# CubeSat project for the investigation of the beaming structures of Jupiter's decametric radio emissions

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Since the discovery of Jupiter's radio emissions in 1955, important details of its radiation mechanism have not yet been elucidated. Jupiter radio waves are powerful enough to easily observe on the earth, because large particle energies generated in the Jovian magnetosphere are converted into radio wave radiation energy. In order to investigate the beaming concept of Jupiter radio waves, which is important for clarifying this Jupiter radio emission mechanism, we will launch a 2U-size CubeSat for observation of Jupiter radio waves and observe simultaneously in outer space and on the ground. The purpose of this project is to measure the emission delay time by using a correlation analysis method.

It is estimated that the beaming structure of the S bursts of the short Jovian radio bursts (S bursts), has a large angle with respect to the Jovian magnetic field lines and has a narrow beam thickness. The delay time can be measured by the correlation analysis of waveform data obtained by simultaneous observations of Jupiter radio S bursts between this satellite and the ground. If the beam of Jupiter radio S bursts is moving together with the rotation of Jupiter, we can calculate a time difference of about 70 milliseconds at the base line length of 8000 km. Using the proposed simultaneous observations it is possible to test whether the Jovian S bursts are emitted like a 'beacon', rotating with Jupiter's magnetic field and sweeping by the Earth, or like a 'flashlight', an instantaneous emission with a 0 millisecond time delay. This result is very important information to determine the nature of the Jupiter radio emission mechanism.

The development of a 2U-CubeSat for Jupiter's decametric radio observation has been made by the collaboration with 8 colleges that belong to KOSEN-Space-Renkei Group. The students and teachers have been collaborating to develop the 2U-size CubeSat. This CubeSat is being considered to be launched from the International Space Station (ISS). The duration of the possible observation is estimated to be more than 50 days. During this period we are considering the measurement of the delay time between the CubeSat and ground observatories for the detection of Jovian S-bursts. The worldwide ground-based observations will be supported by the NASA RadioJOVE project, an education and outreach program for planetary radio astronomy.

We will show the design of the CubeSat for the observation of Jupiter's radio emissions, including the data acquisition system using a Raspberry Pi Zero with a GPS module, and the deployment of the antenna system. This Raspberry Pi Zero is a microcomputer board with Linux installed; it is considered to be suitable for this mission because of the small size and low power consumption. In order to observe Jupiter's radio waves, it is necessary to deploy a 3.6 m antenna at 20 MHz. We propose an antenna deployment mechanism using biometal fiber (BMF). BMF is a thread-like form in which fibers of Ti-Ni alloy have the property of contracting when voltage is applied. This antenna deployment mechanism using BMF has been tested and shows good function.

The measurement of the delay time between the CubeSat and ground observatories by the correlation analysis of Jupiter's S bursts is proposed to reveal the beaming structure of Jupiter's radio emissions. The elucidation of the radiation mechanism of Jupiter radio waves, which is the ultimate goal of Jupiter radio research, may lead to a better understanding of particle-wave energy generation mechanisms and their applications. From this point of view the contribution of this mission is believed to be significant.

This project is supported by the Coordination Funds for Promoting AeroSpace Utilization the Ministry of Education, Culture, Sports, Science and Technology (MEXT), JAPAN.