月周回衛星かぐやによる自然電波観測

熊本 篤志 [1]; 小野 高幸 [2]; 三澤 浩昭 [3]; 中川 広務 [4]; 笠原 禎也 [5]
[1] 東北大・理; [2] 東北大・理; [3] 東北大・理・惑星プラズマ大気; [4] 東北大・理・地球物理; [5] 金沢大

Natural radio wave observations by the lunar orbiting spacecraft Kaguya

Atsushi Kumamoto[1]; Takayuki Ono[2]; Hiroaki Misawa[3]; Hiromu Nakagawa[4]; Yoshiya Kasahara[5]
[1] Tohoku Univ.; [2] Department of Astronomy and Geophysics, Tohoku Univ.; [3] PPARC, Tohoku Univ.; [4] Dept. of Geophysics, Tohoku Univ.; [5] Kanazawa Univ.

Since the start of Lunar Radar Sounder (LRS) operations on Oct. 29, 2007, the Kaguya spacecraft has observed natural radio waves such as auroral kilometric radiation (AKR), Type-III solar radio bursts, galactic noises, and Jovian hectometric radiation (HOM). Because the Kaguya spacecraft is orbiting near the lunar surface, radio wave interferences are often caused by the reflection at the lunar surface. Observation of them will be useful for the investigation of the structure, albedo, and electric property of the lunar surface. The Kaguya HF receiver covers a frequency range from 20 kHz to 30 MHz with time resolution of 2 sec or 0.1 sec. Frequency range below the 10 MHz can not be covered by the observation from the ground due to the reflection by the earth's ionosphere. There are, however, few spacecrafts which cover frequency range above 1 MHz, such as Voyager-1, -2, Akebono, WIND, Galileo, and Cassini. The time resolution of the Kaguya HF receiver is better than the spacecrafts. Considering the merits and uniqueness of the radio wave observations by the Kaguya spacecraft, following analyses have been performed.

[Calibration] In order to obtain the correct spectra of the natural radio waves, the frequency response of the receivers has to be known. It is, however, difficult in the ground tests to measure the frequency response of the space-borne receiver connected with fully extended dipole antenna. The calibration should be carried out after the spacecraft launched based on the levels of onboard calibration signal and some natural and artificial radio waves. In the case of the Kaguya HF receivers, we assumed an equivalent circuit model which consists of antenna impedance obtained theoretically, receiver input capacitance measured in the ground tests, and some other impedance, which is probably due to the cables between the antenna and the receiver. Based on the spectrum of galactic noises and type-III solar radio bursts, the unknown impedance was determined and frequency response of Kaguya HF receivers was clarified. The noise level of the receiver is -190 dBW/m^{2}Hz in a frequency range below 14 MHz while it is -170 dBW/m^{2}Hz or higher in a frequency range above 14 MHz because input capacitance of the receiver is not small enough.

[Interference of AKR] AKR is often observed by the Kaguya spacecraft. Just before the spacecraft is occulted by the moon, interference patterns are often seen on the AKR spectrogram. They are probably caused by the reflection of AKR at the lunar surface. It is inferred that AKR is reflected at the lunar surface and superpose on directly arrived AKR. We performed calculation of interference patterns based on the difference of propagation distances of directly arrived AKR and reflected AKR. Calculated interference pattern was quite similar with observed one. AKR is most intense natural radio wave around the moon. It is probably possible that not only surface echoes but also subsurface echoes are included in the reflected AKR and affect the interference patterns.

[Fine structures of Jovian HOM] Some Jovian radio wave events in a hectometric wavelength range have been detected by the Kaguya HF receivers. Among them, there are two events whose spectrogram shows clear fine structures. The first event was observed on May 28, 2008. There were seen many fine structured emissions with negative frequency drift in the spectrogram. The interval was about 10 sec and the drift rate was -35 kHz/sec. The second event was observed on June 23, 2008. There were seen many bursts without any clear frequency drift in the spectrogram. The interval of the bursts was 10-30 sec and the duration was less than 10 sec. These two events are observed within large arc-like structures. It is, therefore, inferred that they are low-frequency extension of Jovian decametric radiation (DAM) and fine structures correspond to modulation lane and L bursts which are often observed in decametric wavelength ranges.