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A possible influence of the Great White Spot on the rotation of Saturn´s magnetosphere

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Abstract

Saturn kilometric radiation (SKR) is a powerful non-thermal radio emission from Saturn's aurora. Its modulation turned out to be a good tracer of magnetospheric periodicities which are also present in the magnetic field, the charged particles, and energetic neutral atoms [1]. SKR as well as Saturn narrowband (NB) radio emission exhibit an unexplained seasonal course with changes in the period of the order of ~1% over the years [2, 3, 4]. There have been models suggesting a magnetic cam field structure [5] or a centrifugally driven convective instability in the equatorial plasma disc of the inner magnetosphere [6] to explain this variation in rotation.

In this presentation we will show that the period of SKR as well as NB emission has temporarily slowed down by ~1% from the end of 2010 until August 2011, disrupting the expected seasonal course of the modulation. This time period exactly coincides with the occurrence of the giant thunderstorm called Great White Spot (GWS) [7, 8] that emitted radio waves associated with Saturn lightning discharges from 5 December 2010 until 28 August 2011. Furthermore, the head of the GWS and the SKR from the southern hemisphere show the same period of 10.69 h over several months in the first half of 2011. This observation strongly suggests that magnetospheric periodicities are driven by the upper atmosphere [9, 10]. The GWS has evidently produced large perturbations in Saturn´s stratosphere most likely caused by wave heating [11]. On Earth, penetrative cumulus convection from severe thunderstorms is a well-known generation mechanism of atmospheric gravity waves that can also propagate vertically upward [12, 13]. At Saturn, such thunderstorm-induced gravity waves could have transported additional power of the order of terawatts from the troposphere to the thermosphere/ionosphere. This might have led to a temporal change in Saturn´s global thermospheric circulation. The corotation of the magnetosphere is then maintained by the torque exerted by ion-neutral collisions in the upper atmosphere [14], which is linked to the magnetosphere via field-aligned currents.

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