Short-term intense burst of Saturn kilometric radiation: Its relationship to the rotational phase and the north-south asymmetry

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This paper presents characteristics of short-term intense bursts of Saturn kilometric radiation (SKR) from 2005 to 2006. Our result shows the dependence of SKR bursts on the rotational modulations of Saturn in the northern and southern hemisphere, respectively. This supports that there exist field-aligned current (FAC) systems separated into two hemispheres in the Kronian magnetosphere.

At Earth, auroral kilometric radiation (AKR) spectra show the bursty changes characterized by a sudden increase of the main emission with the extension of their spectra down to lower frequencies in response to substorms (magnetic reconnection) driven by external (solar wind) drivers. It means that the occurrence of such variations is independent of the terrestrial rotation phase. SKR shows the similar short-term bursts like AKR although they occur on a longer time scale (several hours). In the case of Saturn, its magnetotail activities are affected by both external and internal (planetary rotation) drivers [Cowley et al., 2004]. Jackman et al. [2009] suggested the link between the SKR rotational modulations and the magnetotail reconnections. On the other hand, SKR has the rotational modulations with north-south asymmetric periods [Kurth et al., 2008; Gurnett et al., 2009]. There should therefore be some difference between northern and southern SKR bursts if they reflect strength of the field-aligned current system with distinct two rotational periods in each hemisphere [Andrews et al., 2010].

In this study, we examined the relationship between the short-term intense bursts and the SKR rotational phases with northern and southern SKR spectra observed with the Radio and Plasma Wave Science [Gurnett et al., 2004] on board Cassini spacecraft from 2005 to 2006. During this period, Cassini was traveling in an equatorial orbit, which is suitable to receive radio emissions from both northern and southern polar region. Northern and southern SKR phases are defined based on rotational modulations of SKR from each hemisphere [Lamy, 2011]. We selected 15 short-term intense bursts in northern SKR and 35 in southern SKR with the criteria, which consist of the followings: (1) SKR flux densities at low frequencies and (2) SKR total power must be significantly higher than median values of those during about 60 hours before and after the time of an SKR burst. (3) There must be no spectral gap between SKR main and lower-frequency bands. The result shows that more than 60 percent of bursts took place around time when northern or southern SKR phase was from 300 to 60 degrees, respectively. It suggests that the short-term SKR bursts occur in synchronization with SKR rotational modulations. And it supports the existence of the north-south asymmetric FAC systems separated into two hemispheres as proposed by previous studies although more events are needed to prove it. In addition, the fact that we detected more SKR bursts in the southern hemisphere than in the northern hemisphere shows ionospheric conditions can affect the frequency of SKR bursts. We will examine whether these tendencies are different after the equinox in 2009 in further studies.