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Characteristics of plasma transport energization in the inner magnetosphere: Long-term observations by Arase/MEP-i

Kunihiro Keika [(1)], Kanako Seki[(1)], Satoshi Kasahara[(1)], Shoichiro Yokota[(2)], Yoshizumi Miyoshi[(3)], Tomoaki Hori[(3)], Iku Shinohara[(4)], and Ayako Matsuoka[(5)]
(1) Graduate School of Science, The University of Tokyo, Tokyo, Japan; e-mail: keika@eps.s.u-tokyo.ac.jp
(2) Graduate School of Science, Osaka University, Osaka, Japan
(3) Institute for Space-Earth Environmental Research, Nagoya University, Nagoya, Japan.
(4) Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency, Sagamihara, Japan.
(5) Graduate School of Science, Kyoto University, Kyoto, Japan.

This study investigates the energization of near-Earth magnetospheric plasma, particularly inside the geosynchronous orbit called the inner magnetosphere. It is well known that the inner magnetosphere is composed of plasma with a wide range of energies, from eV to MeV. The plasma pressure is contributed mostly from ions with energies of ~1 to a few hundreds of keV. The energetic ions are primarily transported from the plasma sheet and energized during the transport. The spatial distribution of the energetic ions and its temporal evolution play important roles in a drastic change of the global current system including the ring current during magnetic storms. The distribution function of the energetic ions in velocity space is a key to determining the generation of electromagnetic waves such as electromagnetic ion cyclotron (EMIC) waves and ultra-Low frequency (ULF) waves. These waves can affect the velocity distribution of energetic ions, for example, by scattering pitch angles scattering.

This study primarily (1) examines the temporal and spatial variations of phase space densities of the energetic ions during the entire period of a magnetic storm including the initial, main, and recovery phases, and (2) performs a statistical study of the energetic ion characteristics for >50 magnetic storms observed by the Arase spacecraft in 2007 to present. These analyses aim to determine (a) the dependence of the dominant transport process on the adiabatic invariants and ion mass and (b) the contribution from EMIC, ULF, and other plasma waves to the transport and energization. Our previous study [1] focused on the outer part of the ring current, in the radial distance range of ~5 to ~7, suggesting that, with the analysis of ion energy spectra, lower-charge-state heavier ions are energized more preferentially during the main and early recovery phases of magnetic storms. This study extends the spectral analysis toward observations that were made in the deep inner magnetosphere and during longer time periods including the initial and late recovery phases and non-storm times.

References

[1] K. Keika, S. Kasahara, S. Yokota, M. Hoshino, K. Seki, T. Amano, L. M. Kistler, M. Nosé, Y. Miyoshi, T. Hori, and I. Shinohara, “Preferential Energization of Lower-Charge-State Heavier Ions in the Near-Earth Magnetotail”, Journal of Geophysical Research: Space Physics, 127, e2021JA029786. doi:10.1029/2021JA029786.