IAF SPACE EXPLORATION SYMPOSIUM (A3)
Small Bodies Missions and Technologies (Part 2) (4B)

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SMALL SPACECRAFT BASED MULTIPLE NEAR-EARTH ASTEROID RENDEZVOUS AND LANDING WITH NEAR-TERM SOLAR SAILS AND 'NOW-TERM' TECHNOLOGIES

Abstract

Physical interaction with small solar system bodies (SSSB) is the next step in planetary science, in-situ resource utilization (ISRU), and planetary defense (PD). It requires good understanding of their properties, including composition, surface structures, thermal response, and interior structure. Currently, our understanding may be simplified as "If you've seen one asteroid, you've seen one asteroid": A settled scheme of SSSB classification still has to be evolved. It would enable generic mission features, particularly for ISRU and science. Without, any target requires dedicated precursor missions for the design of the mission to interact with it. To open up strategic approaches, much broader in-depth characterization surveys of SSSB populations would be highly desirable. The DLR-ESTEC Gossamer Roadmap undertook 3 parallel Science Working Group studies. Multiple Near-Earth asteroid (NEA) Rendezvous (MNR) was identified as one of the space science missions uniquely feasible with solar sail propulsion. The Solar Polar Orbiter (SPO) study showed the ability to access any inclination and a wide range of heliocentric distances, and to drop a payload in its final orbit. The Displaced-L1 (DL1) study's spaceweather early warning sailcraft operates close to Earth, where all objects of interest to PD must pass and low delta-v objects for ISRU reside. Other studies outline the unique capability of solar sails to provide access to all SSSB, at least out to Jupiter's orbit. Significant progress has been made to explore the performance

envelope of near-term solar sails for MNR. However, it is difficult for sailcraft to interact physically with a SSSB. We expand and extend the philosophy of the recently qualified DLR Gossamer solar sail deployment technology using multiple sub-spacecraft for deployment. In the same manner, landers are added for one-way in-situ investigations and sample-return missions by synergetic sail-lander integration and operation. An ideal counterpart for this purpose is the MASCOT nano-lander design concept. MASCOT integrates at the instrument level to its mothership and is compatible with small interplanetary missions. Its unique mobility hopping mechanism was already adapted to the specific needs of the long-lived AIM/MASCOT2 mission which was envisaged as ESA's part of the NASA-ESA AIDA mission to binary NEA Didymos. The methods enabing the realization of MASCOT such as Concurrent Engineering, Constraints-Driven Engineering and Concurrent Assembly Integration and Verification enable responsive missions based on now available as well as near-term technologies. Designing the combined spacecraft for piggy-back launch accommodation enables low-cost massively parallel access to the NEA population.