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Reconnection and boundary layer formation at Saturn's magnetopause

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The electron and ion experiments on the Cassini Plasma Spectrometer instrument suite have been measuring low energy electrons, in the range 0.58eV to 28keV, and ions from 1eV to 50keV with an unprecedented temporal resolution from the pre-noon sector of Saturn's magnetopause. The dynamics of this boundary are expected to directly result from the interaction between the large, corotating magnetosphere and the exterior, shocked solar wind in the magnetosheath. Inside the magnetopause, the plasma is observed to travel at $\sim$ 30% of corotation speed such that the velocity shear with the magnetosheath flow is significant in the dawn sector. Under these circumstances, this large shear might be expected to suppress the occurrence of reconnection in this sector. Rather, the occurrence of boundary instabilities, such as Kelvin-Helmholtz waves, or centrifugally-driven outward bulges in the magnetopause may be preferentially driven under these high shear conditions.

Here we report the characteristics of the plasma and magnetic field at the dawn side magnetopause boundary in an effort to test these expectations. We show evidence of an open topology at the magnetopause in the magnetic field structure, as well as enhanced particle flows, which suggest magnetic reconnection is indeed occurring at Saturn. In addition, the presence of boundary layer plasma inside the magnetopause is observed for approximately 50% of crossings. We investigate its composition to

find clues to the mechanism(s) behind its formation. For example, a solar wind origin would be consistent with reconnection occurring at some point on the magnetopause or perhaps anomalous transport associated with boundary waves. Alternatively, the plasma may be of plasma sheet origin and transported to the dayside under the influence of a centrifugally-driven flute instability which may even result in its detachment from the magnetopause and ultimately release into the interplanetary medium.

We note also in passing that in the dusk sector (not yet explored by Cassini), the flow shear across the magnetopause is likely to be smaller if the interior plasma also travels at a significant fraction of the corotation velocity. Thus, under favourable field conditions, it may be that this region of the magnetopause is the preferential site of reconnection activity.