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The location and topology of electron beams in Io‘s wake

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The Galileo spacecraft measured hot field aligned electron beams near Io during three flybys. We apply our 3D MHD model of the Io-Jupiter interaction to constrain the location and shape of field aligned electron beams for the individual flyby scenarios.

Io continuously generates MHD waves by disturbing the Jovian magnetoplasma. Currents carried by Alfvén waves propagate predominantly along the magnetic field lines. The waves accelerate electrons as the number of charge carriers decreases on their way to Jupiter. These energetic electrons precipitate into the Jovian ionosphere, visible as prominent Io footprint emission in the Jovian aurora. On the other hand electrons have to be accelerated upward to form the beams measured by Galileo. Unlike the beam formation, the position and spatial structure of these beams has been poorly discussed.

We adopt our 3D MHD model initial conditions to the individual flyby scenario and determine the spatial morphology of beams in Io’s orbital plane. We compare our findings to Galileo observations and find very good agreement. Moreover, we use our model to further investigate in detail a recent concept which involves cross-hemisphere electron beams to explain certain auroral features of the Io footprint emission such as a leading spot and secondary spots [Bonfond et al., 2008].

Our results indicate that besides geometrical properties, such as Io’s position in the torus, the incoming plasma density controls the travel path and topology of an electron beam.