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Non-ideal Alfven wings and the qcceleration of electron beams by Enceladus

Frank Crary (1), Donald Gurnett (2), Andrew Coates (3), and Geraint Jones (3)

(1) Southwest Research Institute, San Antonio, United States (fcrary@swri.edu), (2) University of Iowa, Iowa City, United States (donald-gurnett@uiowa.edu), (3) Mullard Space Science Laboratory, Dorking, United Kingdom (ajc@mssl.ucl.ac.uk, ghj@mssl.ucl.ac.uk)

Saturn's moon Enceladus is coupled to its magnetosphere through the electric currents generated in the water-vapor plume emerging from its southern polar region. These currents close along magnetic field lines and produce an Alfven wing, or standing Alfven wave, similar to that produced by Jupiter's moon, Io. The Io interaction is known to generate field-aligned electron beams. Proposed mechanisms for generating these beams include field-aligned potentials due to non-ideal effects in these Alfven wave. In the case of Io, these effects are weak near the satellite and would only become significant as the wave propagates away from the equator and into lower density regions. We show that, in the case of Enceladus, non-ideal effects are significant, and may produce field-aligned potentials, even in the immediate vicinity of the satellite. Both the ion gyroradius and the collisionless skin depth are of order likely perpendicular length scales. The electron thermal velocity is comparable to the wave phase velocity. These quantities also vary along the field line, so that the wave passes through several different, non-ideal regimes as it propagates away from Enceladus. We describe the resulting effects on the Alfven wing, and estimate the associated parallel electric fields. We then compare these results to measurements of electron beams observed by the Cassini spacecraft in the vicinity of Enceladus.