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SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
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MASSDRIVER CAPABILITIES OF THE BODIES OF THE SOLARSYSTEM

Abstract

With the ongoing considerations of interplanetary colonization and the future expansion of space based activities in general tapping into in-situ resources beyond Earth, Moon and Mars might be of interest to support and expand such projects. In this paper the capability of bodies of the solar system to use a massdriver as means of transporting significant quantities of in-situ mined resources into space is explored. A massdriver is a linear acceleration device that uses electromagnetic principles to propel a payload to launch velocity. The results of this paper shall give an indication of the energetic requirements to transport material from the body surface onto trajectories that are of interest. With this quantity the effectivity of an in-situ resource mining operation can be determined. As most moons of the solar system are at least partially rocky, the two key ingredients for constructing a massdriver silicon and electrically good conducting metal are assumed to be present within present minerals. Silicon is needed for the construction of photo-voltaic cells to collect energy for accelerator operation. The electrical conductor is required for the construction of accelerator structures that will bear high current and voltages for a short amount of time. The orbital mechanics approach for determining the required launch was first developed for lunar application and is refined for general application here. A horizontal launch from the orbiting bodies surface and a parallel or antiparallel velocity vector during intersection with sphere of influence intersection is used as boundary condition to obtain an effective and efficient launch velocity estimate. A design parameter for a desired peri- or apoapsis determines the system of equations dependent, if either energy is to be gained or lost with respect to the central body. The solution, a required launch velocity or mass specific kinetic energy, determines the dimensions of a respective massdriver and its peripheral facilities, when a payload constraint parameter of maximum acceleration is given. An exhaustive list of solutions of this parameter is given for the bodies of the solar system. The launch via massdriver represents an ideal launch, as the achieved velocity at the muzzle of the massdriver equals to an infinitesimal velocity pulse. Nonetheless, the presented solutions can be applied to alternative launch systems that produce thrust over time. Chemical propulsion systems will converge to the same trajectory as the massdriver will generate, with some additional losses.