EPSC Abstracts
Vol. 5, EPSC2010-352, 2010
European Planetary Science Congress 2010

Modelling the Transport of Iogenic Particles Exiting the Jovian Magnetosphere via the Magnetotail

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Abstract

We show that energetic ions with Iogenic, sulfur-rich, composition are recurrently injected at 150±30R_J (R_J = 71,492 km) anti-sunward of Jupiter and funneled down the magnetotail. The particle events show velocity dispersion and were observed during the first half of 2007 by the PEPSSI (Pluto Energetic Particle Spectrometer Science Investigation) instrument on the Pluto-bound New Horizons spacecraft A case study [1] of one of the most interesting of the many sulfur-rich events, beginning on day-of-year 118, 28 April 2007, contributes to the determination that the ~400 R_J – wide > 9000 R_J – long magnetotail is actually composed of narrow ~1–R_J diameter filaments stretching down the tail (Figure 1). The impact of Io's volcanism is clear as far down the tail as we observed, but between events the abundance of the solar wind tracer helium grows as the spacecraft recedes from the planet, possibly due to solar wind flux tubes mixing with the Jovian flux tubes liberating material trapped in the Io torus and inner magnetosphere into interplanetary space.

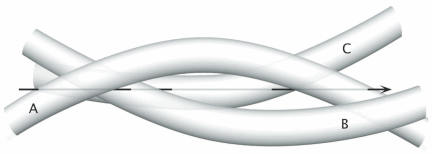

Figure 1: The New Horizons spacecraft passing through filamentary ~1 R_J-wide structures in Jupiter's magnetotail. This illustration is in qualitative agreement with observations during the 28 April 2007 events. Figure adapted from Hill et al. (2009)[1].

We model the transport of escaping Iogenic ions using a mature particle transport code [2,3] that employs a Monte Carlo technique, allowing us to follow the propagation on a physically consistent magnetic field (Figure 2). A large number of particles are injected as a delta-function spatially and temporally with an energy spectrum of E^{-2}, and their motion is followed to the observer, producing synthetic energy spectra and time-intensity profiles, which are compared with the PEPSSI observations.

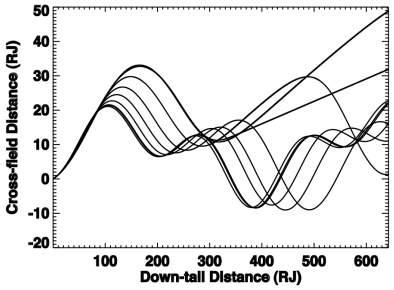

Figure 2: Selected modeled magnetic field lines generated in a physically self-consistent manner at the source location near the planet. The magnetic field model uses 3D rectilinear geometry, with field lines embedded in a 2D random flow field at Jupiter and convected along with the plasma in the third dimension.

References

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