From Earth Missions to Deep Space Exploration (05)
Cis-Lunar Outposts and other Exploration Missions (5)

Author: Mr. Tim McElrath
Caltech/JPL, United States

Dr. Roby Wilson
Jet Propulsion Laboratory - California Institute of Technology, United States
Dr. Gregory Lantoine
Jet Propulsion Laboratory, United States
Dr. Damon Landau
Jet Propulsion Laboratory - California Institute of Technology, United States
Dr. Daniel Grebow
Jet Propulsion Laboratory - California Institute of Technology, United States
Mr. Nathan Strange
Jet Propulsion Laboratory - California Institute of Technology, United States
Dr. Jon Sims
Jet Propulsion Laboratory - California Institute of Technology, United States

USING GRAVITY ASSISTS IN THE EARTH-MOON SYSTEM AS A GATEWAY TO THE SOLAR SYSTEM

Abstract

For spacecraft in the Earth-Moon system, the use of multiple gravity assists of the Earth and Moon to increase the hyperbolic escape energy (or equivalently to increase the delivered mass for a given escape energy) shows great potential to facilitate further exploration of the solar system in the coming decades. This technique has been demonstrated in the past using conventional (high thrust) propulsion, for example with NASA's ISEE-3/ICE and JAXA's Nozomi missions. Refining this technique and coupling it with a low-thrust spacecraft architecture can significantly enhance the types of mission concepts that can be envisioned. We will present a survey of the types of missions that are made possible using this combination of lunar and Earth gravity assists and low-thrust propulsion (such as that provided by Solar Electric Propulsion – SEP) as well as examples with conventional high thrust chemical propulsion. This has implications for both robotic missions, as well as for the human exploration initiatives being put forth by various space agencies around the world.

The goal is ultimately to increase the amount of mass and thus payload that may be delivered to a particular target body, whether planetary or primitive. The limitation is of course, time of flight. The increase in time of flight due to operations in the Earth-Moon system may preclude direct use by human-crewed spacecraft. However, robotic precursors could use this technique to scout possible targets or landing sites, or pre-deliver materiel for later use by human explorers. We will present mission concepts using this technique to enable precursor missions to multiple Near-Earth Objects (NEOs). Additional work will be presented that has been done recently using chemical propulsion to send large-mass spacecraft to Mars, and beyond. It is also possible to utilize this technique for secondary payloads (whether chemical or SEP) co-manifested with other missions. The use of this technique may prove to be enabling in many ways given the increasing complexity of missions, while at the same time helping to keep the cost of solar system exploration affordable.