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Relationship between the occurrence frequency of Jovian substorm-like event and plasma density in the magnetosphere

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Jupiter has the largest magnetosphere in the planets of solar system, which has been produced by its rapid rotation period (about 10hours), strong intrinsic magnetic field and internal source of heavy plasma originated from Io.

The observations of the Galileo orbiter revealed that there are quasi-periodic flow bursts of energetic particles and the variation of the B-theta component implying magnetic reconnections in the Jovian magnetosphere. The signatures of these events are similar to the terrestrial substorm, so they are called substorm-like events.

In the preceding studies (Kronberg et al., 2007; Woch et al., 1998), their generation processes are proposed as follow based on a hypothesis of plasma mass loading in the Jovian magnetotail region; First, the magnetotail is stretched because of the large centrifugal force by the rapid rotation and heavy ions. Second, a reconnection occurs and a plasmoid is released. Third, the magnetic field configuration returns to the initial (non-stretched) state, but then the magnetotail stretching starts again and the cycle repeats to make the periodicity.

Studying physical processes of the events is important to understand global dynamics of the Jovian magnetosphere. Their characteristics, such as their variable periodicity (2.5 - 7 days) and existence of unobserved period etc., have been known well, however, it has not been revealed yet what factor controls the periodicity of the events.

In this study, we have examined the plasma mass loading hypothesis by investigating the plasma density inside the plasma sheet by using the data obtained by the Plasma Wave Subsystems (PWS), Energetic Particle Detector (EPD) and Magnetometer (MAG) onboard the Galileo orbiter.

As a result, it is suggested that there is some correlation between electron density in the magnetotail region obtained from the plasma frequency and the occurrence frequency of the substorm-like events derived from the changing of the north-south component of the magnetic field from the preceding study by Vogt (2010), and that there is also some correlation between energetic sulfur ion density and the occurrence frequency. These results support the proposed hypothesis; the Jovian substorm-like events are driven by an internal process.

Keywords: Jupiter, Jovian magnetosphere, magnetospheric dynamics, substorm, plasma density, Galileo