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Conceptualizing Space Elevators and Tethered Satellites (3)

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APPLICATIONS OF A TETHER FIXED IN THE MOON TO MANEUVER SPACECRAFTS.

Abstract

The study of applications of tethers in space is growing on the last years. A very promising topic is the use of tethers to help to maneuver a spacecraft. The main idea is to replace maneuvers based in fuel consumption delivered by propulsion systems by maneuvers using tethers. Several types of tethers have been considered with this goal, such as electrodynamics tethers to increase or decrease the orbit of a spacecraft traveling around the Earth; momentum exchange tethers, which usually consists of a tether linking two or more satellites that is romped at a certain point; tethered sling shot maneuver, which uses a celestial body to fix a tether that rotates a spacecraft to get energy, similar to a gravity assisted maneuver. Following this line, the present paper study possible applications of the Moon to maneuver a spacecraft that is leaving the Earth to an interplanetary trajectory. A tether is fixed in the Moon and is used to rotate a spacecraft that is passing nearby. It generates a tethered sling shot maneuver that changes the energy, velocity and angular momentum of the spacecraft with respect to the Earth. The new trajectory will have different values for the Keplerian elements with respect to the Earth, including a variation of the inclination, which is a very expensive maneuver to be made based in propulsion systems. Several geometries will be considered, including planar maneuvers, which maximize the variation of energy; and out of plane maneuvers, which maximizes the modifications of the inclination of the trajectory. Engineering aspects will be considered in the present study, and considerations about the size of the tether and the tension that it is subject for each maneuver will be made. Those points are very important to give an idea of the requirements that are necessary to implement a device if this type. A first analysis can be made using the "patched-conics model", which divides the motion of a spacecraft in a series of two-body problems. This approximation can give accurate results for most of the missions. After that it is possible to validate the results using the circular restricted three-body problem. This study shows an interesting possibility to maneuver a spacecraft in the future and can be applied to a large variety of missions, in particular the ones requiring large plane changes.