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# Study on the dawn-dusk asymmetry of Jupiter's radiation belt using radio interferometer and Hisaki

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## Abstract

In order to reveal variations of days to weeks in the brightness distribution of Jovian Synchrotron Radiation (JSR), we made simultaneous radio and ultraviolet observations using the Giant Metrewave Radio Telescope (GMRT) and the Hisaki EXtreme ultraviolet spectrosCope for ExosphEric Dynamics (EXCEED). It is known from visible and ultraviolet observations that Io plasma torus (IPT) has dawn-dusk asymmetry, and that this asymmetry is believed to be due to the dawn-dusk electric field. If this global electric field around Io's orbit penetrates the radiation belt region, the variations in brightness distribution of JSR and IPT are expected to be correlated. The GMRT and Hisaki observations in 2014 and 2016 indicate that JSR and IPT do not have a significant correlation. Although these results do not support our hypothesis, we cannot rule out the possibility that the dawn-dusk electric field was masked by some their process, including the conductivity variation and/or the time-variable longitudinal asymmetry of JSR.

## 1. Introduction

JSR is the most effective probe for the dynamics of the Jovian radiation belt through remote sensing from the Earth. The Jovian radiation belt is located in the strong magnetic field region and external forces such as solar wind disturbances are thought to be difficult to reach the radiation belt region. Although JSR has been thought to be stable for a long time, recent observations of JSR have revealed days to weeks variations of total flux density and brightness distribution. It is theoretically expected that the diurnal neutral wind system produces dawn-dusk asymmetry in the brightness distribution of JSR [1]. However, our Very Large Array data analysis showed that the short term variations in the brightness distribution cannot be examined solely by the scenario [2]. There is a possibility that variations related to diurnal wind system were masked by some other processes which dominated in the variations of the dawn-dusk ratio of the short time scale.

In this study, we examine the effect of dawn-dusk electric field on the Jovian radiation belt. It is known from visible and ultraviolet observations that Io torus has dawn-dusk asymmetry and this asymmetry is thought to be caused by a dawn-dusk electric field. In addition to that, the continuous ultraviolet observation by Hisaki reveals that dawn-dusk asymmetry of Io torus changes in days to weeks, which suggests that the dawn-dusk electric field also varies in days to weeks. If this global electric field affects inside the magnetosphere, the variations in brightness distribution of JSR can be explained by the dawn-dusk electric field.

## 2. Observations

We made a coordinated observation of radio interferometer and Hisaki to investigate the effect of the dawn-dusk electric field on the Jovian radiation belt. This is the first opportunity that dawn-dusk electric field and brightness distribution of JSR can be compared simultaneously. The radio observations were made from 2013 December 31 to 2014 January 16 at 610 MHz and 2016 March 14–June 23 at 1390 MHz with Giant Metrewave Radio Telescope (GMRT), while Hisaki continuously monitored IPT.

## 3. Results and Discussion

The time series of the dawn-to-dusk ratios of IPT and JSR indicated that they sometimes varied in the same trend. However, statistical analysis showed that the IPT and JSR did not have a strong positive correlation as expected from the hypothesis. Spearman's rank correlation coefficient is −0.22 for 2014 and 0.048 for 2016. A correlation t-test at 10% significance level shows that JSR and IPT are regarded as no correlation. Therefore the short-term variation in the dawn-dusk asymmetry of JSR cannot be explained only by the dawn-dusk electric field. Although these results do not support our hypothesis, we cannot rule out the possibility that the dawn-dusk electric field was masked by some other process, including the conductivity variation and/or the time-variable longitudinal asymmetry of JSR.

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