HUMAN EXPLORATION OF THE SOLAR SYSTEM SYMPOSIUM (A5)
Going Beyond the Earth-Moon System: Human Missions to Mars, Libration Points, and NEO's (4)

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TRAJECTORY OPTIONS FOR INTERPLANETARY HUMAN EXPLORATION

Abstract

We have received a "megagrant" from the Russian Ministry of Education and Science to study orbital options to extend human exploration beyond the Moon's orbit. For a viable program, 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 libration points. The work will build on ideas developed by the International Academy of Astronautics' exploration study group presented at the 2008 International Astronautical Congress in Glasgow. The first results presented will 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 libration point orbits (most likely L2) 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 the Sun-Earth L2 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. The first mission might start with an Orion capsule (or something similar) to which modules could be added, including fuel tanks, as needed, for later missions that could include rendezvous with a NEO. Low-deltaV transfers to near an Earth-Moon libration point to support a lunar mission will also be presented.