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Observations of current sheet tilt in Saturn's magnetosphere from solstice to equinox

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Saturn's magnetospheric plasma resides in a thin current sheet (half thickness < 2 Rs), whose shape is determined by centrifugal, solar wind and Lorentz forcings. Arridge et al. (2008a) showed that the solar wind forcing warps the current sheet into a shallow bowl configuration. Arridge et al. (2008b) further showed that the current sheet develops a tilt in the rotating frame of the planet. Khurana et al. (2009) have suggested that the tilt results from the asymmetric lift of the magnetosphere in the presence of ring current asymmetries which rotate with the planet.

Magnetic field and particle observations from Saturn's magnetosphere show that the rotating partial ring current is located between the radial distance of 8 and 13 RS. Khurana et al. (2009) showed that this rotating partial ring current has profound effects on the structure of the magnetosphere. In the outer magnetosphere, the partial ring current imposes a sinusoidal variation of the magnetic field in the lobe region. The resulting asymmetric distribution of magnetic flux in Saturn's magnetosphere leads to an asymmetric lift of the magnetosphere by the solar wind which tilts the planet's current sheet even when the internal field is completely axisymmetric. The current sheet tilt (in the rotating frame) generates out-of-phase periodicities in which the particle fluxes and the magnetic field strength are anti-correlated.

The original model examined Cassini data from the period of 2004-2006, when the solar elevation angle was > 14 degrees. The model has specific predictions for the state of the magnetosphere during equinox. The model posits that during equinox when the solar elevation angle is close to zero, the solar wind would not be able to lift the current sheet out of Saturn's equatorial plane and the current sheet tilt should disappear. Thus, during equinox no periodic current sheet crossings are expected. Now, by examining the magnetic field data through the equinox (July 2009), we show that this indeed is the case. We show that the current sheet tilt is governed largely by the solar elevation angle. We present a new quantitative model of the current sheet tilt which is consistent with the asymmetric-lift model of Saturn's magnetosphere.