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The magnetotails of Jupiter and Saturn: Comparison of charged (and neutral) particle measurements

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Abstract

Galileo and Cassini in-situ energetic particle measurements over 8 years of the two largest magnetospheres in our solar system have provided the opportunity to study their global configuration and well as their dynamics on various time scales. We will show astonishing similarities and huge discrepancies in the responses of energetic particles in those magnetospheres measured onboard the two spacecraft with the Galileo/EPD and the Cassini/MIMI instruments. In addition we will discuss results of the New Horizons Spacecraft which passed through region of the Jovian magnetotail in 2007 where no other measurements are available.

Both magnetospheres are powered by the fast rotation of the systems. The major particle sources filling the magnetospheres are internal with Io (and Europa) in the Jovian case and Enceladus for Saturn. The composition of the plasma and energetic particles, however, are different (H, S, O, SO_2, etc. in contrast to H, H_2O, OH^- etc.).

Both magnetospheres show similar transport processes like particle injections and interchange motion. Time scales, duration and frequencies, local time dependencies are different.

Both magnetospheres show an equatorial magnetodisc where most of the heavy ion plasma is located. However, in the Jovian case this pancake-like magnetodisc is wobbles up and down because of the tilt angle of 9.6 degrees between the rotation axis and the magnetic dipole axis of the planet while in the case of Saturn dipole - and rotation axis are perfectly aligned. The plasma lags rigid corotation in both magnetospheres creating large-scale current systems. Deep in the magnetotails out to 60-150 planetary radii partial corotation is still present and seem to be around 200 km/s in both cases.

Both magnetospheres exhibit large-scale reconnection processes in their magnetotails. However, if the trigger mechanisms are solar wind-driven or internally driven is not clear yet. If those reconnection processes are local time dependent or if they happen periodically every planetary rotation or after a certain mass loading time remains uncertain. Reconnection events are correlated with plasmoid releases where mass is released radially. However, the mass budget enforces that another process of mass release has to be acting in the magnetotails. Those processes are not fully understood.

In this paper we will summarize the results obtained in the magnetotails of Jupiter and Saturn and the remaining and new open questions which could be addressed in future missions like JUICE.