

R006-25

B会場：11/27 AM2 (11:05-12:35)

12:20~12:35:00

2024年5月巨大地磁気嵐時のULF波動による放射線帯電子の拡散について

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ULF wave radial diffusion of radiation belt electrons during the May 2024 super geomagnetic storm

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The acceleration mechanism of radiation belt electrons is a crucial research issue in magnetospheric plasma physics in terms of particle acceleration and space weather. While the local acceleration of radiation belt electrons by plasma waves has been extensively studied in recent years (Thorne, 2010; Reeves et al., 2013; Thorne et al., 2013), radial diffusion is also considered as an important factor that redistributes radiation belt electrons from the region of the local acceleration to other locations (Ma et al., 2018). Previous studies of the radial diffusion caused by ultralow frequency (ULF) waves developed empirical models of the radial diffusion coefficient under various geomagnetic activity levels (Brautigam and Albert, 2000; Brautigam et al., 2005; Ozeke et al., 2012, 2014; Sandhu et al., 2021; Murphy et al., 2023). However, these models do not cover the highest levels ($K_p > 7$, where K_p is the Planetary K index), and thereby event analysis is required to obtain an accurate radial diffusion coefficient during the G4 ($K_p = 8, 9$ -) and G5-class ($K_p = 9$) geomagnetic storms. Therefore, to understand the role of ULF waves in the radial diffusion of electrons during the highest geomagnetic activity, we investigated the ULF wave activity during the G5-class geomagnetic storm in May 2024. In the early recovery phase of this storm, the Arase satellite (Miyoshi et al., 2018) detected toroidal waves with a large amplitude (60 nT peak-to-peak) in the dawn sector (9-11 MLT hours) on May 11, 2024. Although the toroidal waves were detected deep in the magnetosphere at $L > 2.5$, their frequency ranges from 2 to 6 mHz, corresponding to the Pc 5 range. We also analyzed the geomagnetic field observed at the International Monitor for Auroral Geomagnetic Effect (IMAGE) stations near Arase's ionospheric footprint. Using the amplitude-phase gradient method (Pilipenko and Fedorov, 1994), we identified the frequencies of field line resonance (FLR) at the altitude-adjusted corrected geomagnetic (AACGM) latitudes between 47 to 59°. The FLR frequencies obtained from the ground-based observation were close to Arase's observation and gradually decreased with AACGM latitude. These results demonstrate that the toroidal Pc 5 waves observed by Arase are standing Alfvén waves excited through FLR. Using the formula derived by Ozeke et al. (2014), we calculated the radial diffusion coefficients of a 950 keV electron for the toroidal Pc 5 waves with an assumption of $m = 3$, where m is the azimuthal wave number. The diffusion coefficient of the electric field reached $\sim 10 \text{ day}^{-1}$ around $L = 4.6$, an order of magnitude larger than that of $K_p = 6$ calculated by Ozeke et al. (2014). Given that the local peak of the phase space density of $\sim 1 \text{ MeV}$ electrons is located at $L < 4$, we suggest that the toroidal standing Alfvén waves transport the $\sim 1 \text{ MeV}$ electrons from the location of the local peak to an outer region within a few hours.