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USING PHOBOS AS A PASSIVE LAUNCH SYSTEM FOR SOLAR SYSTEM SPACECRAFT

Abstract

Hovering at about 6,000 km from the surface of Mars, Phobos is the moon in the solar system which is closest to its parent body. Phobos moves at high velocity (2.13 km/s) on an approximately circular orbit, with very short radius (about 9,500 km) and period (just above 7.5 hours). It is also tidally locked to Mars, always presenting the same face to it.

A tether deployed on the far side of Phobos, stretching out towards the inner reaches of Deimos' orbit, with a station as counterweight could provide artificial gravity to the station, and linear velocity sufficient to escape the attraction of Mars in any direction along Phobos' orbital plane. The shortest tether which could be stably deployed would lie just outside of Phobos' Hill sphere (about 16 km on its far side). A spacecraft would only need a modest amount of energy in order to climb the tether up to that point. No further energy expenditure would be required while sliding along the remaining portion of the cable.

A 13,000 km tether is the longest that could be deployed without interference with Deimos' orbit. It would provide a station at its far end with artificial gravity (about 12 percent of Earth's), and could provide spacecraft with sufficient velocity (about 5.1 km/s) to reach Earth without expenditure of propellant. Such tether would be able to passively support launch and capture operations in the range of 2.13 to 5.1 km/s.

A 13,000 km Dyneema cable with 6 mm diameter at its thinner end and optimal taper ratio would weight approximately 532 tons, and hold up to 33 tons at the station's end. The cable could be assembled from shorter sections, separately deployed by subsequent missions.

A longer (possibly retractable or steerable) 40,000 km tether would provide the station with artificial gravity equivalent to 25 percent of Earth's, and spacecraft with sufficient system velocity (about 11.2 km/s) to escape the solar system without expenditure of propellant.

An additional tether could be deployed on Phobos' near side, stretching 6,000 km towards Mars, and skimming the surface of the planet at an altitude of about 150 km. Such near-side tether would be able to passively support launch and capture operations in the range of about 0.81 to 2.13 km/s.