Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

PEM07-P01 Room:Convention Hall Time:May 22 18:15-19:30

Statistical analysis of EMIC waves in the inner magnetophere from the Akebono observations

Yuichi Kato[1*], Miyoshi, Yoshizumi[1], Sakaguchi, Kaori[2], Kasahara, Yoshiya[3], Kitamura, Naritoshi[1]

[1]Solar-Terrestrial Environment Laboratory, Nagoya University, [2]National Institute of Information and Communications Technology, [3]Information Media Center, Kanazawa University

Electromagnetic ion cyclotron (EMIC) waves are often observed in the inner magnetosphere and EMIC waves are important to cause the pitch angle scattering of ring current ions as well as relativistic electrons of the radiation belts. Although the spatial distributions of EMIC waves have been investigated by several spacecraft such as CRRES and THEMIS, there have been little studies on the latitudinal distributions. In this study, we use the Akebono satellite data that has observed inner magnetosphere since 1989. We assumed that EMIC waves are the plane wave. Therefore, we have done the polarization analysis using the Means method using both electric and magnetic field data taken from the ELF instrument. We identify EMIC waves by visual inspection, considering characteristics of the wave dispersion relation. As a result of statistical study, EMIC waves are often found for $L<3$, especially, in the dusk-side, while the EMIC waves are found in the post-noon side. Moreover, EMIC waves are found within the magnetic latitude range $|MLAT|<30$ degrees for $L<7$, while the EMIC waves are hardly found within the magnetic latitude range $|MLAT|>$ 60 degrees. In this presentation, we report the spatial distributions of EMIC waves considering the different polarizations as functions of MLT, L and the MLAT and will compare with statistical analyses from CRRES and THEMIS.

Keywords: EMIC waves, Inner magnetosphere, Akebono

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Statistical analysis of chorus emissions in the dayside outer magnetosphere

Toshihiro Habagishi[1*], Natsuki Yamada[1], Satoshi Yagitani[1], Yoshiharu Omura[2], Hirotsugu Kojima[2]

[1]Kanazawa University, [2]RISH, Kyoto University

We analyze chorus emissions observed by Geotail spacecraft in the dayside outer magnetosphere (L from 9 to 10). On the basis of the nonlinear growth theory [1], a rising-tone element is initially generated continuously in the frequency range from 0.1 to 0.7 fce, where fce is the gyrofrequency in the generation region. Because of the nonlinear damping mechanism the rising-tone element is separated into upper and lower bands at half the local gyrofrequency (1/2 fce) during propagation [2]. As the rising-tone emissions are generated in the minimum-B region and propagate toward the larger-B regions along the geomagnetic field line, the upper cutoff of the lower-band chorus indicates 1/2 fce in the generation region, whereas the lower cutoff of the upper-band chorus becomes equal to 1/2 local fce at the observation point. In the previous study, we evaluated these characteristics of dual-band chorus emissions observed by the wave form capture (WFC) and the sweep frequency analyzer (SFA) onboard Geotail [3].

In this study, we statistically analyze the characteristics of the dual-band chorus observed in the dayside outer magnetosphere by Geotail. Because the highly distorted geomagnetic field there due to the solar wind dynamic pressure, we analyze the dependence of the dual-band chorus occurrence on the geomagnetic indices. It is found that the dual-band chorus is observed mainly in the morning side when the Dst index becomes lower than -40, with larger wave intensities in the off-equatorial regions. We will present statistical analysis of the dependence of the chorus frequency and intensity on the solar wind and geomagnetic activity.

[1] Omura Y., Y. Katoh and D. Summers (2008), Theory and simulation of the generation of whistler-mode chorus, J. Geophys. Res., 113, A04223, doi:10.1029/2007JA012622.

[2] Omura Y., M. Hikishima, Y. Katoh, D. Summers, and S. Yagitani (2009), Nonlinear mechanisms of lower-band and upper-band VLF chorus emissions in the magnetosphere, J. Geophys. Res., 114, A07217, doi:10.1029/2009JA014206.

[3] S. Yagitani, T. Habagishi, S. Mori, Y. Omura, and H. Kojima, Generation and propagation characteristics of dual-band chorus emissions observed by Geotail, American Geophysical Union Fall Meeting 2012, December 2012, San Francisco, USA.

Keywords: Chorus emission, Geotail spacecraft, Statistical analysis, Upper-band chorus, Lower-band chorus, half-gyrofrequency

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Wave-Particle Interaction Analyzer onboard ERG satellite

Hirotsugu Kojima[1*], Yuto Katoh[2], Mitsuru Hikishima[2], Masafumi Hirahara[3], Takeshi Takashima[4], Kazushi Asamura[4], Satoshi Kasahara[4], Yoshizumi Miyoshi[3], Yoshiharu Omura[1]

