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EFFECTS OF PLANETARY MAGNETIC FIELDS ON FEEP OPERATIONS

Abstract

Within the solar system many objects posses magnetic fields of various strengths. The Juno mission to Jupiter is one such example of exploration of a body with extreme magnetic fields. Metallic asteroids and other planets, like Mercury, which are closer to the sun, all posses strong magnetic fields and provide viable targets for exploration. Current planetary missions traditionally utilize chemical or pressurized cold gas systems wherein new electric propulsion systems may offer missions benefits. Field Emission Electric Propulsion (FEEP) provides a viable alternative because of its higher specific impulse, efficiency, and compact nature.

FEEP thrusters have been successfully operated in Earth Orbit. However, in the presence of a strong ambient electromagnetic field, the FEEP thruster may not operate as intended. FEEPs ionize and accelerate metal atoms via strong electric fields which may be influenced by presence of external magnetic fields. We intend to analyze the applicability of these thrusters for missions involving travel to planetary bodies or areas which have strong electromagnetic fields. We will utilize Psyche as a case study as it uses electric propulsion near a planetary body with potentially strong local magnetic fields. These effects could be particularly important for future EP missions enabling close surveys of metallic asteroids.

More study is required to fully characterize the effects of external magnetic fields on the FEEP thrusters, and how they affect the ability to generate effective propulsive power for their spacecraft. This characterization will be done via a combination of simulation and experimental techniques. Particle simulation techniques will be used to predict the plume response numerically. Numerical predictions will be compared against laboratory experiments with single emitter FEEP ion sources. For the purposes of this paper, we will strictly focus on the effects of external magnetic fields in the range of magnitudes that would be found around planetary bodies such as asteroids, mercury and the sun.