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Thermal and energetic ion dynamics in Ganymede's magnetosphere

Andrew Poppe (1), Shahab Fatemi (2), and Krishan Khurana (3)

(1) University of California at Berkeley, Space Sciences Lab., Berkeley, United States (poppe@ssl.berkeley.edu), (2) Swedish Institute for Space Physics, Kiruna, Sweden, (3) Institute for Geophysics and Planetary Physics, UCLA, Los Angeles, CA, USA

Ganymede is the solar system's only known moon with an intrinsic, global magnetic field. This field is strong enough to stand off the incident jovian magnetospheric flow and forms a small, yet complex magnetosphere around the satellite. Ganymede's magnetosphere is thought to be responsible for variable surface weathering patterns, the production of a neutral exosphere, and the generation of UV aurorae near Ganymede's open-closed field line boundaries; however, the exact details and underlying mechanisms are not fully understood. Here, we use results from previous three-dimensional hybrid models of Ganymede's magnetosphere and a three-dimensional particle-tracing model to quantify the dynamics of thermal and energetic jovian ions as they interact with Ganymede's magnetosphere and precipitate to the surface. We identify the formation of quasi-trapped ionic radiation belts in the model, similar to that observed by the Galileo Energetic Particle Detector, and variable surface weathering, corresponding to Voyager and Galileo observations of the ganymedean surface. We find that most of the particle precipitation occurs in Ganymede's polar caps, yet energetic ions can also precipitate to Ganymede's equatorial region in somewhat lesser amounts than in the polar regions due to particle shadowing of quasi-trapped ions in Ganymede's ionic radiation belts. Model results predict that for conditions within Jupiter's central plasma sheet, total ion fluxes to Ganymede's polar, leading, and trailing hemispheres are 20x10^{6} cm-2 s-1, 2x10^{6} cm-2 s-1, and 0.06x10^{6} cm-2 s-1, respectively. Finally, convolution of incident ions fluxes with experimentally measured neutral sputtering yields for icy bodies predicts neutral sputtered fluxes in Ganymede's polar, leading, and trailing hemispheres of 1.2x10^{9}, 2.7x10^{8}, and 1.1x10^{8} neutrals cm-2 s-1, respectively.