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In-situ observations of plasma/particle distribution function and plasma waves by the Arase satellite

Y. Miyoshi[1], K. Asamura[2], Y. Kazama[3], S. Saito[4], S. Kurita[5], S. Matsuda[6], Y. Katoh[7], S. Imajo[5], M. Shoji[1], T. Hori[1], C.-W. Jun[1], S. Nakamura[1], S.-Y. Wang[3], S. Kasahara[7], S. Yokota[8], T. Mitani[2] , N. Higashio[2], Y. Kasahara[6], H. Kojima[5], A. Matsuoka[5], I. Shinohara[2]

[1] ISEE, Nagoya University, Japan
[2] JAXA, Japan
[3]Academia Sinica, Taiwan
[4]NICT, Japan
[5]Kyoto University, Japan
[6]Kanazawa University, Japan
[7]Tohoku University, Japan
e-mail (speaker): miyoshi@isee.nagoya-u.ac.jp

In geospace, plasma/particle distributions exist in a wide energy range from eV to several MeV, and electromagnetic disturbances triggered by severe variations in the solar surface, called space storms, can cause intense and prolonged aurora activities, a build-up of ring current, and other large scales variations. During space storms, MeV electrons in the radiation belt show disappearance and enhancement of their flux, indicating that acceleration processes to generate relativistic electrons work associated with space storms. Geospace is a collisionless plasma system, and wave-particle interactions play an important role in plasma/particle dynamics.

To understand how wave-particle interactions in geospace change the geospace plasma environment, how space storms develop, and how energetic electrons in the radiation belts change, the Geospace Exploration Satellite "Arase" was launched in 2016 and has operated since 2017 to present [1][2]. The satellite has instruments for observation of electrons (~ tens eV to ~ MeV) and ions (10 eV/q -180 keV/q) with mass discrimination. The satellite also observes electromagnetic waves (electric field: DC-10MHz, magnetic field: DC-100kHz).

In this presentation, we will introduce the highlights in the scientific achievements of the Arase satellite, focusing on significant variations of the distribution function of plasma/particles. 1) direct detection of electron acceleration and scattering by whistler mode waves, 2) scattering and heating of background ions by electromagnetic ion cyclotron waves and ion Bernstein waves, and mode conversion between waves. About 1), we will discuss wave-particle interactions that produce various electron dynamics, including electron acceleration due to the interaction of electrons with a chorus of nonlinear whistler mode waves, electron scattering, and the correspondence with auroral emission caused by electron scattering [3][4][5][6]. About 2), we will discuss the mode conversion process between ion Bernstein waves and electromagnetic ion cyclotron waves through cross-energy couplings and a possible role on the ion heating. Results about the direct measurements of the phase differences between gyrating ions and electromagnetic waves are presented [7][8].

References

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