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USING LUNAR SWINGBYS AND LIBRATION-POINT ORBITS TO EXTEND HUMAN EXPLORATION TO INTERPLANETARY DESTINATIONS

Abstract

For a viable program of exploration beyond the Moon, we believe that international collaboration, like for the ISS, and reusable spacecraft will be needed. We use high-energy Earth orbits that can be drastically modified with lunar swingbys and small propulsive maneuvers in weak stability regions, especially near the collinear Sun-Earth and Earth-Moon libration points. The work builds on ideas developed by the International Academy of Astronautics' exploration study group presented at the 2008 International Astronautical Congress in Glasgow. The first missions will probably go to the Moon and its vicinity; these are discussed in separate papers. This paper will concentrate on the next possible step, which might be for servicing large space telescopes in Sun-Earth libration-point orbits. Next, flyby and rendezvous missions to Near-Earth Objects (NEO's) will be presented, with an emphasis on options for defense against potentially hazardous objects. Finally, trajectories to reach Mars, first to Phobos and/or Deimos, will be calculated. The study will use highly-elliptical Earth orbits (HEOs) whose line of apsides can be rotated using lunar swingbys. The HEO also provides a convenient and relatively fast location for rendezvous

with crew, or to add propulsion or cargo modules, a technique that we call "Phasing Orbit Rendezvous". From a HEO, a propulsive maneuver, considerably smaller than that needed from a circular low-Earth orbit, can be applied at the right perigee to send the spacecraft on the right departure asymptote to a desired destination. Aerocapture can be used at the return, perhaps helped with a lunar swingby. But the astronauts onboard could separate in an Apollo-style capsule for a direct return. Sun-Earth (and possibly Earth-Moon) libration point orbits and double-lunar swingby orbits, like those flown first by the third International Sun-Earth Explorer, will be used, along with time to change the orbital orientation between missions. There might be waits of several months between missions, when the interplanetary spacecraft could be "parked" in a small-amplitude Lissajous orbit about a libration point, similar to that flown by the WMAP mission. During that time, if there wasn't an L2 space telescope needing servicing, the spacecraft could be unmanned and controlled remotely from the Earth. Sequential missions to fly by and then rendezvous with NEO's will be presented, followed by a mission to the Martian moons.