

## 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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## PROJECT 5S: A SAFE STEPPING STONE INTO THE SOLAR SYSTEM

**Abstract**

The human exploration program, at least in NASA, has been directed to move beyond the Moon and travel on a flexible path into the solar system. Reaching a Near-Earth Asteroid (NEA) is a major interim goal – but such missions have flight times and life support requirements that are a huge step from current known capabilities. An objective between the Moon and a NEA is needed. Example interim objectives are the Lagrangian points in either the Sun-Earth or Earth-Moon (EM) system. The nearest of these points beyond the Moon is E-M L2. The Lagrangian points are empty (as far as we know). As objectives for human flight they suffer from a lack of public interest and are void of meaningful objectives for astronaut operations. To provide a physical target a robotic spacecraft could retrieve a small NEA and bring it to a Lagrangian or other nearer-Earth point to be utilized for human mission objectives. This paper reports on the results of a recently completed study of an asteroid retrieval mission sponsored by the Keck Institute for Space Studies (KISS) at the California Institute of Technology. The study included an evaluation of potential targets, mission objectives, mission and system design and potential capture mechanisms. The study concluded that while challenging there were no fundamental show stoppers and that such a mission is possible with technology expected to be available in this decade. The final destination selected – for safety and mission operations – was high lunar orbit. Two options for target selection are considered: (i) retrieving a small ( 7 meter) NEA with a mass of order 500,000 kg, and (ii) taking a similar size boulder off a large known carbonaceous NEA. Several areas of technology and program requirements were identified, but the most important conclusion was that only by this approach will it be possible to meet a goal of humans going to a NEA by the mid-2020s. The advantages and benefits for human exploration are profound as are the advances that would be made in space resource utilization and science for further exploration and development of the solar system. The combination of the robotic mission to move the asteroid and the human mission to go to its new destination and conduct astronaut operations there would provide a badly needed boost and purpose to human space flight.