Energetic ion acceleration deep in the magnetosphere at the sudden commencement of the May 2024 super magnetic storm

*堀 智昭[1]、新堀 淳樹[1]、三好 由純[1]、山本 和弘[1]、桂華 邦裕[2]、笠原 慧[2]、横田 勝一郎[3]、笠羽 康正[4]、松田 昇也[5]、笠原 禎也[5]、松岡 彩子[6]、篠原 育[7]
*Tomoaki Hori[1], Atsuki Shinbori[1], Yoshizumi Miyoshi[1], Kazuhiro Yamamoto[1], Kunihiro Keika[2], Satoshi Kasahara[2], Shoichiro Yokota[3], Yasumasa Kasaba[4], Shoya Matsuda[5], Yoshiya Kasahara[5], Ayako Matsuoka[6], Iku Shinohara[7]

1. 名古屋大学宇宙地球環境研究所、2. 東京大学、3. 大阪大学、4. 東北大学、5. 金沢大学、6. 京都大学、7. 宇宙航空研究開発機構宇宙科学研究所
1. Institute for Space-Earth Environmental Research, Nagoya University, 2. The University of Tokyo, 3. Osaka University, 4. Tohoku University, 5. Kanazawa University, 6. Kyoto University, 7. ISAS/JAXA

The Arase satellite observed repetitive acceleration of energetic ions associated with electric and magnetic field fluctuations deep (L ~ 5.5) in the late afternoon sector (MLT ~ 16h) of the Earth’ s magnetosphere upon the sudden commencement of the May 2024 super magnetic storm. Our previous study revealed that energetic proton fluxes periodically intensified over an energy range of a few tens up to ~120 keV with a period of ~3 minutes, in synchronization with dumping oscillations of the electric and magnetic field with the same period. Taking a closer look at each of the flux intensifications, we also identified that its higher energy part (~70 to 120 keV) consisted of repeated, impulsive flux enhancements with a period of ~30 s, each of which show clear energy and pitch-angle dispersion. The impulsive nature accompanied by dispersion signatures implies that ion acceleration took place somehow impulsively every ~30 s around the magnetic equator and dispatched a range of energy and pitch angle of energetic protons along the field line toward Arase at a magnetic latitude of ~20 degree in the northern hemisphere; ions with different energies and pitch angles arrived at the satellite with different time-of-flights. As an extended study, we proceed to analyze high-time resolution (64 Hz) data of the magnetic field and have found that the magnetic field fluctuation also contains a significant toroidal component with a period of ~30 s (in the Pc3 frequency range), the same as that of the fine-scale proton flux enhancements. This fact allows us to speculate that some Pc3-range ultra-low frequency (ULF) waves are excited locally at or propagate from the dayside to the particular field line where Arase was situated and plays a role in causing the repeated acceleration of energetic protons. We examine in more detail the wave property of the observed ULF wave and discuss how they are excited in association with the rapid compression of the magnetosphere impinged by the interplanetary shock.

キーワード：磁気圏、磁気嵐、粒子加速、超低周波波動
Keywords: magnetosphere, magnetic storm, particle acceleration, Ultra-low frequency wave

