CHARGE: A Small Satellite Mission to Answer Outstanding Questions in the Challenging Radiation Environment at Jupiter.

G. Clark[1], H. T. Smith[1], I. Cohen[1], C. Paranicas[1], P. Kollmann[1], G. Ho[1], F. Bagenal[2], P. Delamere[3], J. Saur[4], L. Roth[5], [1]Johns Hopkins University Applied Physics Laboratory (george.clark@jhuapl.edu), [2]University of Colorado Boulder, Laboratory for Atmospheric and Space Physics, [3]University of Alaska Fairbanks, [4]University of Cologne, [5]KTH Royal Institute of Technology

Abstract: The processes that source and sustain the neutral cloud near Europa are still debated within the community. In general, there are two hypotheses: 1) the cloud near Europa is produced locally by Europa itself through atmospheric or geyser interactions or some combination thereof; and 2) the cloud is produced and sustained by material produced at Io, which moves out radially, filling the near-Jupiter space environment. The first hypothesis, if true, may have implications for Europa's geological activity. Support for this hypothesis first originated in the early 2000s with Galileo energetic charged particle measurements and remote observations of neutral atoms from Cassini/INCA [1,2]. More recently, Hubble observations of Europa also provide evidence of transient geysers spewing water vapor into the near-Jupiter space environment [3,4]. However, it remains unclear how a transient phenomenon, like geysers, can sustain a neutral cloud with densities around 50 cm^{-3}. In addition, a recent analysis of Cassini/UVIS data from the 2001 flyby concluded [5] that there is little or no evidence of water vapor injections and question the idea of Europa's activity. Ion charge state measurements in the region between Io and Europa are necessary to unambiguously confirm or refute these hypotheses, providing a significant improvement in our understanding of Europa's role and the ion chemistry taking place between Io and Europa.

CHARGE is a small satellite mission concept to investigate the material introduced into the near-Jupiter space environment by Europa and Io. CHARGE will provide measurements to confirm or refute the hypotheses by distinguishing the relative contributions to these satellites' neutral and plasma tori from their surfaces, atmospheres, and possible geyser interactions from those originating from other Jovian sources. The scientific payload comprises an ion energy, composition, and charge state sensor spanning thermal to energetic ions, a suprathermal electron sensor, and a magnetometer. CHARGE's modeled trajectory will take its perijove inward as far as 5.5 R_J (inside Io) and its apojove outward beyond Europa, allowing CHARGE to measure the radial profiles of ion energy, composition, and charge state and unambiguously determine the sources and sinks of the major and minor ion species between the satellites. In addition to its orbit, we will also present other engineering trade studies that have been performed by APL's mission design team.

Finally, we find that deep space exploration with small satellites missions, like CHARGE, offers rich and diverse scientific opportunities. Such missions are extremely well-suited for addressing focused, high-impact scientific objectives in high-risk environments such as the Jovian radiation belts. By taking advantage of ride share opportunities that significantly reduce mission cost and complexity, these small satellite missions can provide important and complimentary measurements in regions that are not planned for investigation by current or planned missions.

References:

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