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Relativistic electron acceleration in Earth's Van Allen Belt: Observations from the Arase satellite

Y. Miyoshi[1], I. Shinohara[2], T. Takashima[2], T. Mitani[2], N. Higashio[2], S. Kasahara[3], S. Yokota[4], K. Asamura[2], Y. Kazama[5], S-Y. Wang[5], Y. Kasahara[6], S. Matsuda[2], Y. Kasaba[7], S. Yagitani[5], A. Matsuoka[2], H. Kojima[8], Y. Katoh[7], K. Shiokawa[1], S. Kurita [1], S. Saito[1], M. Shoji[1], M. Teramoto[1], T. Hori[1], InChun.Park[1], T.F. Chang[1], and Y. Tsugawa[1]

[1] Nagoya University, [2] JAXA, [3] The University of Tokyo, [4] Osaka University, [5] Kanazawa University, [6] ASIAA, [7]Kyoto University

e-mail (speaker): miyoshi@isee.nagoya-u.ac.jp

Relativistic electrons of the Van Allen belts dynamically change associated with disturbances of the solar wind. Typically, MeV electron fluxes of the outer belt decrease during the main phase of geospace storms and then recover and often increase during the recovery phase. Recent studies suggest that the cyclotron resonance between non-linear whistler mode waves (chorus) and sub-relativistic electrons is the fundamental process to cause the large flux enhancement of MeV electrons. Different plasma/particle populations contribute to this process. The whistler mode waves are generated through the temperature anisotropy of 10s keV electrons, i.e., ring current and plasma sheet electrons. The thermal plasma population controls the dispersion relation and the resonance condition between waves and particles as an ambient media. Therefore, cross-energy coupling with different energy ranges of 6 orders through wave-particle interactions is essential to cause accelerations of MeV electrons.

In order to elucidate the flux enhancement and loss process of relativistic electrons of the outer belt as well as the dynamics of geospace storms through cross-energy couplings, the Exploration of energization and Radiation in Geospace (ERG) project has been organized [Miyoshi et al., 2018]. The following teams are involved in the ERG project: the satellite observation team, ground-based network observation team, and integrated data analysis/simulation team. The synergetic approach with these teams provides a comprehensive view of the radiation belts and inner magnetosphere for geospace storms. The main science questions of this project are as follows:

1) Which external source process and internal acceleration process are dominant for the large flux enhancement of relativistic electrons during geospace storms?

2) How do wave-particle interactions accelerate the relativistic electrons of the outer radiation belt?

3) What are the dominant loss processes for the relativistic electrons of the outer radiation belt?

The ERG (Arase) satellite was successfully launched on December 20, 2016. After the initial operation including maneuvers, Arase has started normal observations since March, 2017. Arase has observed several geomagnetic storms driven by coronal hole streams and CMEs. The six particle instruments; LEPe/LEP-i/MEP-e/MEP-i/HEP/XEP have shown large flux enhancement as well as loss of wide energy electrons and ions as well as changes of pitch angle and energy spectrum. In some of these disturbances, the Arase satellite observed large flux enhancements of MeV electrons of the outer belt and hot electron/ion injections from the plasma sheet. The two field/wave instruments: PWE and MGF observed significant enhancements of several kinds of plasma waves such as chorus, hiss, EMIC and MHD waves in the inner magnetosphere.

In this presentation, we will report overview of flux variations of the outer radiation belt electrons from the Arase observations. Especially, we will discuss which solar wind streams cause the large flux enhancement of multi-MeV electrons of the outer radiation belt, taking into consideration of balance between source and loss processes of the outer belt electrons.

References

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