Long-term variation of the North–South asymmetry in the intensity of Saturn Kilometric Radiation (SKR) in 2004-2017

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This study investigates the long-term variation of Saturn Kilometric Radiation (SKR) intensity observed by the Radio and Plasma Wave Science (RPWS) instrument on board the Cassini spacecraft from 2004 (southern summer) to 2017 (northern summer). The results clearly showed that the SKR intensity was more enhanced on the summer side than on the winter side. No clear correlation was found between the SKR intensity and the solar EUV flux.

SKR is a proxy of Saturn's auroral activity and magnetospheric dynamics. SKR emissions are right-handed extraordinary (R-X) mode waves excited via the cyclotron maser instability in the polar auroral regions along high-latitude magnetic field lines. Northern SKR (N-SKR) and Southern SKR (S-SKR) can be distinguished from their right-handed and left-handed sense of circular polarization, respectively. Its intensity has a long-term variation with north-south asymmetry. Kimura et al. [2013] studied the long-term variation of SKR intensity in the southern summer season from 2004 to 2010, and showed that the peak spectral density of S-SKR was found to be up to 100 times greater than that of N-SKR in 2004 (mid southern summer), and became comparable around equinox in August 2009. SKR was thus brighter on the summer side than on the winter side. This trend seemed to be also related to the declining solar activity.

We extended this study up to September 2017, taking advantage of radio observations acquired over the whole Cassini mission. We used the SKR spectral densities integrated over 100 –800 kHz and normalized at the distance of 1 AU. To remove visibility effects resulting from strongly anisotropic emission, we restricted to Cassini near-equatorial observations (latitudes $|\lambda| < 5°$), where both N-SKR and S-SKR can additionally be observed simultaneously.

We first investigated the long-term variation of the N- and S-SKR intensities separately. The integrated N-SKR flux did not largely change from 2004 to 2017, while the S-SKR flux became 100 times smaller at northern summer than at southern summer. Then, we investigated the intensity ratio of S-SKR to N-SKR. This ratio evolved from ˜10 around mid southern summer (2004), reduced to ˜1 around equinox (2009), and to ˜0.1 in mid northern summer (2015). These results illustrate that SKR is brighter in the summer hemisphere, in agreement with Kimura et al. [2013].

Our study also revealed two interesting results. (1) The reversal in the intensity ratio of S-SKR to N-SKR was mainly caused by the long-term reduction of the S-SKR intensity. (2) The long-term variation of the intensity ratio was not clearly synchronized to that of N- and S-SKR rotational periods. We checked the correlation between the SKR intensities and the solar EUV flux, but found no clear correlation. On long-term timescales, while the solar activity increased from 2010 to 2014, the N-SKR intensity was

almost constant and the S-SKR intensity decreased by a factor of 10. On short-term timescales, when the EUV flux suddenly increased due to a solar flare, there were no apparent changes in the SKR flux in both hemispheres. We thus conclude that the seasonal (and also short-term) variation of solar EUV illumination of Saturn's ionosphere do not directly affect the SKR intensity.

Keywords: Saturn, Aurora, Saturn Kilometric Radiation