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Saturn's Other Ring Current

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Abstract

Saturn's main rings orbit the planet within an atmosphere and ionosphere of water, oxygen and hydrogen, produced by meteoritic impacts on and ultraviolet photodesorbtion of the ring particles [Johnson et al., 2006; Luhmann et al., 2006; Tseng et al., 2010]. The neutral atmosphere itself has only been tentatively detected through ultraviolet fluorescents of OH [Hall et al., 1996] while the ionosphere was observed in situ by the Cassini spacecraft shortly after orbital insertion [Coates et al., 2005; Tokar et al. 2005, Waite et al. 2005].

Although the plasma flow velocity of this ionosphere is not well-constrained, but the close association with the rings suggests that its speed would be couppled to the keplarian velocity of the rings themselves. As a result, the motion of the plasma through Saturn's magnetic field would produce an induced voltage, oriented away from the planet outside synchronous orbit and towards the planet inside synchronous orbit. Such a potential could result in currents flowing across the ring plane and closeing along magnetic field lines and through Saturn's ionosphere at latitudes between 36^o and 48^o. Cassini observations of whistler-mode plasma wave emissions [Xin et al., 2006] centered on synchronous orbit (1.76 Rs, mapping to 41^o latitude) have been interpreted as a product of field-aligned electron beams associated with such a current.

This presentation will investigate the magnitude of these currents and the resulting Joule heating of the ionosphere. An important constraint is that no auroral ultraviolet emissions have been observed at the relevant latitudes. In contrast, Joule heating could affect infrared emissions from H_3^+. Variations in H_3^+ emission associated with Saturn's rings have been reported by O'Donoghue et al., 2013, and interpreted as a result of ring "rain", i.e. precipitating water group species from the rings which alter ionosphereic chemistry and H_3^+ densities. As noted by O'Donoghue et al., this interpretation may be complicated by Joule heating by the ring-related currents.

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