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Study on the source structure of Jovian decametric radiation by using 500 km class long baseline interferometer

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Jovian decametric radiation (JDR) has been categorized as characteristic emissions from celestial objects which have intrinsic dipole type magnetic fields. Though many ground and satellite based observations have been carried out since the discovery in 1955, the emission mechanism has not been understood in their details points. Especially, the source position and structure has not been fully revealed. Because of the significant effects of propagating media on the decameter radio waves, very long baseline interferometer technique (VLBI) has not yet been established in this wavelength range. The phenomena such as refraction and scintillation affect the fringe phase and the correlation coefficient in the interferometer observations. To overcome these disturbing effects, the Tohoku University group has carried out 100 km class VLBI observations for JDR since 1970s.

We have developed a 500 km class long baseline interferometer network for JDR observation in order to solve the problem of propagation effect through collaboration works between Tohoku University and Fukui University of Technology from 2003. In 2008, remarkable decameter wave emissions from Jupiter were successfully received in March 28.

From the data analyses for the intensity, the effect of interplanetary scintillation (IPS) was detected clearly, indicating the solar wind velocity of about 422 km/s with the spatial scale of irregularity of plasma density from 400 km to 1500 km. These evidences for the solar wind parameters are able to be obtained due to the characteristics of source regions of JDR, which is smaller than 3.4 arcsec in angular size.

From the correlation analyses for the data, we obtained maximum normalized correlation coefficients of 0.98 giving the angular size of observed JDR source as to be smaller than 3 arcsec. Furthermore, the closure phase value of the interferometer becomes to be zero in error range less than 6 degrees estimated from the S/N ratios of received signals. These results also support that the source size of observed JDR is very compact.

The effect of propagation media on resulted fringe phases of the interferometer takes place changing features corresponding to the baseline length of the system, as the effect of refraction in the terrestrial ionosphere was dominated in 100 km class baseline, while the effect of IPS was often dominated in 500 km class baseline. Because the extent of the IPS effect depend on the scale size of irregularities in plasma density, a long baseline of the interferometer more than a few hundred km is required to investigate near opposite condition.