rocks on the asteroid's surface. GRASP is equipped with a rocket-based propulsion system allowing it to rove by hopping, capable of visiting 100 stations spread about the surface of an asteroid 1 km or smaller in size; gravity measurements from these stations can be inverted to estimate the asteroid's internal density distribution. GRASP would be carried to its target asteroid as a secondary payload aboard a larger asteroid-rendezvousing mission, which would release GRASP to land on the asteroid's surface, after which it would provide communications relay between Earth and GRASP, eliminating the need for GRASP to carry a high-delta-V propulsion capability or a long-range communications capability.