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Test observation of the Jovian synchrotron radiation by the newly developed radio telescope at the Iitate observatory

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A new radio telescope has been completed in Iitate village of Fukusima prefecture. The telescope is a fully steerable offset parabola antenna with physical aperture of 1023 square meters. Observational frequency range for this telescope is 300 to 800 MHz.

Primary purpose of this telescope is to detect short-term variations of the synchrotron radiation from Jupiter's radiation belt and clarify their physical processes. We present overviews of the system requirements, receiver and calibration systems for the new telescope, and initial observational results of some radio stars and Jupiter.

The Jovian synchrotron radiation (JSR) is emitted from relativistic electrons trapped in the Jovian radiation belt. An observation of JSR by using a ground telescope is most useful tool for remote sensing of electromagnetic environment of Jupiter's inner magnetosphere because of difficulties of in-situ observations. Resent observations of JSR confirmed the presence of short-term variation with the time scale of a few days to a few months. The short term variations are considered to be caused by some magnetospheric processes, such as a solar wind energy input into the magnetosphere and/or electromagnetic coupling between the magnetosphere and the upper atmosphere, and then subsequent acceleration and transport of relativistic electrons. Acceleration and transport processes modify the energy spectrum and pitch angle distribution of relativistic electrons in the radiation belt. In order to research physical processes in the Jovian radiation belt, therefore, it is necessary to measure spectrum and polarization of JSR, which reflect spectrum and pitch angle distribution of the electrons, and to detect time scale of the variation, which reflects the time constants of electron acceleration and transport in the radiation belt.

Variations of total flux density of JSR also reflect the re-distribution of the relativistic electrons. Flux density of JSR is about 5 Jy (1 Jy = 10^-26 W/m^2 Hz) with periodic amplitude variation of about 1 Jy due to the rotation of Jupiter. In order to detect natural variations of JSR, receiver system for the new telescope should be designed to enable an absolute flux measurement with minimum detection sensitivity of about 0.1 Jy.

Receiver and calibration systems for the new telescope are designed to satisfy above requirements. We plan to choose two frequency bands for the spectrum observation, 325 MHz and 780 MHz. Polarization measurements are also planed at both frequency bands. In February 2002, the development of front-end receiver system at a frequency of 325 MHz has been completed. The design and development of front-end receiver at another frequency, and back-end receiver system including polarization measurement unit and gain/phase calibration unit, are now under way. In order to improve aperture efficiency, which is anti-proportional to the minimum detection sensitivity, beam forming of primary feed dipole is also in progress.

Details of the receiver and calibration systems and methods of system evaluation are presented by Watanabe et al. in this meeting.

At the frequency of 325MHz, test observations were carried out to evaluate effective aperture efficiency and pointing error of the telescope, and observations of JSR has been started. Galactic structures with large radio flux are presented behind Jupiter in this frequency range, it is necessary to observe galactic component after Jupiter passes away to remove the background confusion.