【Grant-in-Aid for Scientific Research(S)】
Science and Engineering (Mathematical and physical sciences)

Title of Project : Study on relativistic electron accelerations with a development of wave-particle interaction analyzer

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Research Area : Earth and planetary science
Keyword : solar-terrestrial physics, radiation belts, electron acceleration, space weather

【Purpose and Background of the Research】

In geospace (inner magnetosphere), there exist the radiation belts that consist of trapped relativistic electrons and ions. Recent advances of theoretical and computer simulation studies suggest that whistler mode chorus emissions play an important role to generate relativistic electrons. The direct measurement of the relative phase between the cyclotron motion of an electron and wave field vector is essential for the identification of the energy transfer process between particle and waves. In conventional observations, the particle distribution function is derived from the integrations of the particle counts in the velocity space, which conceals the energy transfers between particle and waves.

We have proposed the new measurement concept of wave-particle interaction analyzers (WPIA) that can correlate the phase between an electron and wave, which can provide definitive evidence on the energy transfer via wave-particle interactions. In this project, we will realize this idea as a software program in CPU onboard the satellite. This Software-type WPIA (S-WPIA) system will be installed in the satellite and sounding rocket for in-situ observations, which will establish the new measurement methods of space plasma

【Research Methods】

In this research project, the following three subjects are conducted.

1) Development of S-WPIA simulator
2) Development of S-WPIA system
3) Operational tests of S-WPIA system with sounding rocket and satellite programs.

1) We study the chorus generation as well as the electron acceleration processes by a comprehensive simulation combined with the global simulation for the inner magnetosphere and the micro simulation for the wave-particle simulation. The developed pseudo-S-WPIA observations will be conducted using the S-WPIA simulator, which can be used for a design of measurement algorithm and observation plan.
2) We develop the pulse conversion unit of the particle measurement, onboard plasma density measurement unit, and timing synchronization unit that are essential components of the S-WPIA system. Taking into consideration of the study of subject 1), we develop software for the S-WPIA systems.
3) The S-WPIA observation system is established by in-situ observation for wave-particle interactions with sounding rocket and the satellite.

【Expected Research Achievements and Scientific Significance】

The S-WPIA system developed by this project realizes the direct measurement method for wave-particle interactions in space plasma. The concept of S-WPIA is an innovative method of space plasma measurements, which contributes a great advance for understanding of wave-particle interactions and particle acceleration mechanism.

【Publications Relevant to the Project】

- Fukuhara, H., H. Kojima, Y. Ueda, Y. Omura, Y. Katoh, and H. Yamakawa, A new instrument for the study of wave-particle interactions in space: One-chip wave-particle interaction analyzer, Earth Planets Space., 61, 756-778, 2009.
- Miyoshi, Y., et al., Geospace exploration mission: ERG project, Trans. Japan Soc. Aer. Space Science, 8, ists27, 2010.

【Term of Project】 FY2011-2015

【Budget Allocation】 162, 200 Thousand Yen

【Homepage Address and Other Contact Information】

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