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Lunar ionosphere examination using natural plasma wave

Yoshitaka Goto[1*], Takamasa Fujimoto[1], Yoshiya Kasahara[1], Atsushi Kumamoto[2], Takayuki Ono[2]

[1]Kanazawa University, [2]Tohoku University

The evidence of the lunar ionosphere was first provided by radio occultation experiments performed by the Soviet spacecraft Luna 19 and 22. This result has been, however, controversial for these three decades because the measured large density was difficult to explain theoretically without magnetic shielding from the solar wind. In the KAGUYA mission, electron density profiles above the lunar surface were also measured by the same technique using V-star sub-satellite. Since the measurements by this technique include influences of the earth's ionosphere, it is necessary to remove them precisely in order to evaluate the lunar ionosphere. On the other hand, natural wave observations from the KAGUYA give opportunity to investigate the existence of the lunar ionosphere with another method.
The Lunar Radar Sounder (LRS) makes passive observations of electric field of natural waves as well as subsurface radar experiments. In the observations, dynamic spectrum of auroral kilometric radiation (AKR) around a few hundred kHz from the earth shows clear interference pattern with stripes which is caused by phase differences between direct waves and waves reflected on the lunar surface or lunar ionosphere. Since phases of the reflected waves are associated with electron density profile below observation points, the existence of the lunar ionosphere can be discussed from the interference patterns. In the presentation, we demonstrate that such observed interference patterns are accurately constructed with ray tracing technique by giving suitable density profile and landform data of the lunar surface. Then, the existence of the lunar ionosphere is discussed for each observed pattern using theoretically reconstructed ones for variety of simulated electron density profiles.

Keywords: KAGUYA satellite, lunar ionosphere, natural plasma wave