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Energetic Ion Auroral Modeling for Jupiter and its Implications for Magnetosphere-Ionosphere Coupling

Stephen Houston (1), Nataly Ozak (2), Thomas Cravens (1), David Schultz (3), Jackson Young (1), Dennis Haggerty (4), and Barry Mauk (4)

(1) Department of Physics and Astronomy, University of Kansas, Lawrence, Kansas, USA (sjh@ku.edu) , (2) Centre for Mathematical Plasma Astrophysics, KU Leuven, Celestijnenlaan 200B - bus 2400, B-3001 Leuven, Belgium, (3) Department of Physics, University of North Texas, Denton, Texas, USA, (4) The Johns Hopkins University Applied Physics Laboratory, Laurel, Maryland, USA

Auroral particle precipitation dominates the chemical and physical environment of the upper atmospheres and ionospheres of the outer planets. Precipitation of energetic electrons from the middle magnetosphere is responsible for the main auroral oval at Jupiter, but both energetic electron and ion precipitation take place in the polar caps. At least some of the ion precipitation is associated with soft x-ray emission with about 1 GW of power, as observed by the Roentgen satellite, Chandra X-ray Observatory, and XMM-Newton. Theoretical modeling has demonstrated that the incident sulfur and oxygen ion energies must exceed about 0.5 MeV/nucleon in order to produce the measured x-ray emission, although lower energy ion precipitation cannot be excluded. The polar cap location of the emission and magnetosphere-ionosphere coupling considerations both indicate the associated field-aligned currents must originate near the magnetopause or perhaps the distant tail. Secondary electrons produced in the upper atmosphere by ion precipitation could be accelerated upward to relativistic energies due to the same field-aligned potentials responsible for the downward ion acceleration. Recent Juno data indicates the presence of both upward and downward relativistic energy beams over the polar cap. Models of ion precipitation will be presented and put into the context of the recent Juno results.