Plasma Sources and Processes in Saturn's Magnetosphere

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As we discuss in this paper, Saturn is an altogether different magnetosphere. After six years in orbit, Cassini has turned up a host of new and unexpected plasma populations and phenomena. Icy satellites and rings are the primary source of Saturnian plasma, so it's not surprising that the magnetosphere is dominated by water-group ions. However, of the myriad sources none is more mysterious than Enceladus where Cassini has identified positively *and* negatively ions ranging from 16 to over 50,000 amu/e—a compositional mix probably unique in the solar system. This material is spewed from the plumes at a rate >100 kg/s, adding >1 kg/s of plasma, which is sufficient to slow local co-rotation by >10 km/s. Dynamically the inner magnetosphere is extremely active. Hundreds of injection events take place each Saturnian day, accounting for outward plasma transport. Farther out, large water-dominated plasmoids are observed to separate on the nightside and drift down the magnetotail.

As amazing as Enceladus is, Titan is perhaps even more intriguing. Its interaction with co-rotating plasma sets up an induced magnetosphere dominated by pickup of heavy organic ions. Co-rotating plasma also carries water-derived ions from the inner magnetosphere into Titan's atmosphere, perhaps significantly altering its chemistry. An unexpected discovery is the existence of a large population of negatively charged organic molecules in the upper ionosphere whose masses range as high as 13,000 amu/e. In addition to making the plasma interaction interesting, these heavy ions are also likely to be the source of the aerosol "smog" that forms Titan's famous haze layers.