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Plasma-depleted flux tubes in the Saturnian magnetosphere and their implications

Hanying Wei (1), Hairong Lai (1), Christopher T. Russell (1), Michele K. Dougherty (2), and Yingdong Jia (1)

(1) Dept of Earth and Space Science, Univ of California Los Angeles, Earth and Space Science, UCLA, Los Angeles, United States (hwei@igpp.ucla.edu), (2) Imperial College London, The Blackett Laboratory, London, UK

The Saturnian magnetosphere is driven internally by the acceleration of plasma originating from the Enceladus plume and the neutral cloud. The newly added plasma is accelerated to the rotational speed of the planet and convects outwards from the inner magnetosphere. Eventually it is lost through magnetic reconnection in the tail, resulting in massive plasmoids moving tailward and "empty" flux tubes moving Saturnward. These plasma-depleted flux tubes return magnetic flux from the tail back to the inner magnetosphere, due to interchange instability in a centrifugally driven system. The magnetic fields in such flux tubes are quite different from the ambient fields, with either enhanced or reduced field strengths bounded by sharp edges due to the lower or higher temperature of the plasma inside the tubes than the ambient plasma. These flux tube events are the magnetic counterpart of the injection events observed by other Cassini instruments. We examine the Cassini magnetometer data to characterize the statistical properties of their occurrence rates, sizes, and local time distributions. Finally we compare our results with the injection events to understand whether and how Enceladus controls plasma transport in the inner magnetosphere of Saturn.