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Is Periodic Plasmoid Release the Driver of Periodic Phenomena in Saturn's Magnetosphere?

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Saturn's magnetic dipole axis is almost perfectly aligned with its rotation axis and thus one expects a totally axisymmetric magnetosphere. It was therefore suprising to find periodic phenomena in almost all of the magnetospheric measurements, but an apparent lack of a longitudinal asymmetry to account for those phenomena. The Saturn Kilometric Radiation (SKR) was the first remote measurement to show clear periodicities, which was used to define a rotational period of the planet, in similar way that had been done for Jupiter. However, the SKR-derived period later changed by several minutes, which suggests that SKR is only loosely related to the true rotation period of the planet and is a magnetospheric and/or ionospheric phenomenon. The Cassini measurements have revealed periodic modulations close to the SKR-derived period in the magnetic field, energetic particles, energetic neutral atoms (ENA), and more.

In this paper we address the question of what drives these periodic phenomena and how they are related. We will give a brief overview of recent hypotheses, but will focus on periodic plasmoid release and its magnetospheric consequences. Observations suggests that periodic release of plasmoids formed by centrifugally induced tail reconnection is the common driver of the periodic phenomena observed in the magnetosphere. We will discuss how ions are accelerated, injected and transported by field reconfiguration following the plasmoid release, as revealed by ENA, in-situ energetic particle and field observations. The energetic particle distribution subsequently drifts and disperses around Saturn, while perturbing the magnetic field through pressure-driven currents, which we will demonstrate gives rise to the observed field periodicities. An attempt to characterize different types of injections and their temporal evolution around Saturn will be presented. SKR emissions will be shown to display a very high degree of correlation to injections in the post-midnight sector, but less so to injections/intensifications in the pre midnight sector. We will conclude by discussing open questions such as the relation between plasmoid release and solar wind dynamic pressure and mass loading by Enceladus.