Occurrence characteristics of Saturn kilometric radiation short-term intense burst (SKR burst)

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We focus on Saturn kilometric radiation short-term intense burst (hereafter, referred to as SKR burst), which has a time scale of several hours and the extension to lower frequency ranges generated in higher altitudes. It is well known that the SKR from the northern and southern hemispheres shows different rotational modulations. This study examined the occurrence characteristics of SKR burst and its relationship to the SKR variation, such as (1) the north-south difference, (2) the dependence on SKR rotational phases in the northern and southern hemisphere, (3) the relationship to the strength of background SKR main band emission in 100-400 kHz, and (4) the relationship to the tail reconnection events seen as the plasmoid events.

We define SKR bursts by the enhancement of the emission power integrated between 10 and 1000 kHz and the spectral extension to lower frequencies lower than 50 kHz. Since SKR is emitted at or close to the local electron cyclotron frequency, the extension of the spectrum can be interpreted as the extension of SKR sources to an altitude higher than 2 Rs. Jackman et al. [2009] showed the relationship between SKR bursts and substorm-like reconnection events identified by plasmoids in the Kronian magnetotail region. They also suggested that SKR bursts occurred in association with the SKR rotational modulation without north-south separation. After that, however, SKR period was found to have the north-south asymmetry [Kurth et al., 2008; Gurnett et al., 2009]. Thus, north-south separation is necessary for the understanding of SKR bursts.

We used northern and southern SKR spectral data separated according to polarization state. They are observed with the Radio and Plasma Wave Science [Gurnett et al., 2004] on board Cassini spacecraft. The analyzed data was derived in 2005-2006, when Cassini was in an equatorial orbit and detected radio emissions from both the northern and southern hemispheres. In order to identify SKR bursts, we need to identify the averaged level of the SKR whose intensity and spectral shape vary according to northern and southern SKR phases. We set the selection criteria of SKR bursts as follows: (a) Median SKR flux density from 10.1 to 45.6 kHz and (b) an SKR emission power integrated between 10 to 1000 kHz must be higher than their 75th percentiles, respectively. They are calculated every SKR phase of 5 degrees for 5 rotations (about 60 hours) before and after the timing when an SKR burst took place. The criterion (a) and (b) are for the detection of a lower-frequency extension and of the enhancement of SKR emission power, respectively. In addition, (c) there must be no obvious spectral gap between SKR main band and lower frequency band (from 21.5 kHz to 205 kHz) to exclude narrowband emissions which we do not take notice of.

As the result, we picked out 14 northern and 33 southern SKR burst events. (1) The difference in the number of events shows that southern SKR bursts tended to frequently occur than northern SKR bursts. (2) Approximately 40 percent of northern and southern SKR bursts occurred in phase with ordinal northern and southern SKR modulations, respectively. Assuming that there are two main components causing SKR enhancement, i.e., the rotational modulations and tail reconnections, the former seems dominant factor determining the timing of an SKR burst.

In the further analyses, we will investigate (3) and (4) in the first paragraph. For (3), we will examine a possible threshold value in flux density at SKR main band to discuss whether SKR bursts are controlled by the magnitude of filed-aligned current flowing in SKR source regions like AKR. For (4), Jackman et al. [2009] reported nine plasmoid events related to lower-frequency extensions of SKR. They did not, however, take into account the north-south separation of SKR. We will confirm whether the plasmoid events are always related to both northern and southern SKR bursts.