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COST-EFFECTIVE ICY BODIES EXPLORATION USING SMALL SATELLITE MISSIONS

Abstract

It has long been know that Saturns moon Enceladus is expelling water-rich plumes into space, providing passing spacecraft with a window into what is hidden underneath its frozen crust. Recent discoveries indicate that similar events could also occur on other bodies in the solar system, such as Jupiters moon Europa and the dwarf planet Ceres in the asteroid belt. These plumes provide a possible giant leap forward in the search for organics and assessing habitability beyond Earth, stepping stones toward the long-term goal of finding extraterrestrial life. The United States Congress recently requested mission designs to Europa, to fit within a cost cap of one billion dollars, much less than previous mission designs estimates. Here, innovative cost-effective small spacecraft designs for the deep-space exploration of these icy worlds, using new and emerging enabling technologies, and how to explore the outer solar system on a budget below the cost horizon of a flagship mission, are investigated. Science requirements, instruments selection, rendezvous trajectories, and spacecraft designs are some topics detailed. The mission concepts revolve around a comparably small-sized and low-cost Plume Chaser spacecraft, instrumented to characterize the vapor constituents encountered on its trajectory. In the event that a plume is not encountered, an ejecta plume can be artificially created by a companion spacecraft, the Plume Maker, on the target body at a location that time with the passage of the Plume Chaser spacecraft. Especially in the case of Ceres, such a mission could be a great complimentary mission to Dawn, as well as a possible future Europa Clipper mission.The comparably small volume of the spacecraft enables a launch to GTO as a secondary payload, providing multiple launch opportunities per year. Plume Makers design is near identical to the Plume Chaser, and fits within the constraints for a secondary payload launch.The cost-effectiveness of small spacecraft missions enables the exploration of multiple solar system bodies in reasonable timeframes despite budgetary constraints, with only minor adaptations. The work presented here is a summary of concepts targeting icy bodies, such as Europa and Ceres, which have been developed over the last year at NASA Ames Research Centers Mission Design Division. The platforms detailed in this work are also applicable to the cost-effective exploration of many other small icy bodies in the solar system.