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ARGO: A PLANETARY DEFENSE MISSION TO TEST GRAVITY TRACTION TECHNIQUES

Abstract

Asteroid Redirection with Gravity tractoring and Observation (ARGO) is a preliminary mission design in the framework of the planetary protection topics; the 162000 (1990 OS) binary Near-Earth Asteroid system is selected as well suited training environment to assess the gravity tractor (GT) technique effectiveness for potential Earth impact hazard mitigation, here applied on the system secondary. As a secondary goal, the mission would also scientifically characterize the system.

The transfer to 162000 follows a low thrust trajectory performed with a flight proven ion propulsion technology. Power requirements of the propulsion system and EPS limits drove the transfer trajectory design. During close-proximity operations, several observation phases are envisioned to safely and robustly characterize both primary body and moonlet of 162000 and to allow safe GT operations. The characterization aims to map gravitational harmonics, shape, and orbital characteristics of the binary system along with spectroscopic, thermal inertia and volatile studies. The similar orders of magnitude of the gravity field of 162000 and SRP perturbation become, along with the EPS, the primary challenges in mission design during this phase. Intrinsically stable orbits are chosen to limit the use of propellant for active control.

Separate communication phases are envisioned, allowing the downlink of science data between each major phase for ground processing. The ARGO mission relies on a secondary Cubesat for further observation and navigation during the GT phase, which also acts as a relay to allow unobstructed communication with ground stations. After the characterization phase, a robust combined rendezvous/station-keeping GNC system is designed to perform the towing phase using electric thrusters. It also accounts for orbital perturbations and uncertainties, and coping with ADCS for the multiple pointing requirements involved during GT operations. A high-speed impact with the moonlet is proposed as the End-of-Life strategy for ARGO, allowing a preliminary insight and comparison with the kinetic impactor technology.

According to simulations, ARGO can operate a 15 % change in semi-major axis of the moonlet's orbit over a three-year span, thereby demonstrating the GT technology within a reasonable time frame. Additionally, thanks to the system partial scalability makes the gravity traction be enumerated among one of the possible alternatives for effective planetary defense actions against non characterized hazardous objects. This paper details the mission design with subsystem specifications and key technologies used in ARGO, providing an insight into its feasibility and current limitations.