Delay time analysis for determining the source structure of Jovian decametric radiation

Tomoyuki Nakajo[1]; Hiroshi Oya[2]; Takayuki Ono[3]; Masahide Iizima[4]

[1] Space Commu. Fukui Univ.; [2] Space Commu. Fukui Univ. Tech.; [3] Department of Astronomy and Geophysics, Tohoku Univ.; [4] Geophysical Inst., Tohoku Univ.

It has been well known that the coherent radio waves are radiated in decameter range with the occurrence of solar flare or the emission of Jovian aurora. The Jovian decametric radiation (JDR) is the only one that we can observe from the ground among the radio waves radiated from the planets which have the dipole magnetic fields. In Tohoku University, the 100km-class long baseline interferometer observations have been carried out for purpose of determining the position or the structure of JDR sources. However, the accurate determination of source position becomes difficult due to the variation of electron density in the terrestrial ionosphere. We study the delay time analysis as alternative approach of phase detection seeking for the improvement of S/N ratio under the influence of terrestrial ionospheric plasma.

In the delay time analysis, cross-correlation function is calculated for the signals observed at each observation station. In the case of white noise from a point source, the waveform of the calculated cross-correlation shows a functional form similar to that of the delta function. For the delay time deduced from the calculated correlation can be converted to the arrival direction so that the cross-correlation function works as a function of directivity of the array antenna system. When the baseline length of the interferometer becomes longer or the frequency bandwidth of the receiver in the system becomes wider, the half-width of the equivalent antenna beam becomes narrower.

We demonstrated the delay time analysis by using the JDR event (Io-B) observed at Yoneyama and Iitate stations in Tohoku University from 19:20:00 to 19:40:00 (JST) on April 16 in 2002. The baseline length of the interferometer for this observation is about 111 km and the baseline direction is nearly north to south. The front-end of the observation system consists of 9 elements log periodic antenna and pre-amplifier. The received signals passing through the front-end of the system are fed into the main receiver, which consists of two receiving system so that dual frequency observation is made. In this main receiver, the signals are converted from 5 kHz to 15 kHz. The converted signal is digitized by the AD converter where the data are sampled with frequency of 50 kHz, and the digitized data are stored in HDD at each observation station. In order to ensure the phase stability of signals and to make all timing of system to be accurate, the cesium frequency standards are installed at all stations.

The results of analyses have indicated feature of the delta function showing that JDR consists of white noise like components. Microscopic feature of JDR shows the coherent nature, then it can be concluded that JDR sources consist of multiple of coherent sources which emit the radio waves independently. Additionally, the half-width of the equivalent antenna beam of the interferometer system is estimated to be 8 degrees. Based on the results, it is expected that the half-width of the equivalent beam pattern is close to about 47 arcsec (Jovian apparent diameter is about 40 arcsec) by using the receiver which has 2MHz bandwidth and the 400km-class baseline interferometer system consists of Awara station in Fukui University of Technology and observation stations in Tohoku University.