Exploration of Near Earth Asteroids (06)
Precursor Missions to NEAs (2)

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PAYLOAD USE AND CLOSE PROXIMITY OPERATIONS AT NEAR EARTH ASTEROIDS

Abstract

Small bodies are considered one of the most primitive remnants of our solar system formation; understanding their formation and evolution provides direct insights into the evolution of our solar system. To date, there have only been a few missions to these small bodies, but revealing a wealth of new science. In light of recent announcements, small bodies have now spurred new interest for future human exploration, providing a way to establish and validate capabilities of operating beyond low Earth orbit. Addressing NASA's objective to rendezvous humans with a NEA in the 2025 time frame, the NEA User Team (NUT) concluded that, first, a chosen NEA must be visited with close proximity operating spacecraft (S/C) in order to ensure "human visitation certification" (e.g., slow spin rate, debris hazards, surface properties).

In answering this request, several technical challenges have been identified. These include low-cost solutions (see abstract submitted to "Robotic precursors" topic), but also NEA location and navigation, and rendezvous and proximity operations sufficiently accurate to identify target areas and deployment of surface probes. Given the communication time delays in deep space operations and the unknown and potentially changing target properties (e.g., changing solar illumination and dust migration), the spacecraft shall be well-suited to account for unknown unknowns and qualify a potential target for future human exploration.

To characterize asteroids near-space and surface environment, a number of observations are required: the presence of volatiles and metals, the asteroid morphology, the internal structural properties, the surface and near-surface environments, the existence of hazards, and the time-evolution dynamics. Remote sensing and surface experiments are discussed, with case examples highlighting the instrumentation required and desired for minimum and enhanced measurements. In addition, the associated proximity operations involved allowing sufficient surface characterization and surface probe deployment are described.

Mission science, engineering, and operations vary depending on the nature of the target, and the overall mission design and goals. The interest in higher resolution, surface, and sub-surface science also brings challenging requirements. This paper discusses examples of payload use and proximity operations at various small bodies, highlighting similarities and differences between science and exploration mission objectives.