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Tail reconnection at Saturn: An overview of local plasmoid properties and the role of reconnection in global magnetospheric dynamics

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Abstract

We present a comprehensive review of the magnetic field and plasma signatures of reconnection events observed with the Cassini spacecraft during the tail orbits of 2006. We examine their "local" properties in terms of magnetic field reconfiguration and changing plasma flows. We also describe the "global" impact of reconnection in terms of the contribution to mass loss, flux closure, and large scale tail structure. The signatures of 69 plasmoids, 17 travelling compression regions (TCRs), and 13 planetward-moving structures have been found in total to date in the tail orbits of 2006. The direction of motion is inferred from the sign of the change in the B_θ component of the magnetic field in the first instance, and confirmed through plasma flow data where available (for 30 events). We discuss the location spread of the observations, showing that where spacecraft coverage is symmetric about midnight, reconnection signatures are observed more frequently on the dawn flank than on the dusk flank and comment on the importance of this in terms of understanding Dungey- and Vasyliunas-cycle flows. We probe the interior structure of plasmoids and find a preference for loops over flux ropes at Saturn, exploring the implications of this for large-scale tail structure.
We estimate the mass lost downtail through reconnection and suggest that the apparent imbalance between mass input and observed plasmoid ejection may mean that alternative mass loss methods contribute to balancing Saturn's mass budget. We also estimate the rate of magnetic flux closure in the tail and find that, where open field line closure is active, it plays a very significant role in flux cycling at Saturn.