EPSC Abstracts
Vol. 10, EPSC2015-698, 2015
European Planetary Science Congress 2015

CubeSats to study the Didymos asteroid system

J.-E. Wahlund (1), E. Vinterhav (2), J. M. Trigo-Rodriguez (3), M. Hallmann (4), S. Barabash (5), N. Ivchenko (6)
(1) Swedish Institute of Space Physics (IRF), Uppsala, Sweden; (2) ÅAC Microtec AB, Uppsala, Sweden; (3) Institute of Space Sciences (CSIC-IEEC), Barcelona, Spain; (4) DRL, Cologne, Germany; (5) Swedish Institute of Space Physics (IRF), Kiruna, Sweden; (6) Royal Institute of Technology (KTH), Stockholm, Sweden. (jwe@irfu.se / Fax: +46-18-470 5905)

Abstract

Among the growing interest about asteroid impact hazard mitigation in our community the Asteroid Impact & Deflection Assessment (AIDA) mission will be the first space experiment to use a kinetic impactor to demonstrate its capability as reliable deflection system [1]. As a part of the AIDA mission, we have proposed a set of two three-axis stabilized 3U CubeSats (with up to 5 science sensors) to simultaneously rendezvous at close range (<500m) with both the primary and the secondary component of the Didymos asteroid system. The CubeSats will be hosted on the ESA component of the AIDA mission, the monitoring satellite AIM (Asteroid Impact Mission). The CubeSats will characterise the magnetization, the main bulk chemical composition and presence of volatiles as well as do super-resolution surface imaging of the Didymos components. The CubeSats will also support the plume characterisation resulting from the DART impact (Double Asteroid Redirection Test, a NASA component of the AIDA mission) at much closer range than the AIM main spacecraft, and provide imaging, composition, and temperature of the plume material. At end of the mission, the two CubeSats can optionally land on one of the asteroids for continued science operation. The science sensors consist of a dual fluxgate magnetometer (MAG), one miniaturized volatile composition analyser (VCA), a narrow angle camera (NAC) and a Video Emission Spectrometer (VES) with a diffraction grating for allowing a sequential chemical study of the emission spectra associated with the impact flare and the expanding plume. Consequently, the different envisioned instruments onboard the CubeSats can provide significant insight into the complex response of asteroid materials during impacts that has been theoretically studied using different techniques [2].

The two CubeSats will remain stowed in CubeSat dispensers aboard the main AIM spacecraft. They will be deployed and commissioned before the AIM impactor reaches the secondary and record the impact event from a closer vantage point than the main spacecraft. The two CubeSats are equipped with relative navigation systems capable of estimating the spacecraft position relative to the asteroids and propulsion system that allow them to operate close to the asteroid bodies. The two CubeSats will rely on mapping data relayed via the AIM main spacecraft but operate autonomously and individually based on schedules and navigation maps uploaded from ground.

AIDA's target is the binary Apollo asteroid *65803 Didymos* that is also catalogued as Potentially Hazardous Asteroid (PHA) because it experiences close approaches to Earth. Didymos' primary has a diameter of ~800 meters and the secondary is ~150 m across. Both bodies are separated about 1.1 km [3]. The rotation period and asymmetry of the secondary object is unknown, and it might be tidally locked to the larger primary body. At least the primary body is expected to be associated with ordinary chondrite material, consisting mostly of silicates, and metal, but the earlier made Xk classification suggested a rubble-pile type with large amount of volatile content. The secondary companion spectral class is unknown, but the total mass of the system suggests that the secondary companion could be of similar class.

Detailed empirical information on the physical properties of the Didymos asteroid system, in particular the magnetic field, the (mineralogical) surface composition, the internal composition via the bulk density, the ages of surface units through crater counts and other morphological surface features is valuable in order to make progress in the asteroid field of science. Furthermore, the periodic effect of such a close dynamic system in the presence and temporal displacement of the surface regolith is unknown, and could be followed using close-up video systems provided by the CubeSats.

In conclusion, the proposed two CubeSats as part of the AIDA mission can therefore contribute significantly, since they can monitor the Didymos asteroid components at a very close range around hundred meters, and at the same time monitor in-situ an impact plume when it is created.

References

[1] Michel, P., Cheng, A., Carnelli, I., A. Rivkin, C., Galvez, A., Ulamec, S., and Reed, C. (2015), Conference on Spacecraft Reconnaissance of Asteroid and Comet Interiors, held 8-10 January, 2015 in Tempe, Arizona. LPI Contribution No. 1829.

[2] Jutzi M., Holsapple, K., Wünneman, K., and Michel, P. (2015) Modeling asteroid collisions and impact processes, In Asteroids IV, Arizona Univ. Press, arXiv:1502.01844v1.

[3] Benner, Lance A. M., Margot, J., Nolan, M. C., Giorgini, J. D., Brozovic, M., Scheeres, D. J., Magri, C., Ostro, S. J. (2010) American Astronomical Society, DPS meeting #42, Bull. American Astron. Soc., Vol. 42, p.1056.