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A study of Jovian Radio Wave Observation using LLFAST (Lunar Low Frequency Astronomy Telescope)

Takahiro Iwata[1]*, Kazumasa Imai[2], Tomoyuki Nakajo[3], Tetsuro Kondo[4], Hiroshi Takeuchi[1]

[1]ISAS/JAXA, [2]Kochi N. C. Tech., [3]Fukui Univ. Tech., [4]NICT

Jovian decametric radio emissions (DAM) have been observed since 1955, and it became the starting point to elucidate planetary magnetospheres. However, their radiation mechanism has not yet been fully understood because the spatial in-formation of the radio sources was not enough. The highest spatial resolution obtained by the ground based VLBI (Very Long Baseline Interferometry) observations can not resolve the radio sources with the resolution of 1000 km at Jupiter, so that it has been impossible to inspect proposed models.

LLFAST-1 is one of the candidate mission instruments which will be equipped on the Japanese post lunar explorer in SELENE series which will be launched in the latter half of 2010's. It is an on-orbit station of a space VLBI composed with decametric radio telescope on the lunar orbiter and ground stations. The main objective of this stage is to observe the low frequency radio emissions from Io-Jupiter system. The highest spatial resolution of LLFAST observations will be about 20 km for 20-25 MHz source at Jupiter, which is expected to shed light on the new science for the micro structures and beaming of Jovian radio sources. LLFAST-1 is also regarded as the first step of on-orbit display for the interferometer for the very low frequency, less than 10 MHz, radio wave observations on the lunar far side.

Long period ground observations combined with in-situ observations have suggested an existence of a conical-sheet beam structure [1]. Precise positioning of DAM sources by the modulation lanes methods [2] have also shown the angle of cone and the magnetic flux via Io to be about 60 degree [3]. However, the De (Jovicentric Declination of the Earth) effect suggests a part of the model of a Jupiter radio search-light beam structure [4]. Such micro structures in the Jupiter radio sources region also support a highly coherent source region. This new model shows that the beam structure of Jupiter radio emissions, which is thought to be like a hollow-cone, has a narrow beam like a search-light, which can be explained by assuming the three dimensional shapes of the radio sources expanding along the line of the magnetic field. This model predicts the size of the coherent source region along the line of the magnetic field to be around 1 km for each individual source frequency component.

The highest spatial resolution of LLFAST observations will be about 20 km for 20-25 MHz source at Jupiter. The structures of DAM sources with the expected size of ~1 km can be confirmed by this spatial resolution using fringe visibility analysis with the coherent coefficiencies of more than 0.95. The positions of radio sources can also be estimated by the measurements of circular polarizations. It is also expected that our polarization observation can distinguish two of the wave-particle interaction mechanism; Cyclotron Maser Instability (CMI) mechanism [5] and Mode Conversion mechanism [6]. Our system will, thus, shed new light on the physics of planetary magnetospheres and plasmas.

References - [1] Carr et al. (1983), In Physics of the Jovian Magnetosphere, 226. [2] Imai et al. (2002), JGR, 107, A6, 10.1029/2001JA007555. [3] Dulk (1967), Icarus, 7, 173. [4] mai et al. (2008), AGU Fall Meeting, SM41B-1673. [5] Wu & Lee (1979), ApJ, 230, 621. [6] Oya (1971), Radio Sci., 6, 1131.

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