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THE ACCELERATION OF THE HUMAN EXPLORATION OF THE SOLAR SYSTEM WITH SPACE ELEVATORS

Abstract

Space Elevators are not a new idea, the original concept dating back to Tsilokovsky, but are not commonly considered in near-term plans for space exploration. While a Terrestrial elevator would require substantial improvements in tether material, a Martian Space Elevator (MSE) or a Lunar Space Elevator (LSE) would not, and there are currently possible elevator missions that would enhance the exploration of the solar system. This paper considers two proposed missions leading to a infrastructure capable of supporting human exploration, shortening the time and lowering the cost required for exploration and enhancing the capabilities of robotic and human explorers. Both missions use planetary scale tethers, strings many thousands of kilometers long stabilized either by rotation or by gravitational gradients.

The Deep Space Tether Pathfinder (DSTP) is a 5000 kilometer long rotating tether, weighing two tons, to be sent into deep space to test the engineering of a LSE or MSE. As a test of the ability of Space Elevators to return surface samples, the rotation of the DSTP would be used to match the relative velocity between one tip and the Moon during a flyby, allowing for the collection of a surface sample in a "touch-and-go" fashion from a suitable scientific target, such as the floor of Shackleton Crater in the Lunar South Polar Region. The collected sample would then be returned to Earth by the release of a return capsule roughly one half rotation period later, when elevator tip velocity is directed towards the Earth for a direct return trajectory. After sample release, the DSTP would continue into deep space, allowing for long term observations of tether performance in the space environment.

The Lunar Space Elevator Infrastructure (LSEI), a follow-on to the DSTP, is a much longer tether extending from the Lunar Surface, through the Earth-Moon L1 Lagrange point (EML 1) and into cis-lunar space. The LSEI prototype, requiring one launch of a heavy lift vehicle, would be able to lift roughly 1 ton of lunar samples per year, and deploy a similar quantity of equipment onto the Lunar surface. The LSEI would significantly enhance the ability of a Deep Space Habitat (DSH) at EML1, for a small fraction of the total cost of a DSH by, for example, enabling on-site DSH laboratory research into Lunar samples, as well as supporting robotic exploration on the surface.