Lorentz-Actuated Orbits: Electrodynamic Propulsion without a Tether
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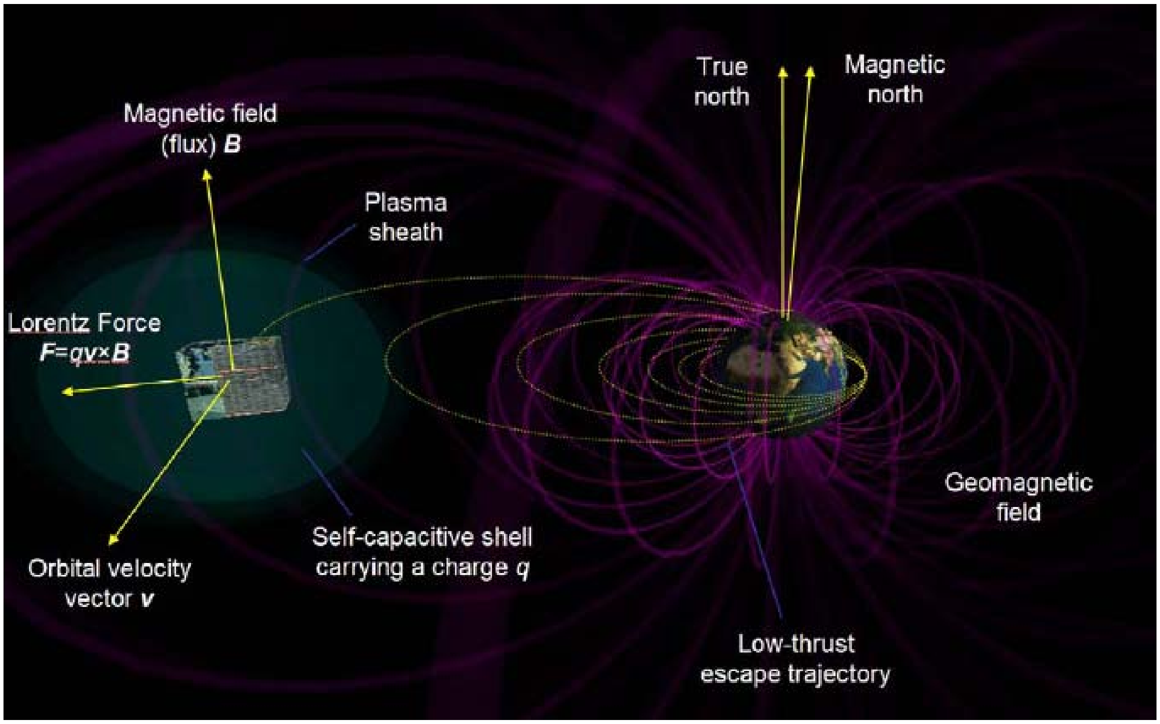

The NIAC Phase II investigation proposed here evaluates the feasibility of using the Lorentz force as a revolutionary means of accelerating a spacecraft. This force acts on a charged particle moving in a magnetic field, as in the case of a satellite carrying a biased electrical charge and orbiting within a planetary or stellar magnetosphere. This propellantless propulsion technique may represent the last area of classical physics that has not yet been considered for spaceflight dynamics. A spacecraft mission whose architecture is based on the Lorentz-Actuated Orbit benefits from propellantless, non-Keplerian orbits: for example,

- Orbit planes that precess synchronously with the planet's rotation, but at lower altitudes than the classical geostationary solution
- Earth and solar escape (elliptical to hyperbolic orbits) and planetary capture (hyperbolic to elliptical)
- Swarms of spacecraft that hover in non-Keplerian orbits, such as a formation of radially positioned vehicles with constant angular velocity at different altitudes
- Rendezvous along the velocity direction, with no need for orbit raising and lowering
- Orbits whose lines of apsides rotate synchronously with the planet, its moon, or the sun, offering continuous lunar free-return trajectories and lunar resupply possibilities
- Low-earth orbits that experience neither cumulative atmospheric drag nor J2 perturbations

We propose to build upon our successful Phase I study, which mapped out the heretofore unexplored, coupled dynamics of familiar celestial mechanics and cyclotron-style motion of a charged particle in a magnetic field and discovered a number of new system architectures for space travel. That project identified areas of technology advancement required for this system to be feasible and compared this concept to existing methods of propulsion in terms of key metrics: mass, power, cost, time of flight, and risk. The Phase II effort will focus on the feasibility issues by evaluating these low-TRL technologies to a point where Lorentz-actuated orbits can be considered for a future NASA mission. Our goals are the following:

- Develop and exercise the algorithms and modeling tools required to understand spacecraft capable of experiencing a Lorentz-Actuated Orbit, including NASCAP and other in-house developed software for evaluating the coupled behaviors of spaceborneplasma charging and orbit dynamics.
- Identify the lowest-risk charge-storage subsystem (i.e. capacitor) from among the technologies identified in the Phase I effort and detail its performance in the space environment, with an emphasis on plasma interactions.
- Demonstrate and characterize the self-capacitance for the case of a scaled test in a representative plasma environment.
- Identify the lowest-risk charge-maintenance subsystem (i.e. charged-particle source and related components) from among the technologies identified in the Phase I effort and detail its performance in the space environment, with an emphasis on plasma interactions
- Devise a promising, candidate mission architecture in an effort to identify and tie up loose ends that would otherwise represent unacceptable risk to a NASA application.