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From Earth Missions to Deep Space Exploration (05)
Exploration Capabilities (1)

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DESIGN STUDIES OF PLANETARY SPACECRAFT USING SOLAR ELECTRIC PROPULSION

Abstract

Use of solar electric propulsion (SEP) can result in mass and propellant savings for future NASA missions to explore the solar system, enabling lightweight probes to targets in the solar system that have previously been out of reach. However, such electric-propulsion missions require large amounts of power, and require extremely lightweight solar arrays. Advanced solar arrays are required as the power source to provide the electrical energy for such future missions to the planets. The NASA Glenn COMPASS team was used to do conceptual designs for several advanced missions, in order to develop a top-level understanding of the difficulties and the technologies needed, and the interaction of the power system with the propulsion system requirements, for both missions both close to, and far from, the sun. Some near term and farther term missions analyzed include an exploration mission to a binary asteroid, a mission to land on and return a sample from the large main-belt asteroid Ceres, a mission to land a surface probe on Mercury, and a mission to orbit the outer planet Uranus. Several different options for power systems and array technology were analyzed. The choice of power technology includes the option of direct drive versus use of a power processing unit, as well as the choice of the array voltage. The array technology used depends on whether the trajectory considered uses direct injection to Earth escape, or if the SEP system is used to spiral out from the Earth to reach escape. Propulsion system options include use of ion engines (e.g., the NEXT ion engine being developed by NASA), Hall or "Stationary Plasma Thruster" (SPT) system, and other advanced propulsion systems. Choice of the propulsion system involves a trade-off between specific impulse and power requirements. The use of advanced electric propulsion is seen to have significant advantages for exploration missions, reducing the launch mass of missions to targets in the inner solar system, and also making possible exploration missions to high delta-V destinations that are beyond the capability of chemical propulsion technology. Such SEP missions will also serve as precursor missions to demonstrate the technology for future use of solar- or nuclear-electric propulsion for human missions to asteroids and beyond.