Paper ID: 65793
student

IAF SPACE EXPLORATION SYMPOSIUM (A3)
Interactive Presentations - IAF SPACE EXPLORATION SYMPOSIUM (IP)

Author: Mr. Joshua Knicely
University of Alaska-Fairbanks, United States, jknicely@alaska.edu

Mr. Nicholas Hasson
University of Alaska-Fairbanks, United States, nhasson@alaska.edu
Dr. Gunther Kletetschka
University of Alaska-Fairbanks, United States, gkletetschka@alaska.edu

KITE: A NOVEL LUNAR PROPULSION SYSTEM FOR CHARACTERIZING ELECTROSTATIC ENVIRONMENT ON AIRLESS SPACE SOLID BODIES.

Abstract

Our central objectives are 1) to characterize the magnetic field of a Lunar swirl and 2) demonstrate the feasibility of electrostatically lofted "kites" as an innovative means of Lunar mobility for future missions, most specifically in characterizing Lunar swirls and other magnetized areas of the Moon, as well as other airless planetary bodies.

We envision a unique method of propulsion by exploiting the Lunar electrostatic plasma phenomenon to extract a repulsive force using the Kinetic plasma Induction Tethering Experiment (KITE). Plasma interaction on airless bodies causes charging of the surface due to two charge separation processes. The first process separates electrons from neutral plasma on the light/shade boundaries. The second process separates the electrons from the neutral plasma on interaction with existing magnetic anomalies (e.g., Reiner Gamma swirl).

Variable plasma conditions result in ion-electric potentials of the surface and regolith that vary over orders of magnitude. The Earth-tail magnetosphere where the Moon spends about 30% of its orbit contains tenuous plasma in the tail lobes and denser and energetic electrons and ions in the plasma sheet [Wang et al., 2021]. Energy dependent reflection aboard JAXA KAGUYA spacecraft revealed the presence of downward parallel electric fields, indicating a standing electrostatic structure in regions with non-zero crustal magnetic fields, implying parallel electric fields and/or wave-particle interactions below the spacecraft [Halekas et al., 2012; Saito et al., 2008]. Recent observations from KAGUYA, Chandrayaan-1 and IBEX indicate that 0.1–1% of the incident solar wind protons are scattered back as ions, producing ion-electric current interactions with lunar magnetic anomalies [Asano et al., 2010]. The currents create a dynamic accumulation of near surface electric fields. This causes the surface to repel any objects that are not bound to the surface and the objects, such as dust grains, levitate. The backscattered protons are accelerated via a "self-pickup" process, resulting in a maximum energy of up to nine times the solar wind energy.

The KITE will enable both geographical and temporal mapping of the electrostatic charge distribution of the Lunar surface and monitoring of the charge variation and recharge potential at Lunar swirls. The resulting maps create the potential for harvesting the electric charge on the Lunar surface as an electrical power source and for understanding the horizontal magnetic field strength and morphological structure of Lunar swirls, some of which (e.g., Reiner Gamma swirl) may provide radiation protection for Lunar surface equipment and personnel.