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The Los Alamos Mission Concept to Connect Magnetospheric Physical Processes to Ionospheric Phenomena

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Extended Abstract

On the nightside of the Earth the magnetic connections between the ionosphere and the dynamic magnetosphere have a great deal of uncertainty: this uncertainty prevents us from scientifically understanding what physical processes in the magnetosphere are driving the various phenomena in the ionosphere. Since the 1990s, the space plasma physics group at Los Alamos National Laboratory (LANL) has been working on a concept to connect magnetospheric physical processes to auroral phenomena in the ionosphere by firing an electron beam from a magnetospheric spacecraft along magnetic field lines and optically imaging the beam spot in the ionosphere [1,2]. The magnetospheric spacecraft will carry a steerable electron accelerator, a power-storage system, a plasma contactor, and instruments to measure magnetic and electric fields, plasma, and energetic particles. The spacecraft orbit will be coordinated with a ground-based network of cameras to (a) locate the electron beam spot in the upper atmosphere via its optical airglow emission and (b) monitor the aurora. Recently, a LANL-led multi-institution team has made rapid advancements in this mission concept. The advancements are based on (1) a new understanding of the dynamic spacecraft charging of the accelerator and plasma-contactor system in the tenuous magnetosphere based on ion emission rather than electron collection [3], (2) a new understanding of the propagation properties of pulsed MeV-class beams in the magnetosphere, and (3) the design of a compact high-power 1-MeV electron accelerator and power-storage system. An overview is presented of the mission concept, the spacecraft-charging problems, the accelerator, the ground-based ground network, and the magnetospheric measurement instrumentation. The overview will include a discussion of the accelerator-energy tradeoffs between reducing spacecraft charging, avoiding loss-cone-drift issues [4] and improving beam detectability, and will include a discussion of a strategy to reduce of spacecraft charging when the accelerator is fired. This strategy to (a) determine the magnetosphere-to-ionosphere magnetic connections and (b) reduce accelerator-platform charging responds to one of the six emerging-technology needs called out in the most-recent National Academies Decadal Survey for Solar and Space Physics: "Magnetosphere-to-Ionosphere Field-Line Tracing Technology".

References

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