[1]RISH, Kyoto university, [2]Tohoku university, [3]Nagoya university, [4]JAXA

One of the key targets in the ERG mission is to investigate wave-particle interactions in the terrestrial radiation belt. The study of wave-particle interactions has been conducted by examining the correlation of wave spectra/waveforms and plasma energy spectra/velocity distributions which are observed by plasma wave receivers and particle detectors, independently. The disadvantage of this method is the difference of the time resolutions of plasma wave data and plasma data. Furthermore, the quantitative data analysis is difficult in this method. In order to overcome these disadvantages, we proposed the new method for the direct measurement of wave-particle interactions. It is addressed by Wave-Particle Interaction Analyzer (WPIA). The WPIA makes use of each pulse which shows the detection of particles in plasma detectors. The WPIA calculates E.V at each timing of particle detection by multiplying instantaneous electric field wave vector. Since E.Vis equivalent to time differential of plasma kinetic energy, the quantitative energy flow among waves and plasmas can be obtained using the WPIA. The current status of developing the WPIA is under considering the appropriate algorithm using computer simulations. The computer simulation reproduces the generation process of the chorus emission and the acceleration of electrons by the chorus emission. The algorithm based on the computer simulation will be examined using the breadboard of the MDP designed for the ERG emission.

In the present paper, we introduce the principle of the WPIA and show the current status of its development towards the ERG satellite.

Keywords: Wave-particle interaction, plasma wave, ERG satellite, Chorus

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Longitudinal phase structures of Pc5 observed during the Relativistic Electron Enhancement (REE) at the outer radiation

Kentarou Kitamura[1*], Satoko Saita[2], Yoshimasa Tanaka[3], Akira Kadokura[3], Hisao Yamagishi[3]

[1]Tokuyama College of Technology, [2]Transdisciplinary Research Integration Center, Research Organization of Information and Systems, [3]National Institute of Polar Research

In this study, we analyzed the magnetic data observed at the high-latitude magnetic stations in both the northern and the southern hemispheres, TJOR (Mag. Lat = 66.51), TRO (66.53), H057 (-66.42), and Skallen (-66.42) to compare with the >2Mev electron flux observed by GOES 10 satellite. Each pair of stations is located at the same latitude and within 1.7 and 30 degrees in longitude, respectively. The pairs of the stations are quite suitable to estimate the azimuthal wave number.

For selected 24 Relativistic Electron Flux Enhancement (REE) events, the superposed epoch analysis is conducted for the horizontal component of the magnetic field data. The power spectrum density (PSD) of the Pc5 pulsations increases corresponding to the increase of the solarwind velocity, also the H/D ratio of the Pc5 power shows obvious change after 0.5 days from enhancement of the PSD, which corresponds to the apparent start time of REE events. This indicates that the toroidal oscillation of Pc5 becomes predominant in the inner magnetosphere at the start time of the REE. Second, although the phase difference between two stations largely fluctuates before the start of REE, it shows certain values with small variances during the REE events. The azimuthal wave numbers (m) of the H and D components estimated from the pair stations in the southern hemisphere are 1.62+/10.99 and -2.25+/-2.86, respectively. In the northern hemisphere, the estimated m number of H and D components are 0.29+/-0.62 and 0.20+/-0.81. Although the error of the m number in the northern hemisphere is much larger than that in the southern hemisphere, the basic characteristics of the variations of the phase structure well correspond to that in the northern hemisphere. The present results suggests that the relativistic electrons in the inner magnetosphere are accelerated by the drift resonance with the toroidal Pc5 pulsations.

Keywords: Pc5 pulsation, Relativistic Electron, Radiation belt

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Evaluation of WPIA by PIC simulations for direct measurement of wave-particle interactions of whistler-mode chorus

Mitsuru Hikishima[1*], Yuto Katoh[1], Hirotsugu Kojima[2], Yoshiharu Omura[2], Yoshizumi Miyoshi[3], Takayuki Ono[1]

[1]Department of Geophysics, Graduate School of Science, Tohoku University, [2]Research institute for sustainable humanosphere, Kyoto University, [3]Solar-Terrestrial Environement Laboratory, Nagoya University

The "Wave Particle Interaction Analyzer (WPIA)" is a new instrumentation measuring interactions between plasma waves and electrons directly and quantitatively in space plasmas, which will be installed as a software function in the ERG satellite (Exploration of energization and Radiation in Geospace). In the WPIA, we use the wave vector and velocity vector of each electron respectively measured by wave and particle instruments on board spacecraft. One of the methods of the WPIA is to evaluate the energy exchange between waves and particles by calculating an inner product E and v, where E and v are the wave electric field and the velocity vector of an electron, respectively. We evaluate the feasibility by applying the WPIA to the simulation results of whistler-mode chorus generation. We also discuss the implementation plan and the data processing flow of the WPIA to be realized in the ERG satellite.

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Long-term variation of plasmasphere observed from the Akebono PWS data

Shuhei Hasegawa[1*], Yoshizumi Miyoshi[1], Naritoshi Kitamura[1], Atsushi Kumamoto[2]

[1]Solar-Terrestrial Environement Laboratory, Nagoya University, [2]Department of Geophysics, Graduate School of Science, Tohoku University

Plasmaspheric density structures have been studied for a long time. However, continuous observations longer than one-solar cycle have not been realized, so that long-term variations associated with solar activity have been unclear. In this study, using plasmaspheric density observations from the PWS experiments on board the Akebono satellite from 1989 to 2008, we conduct statistical analyses on variations of plasmaspheric structures. We divide the data into two groups for geomagnetically quiet/active periods, and derive spatial distributions as functions of L-magnetic local time, and altitude-magnetic latitude. As a result, we confirm that the plasmapause location moves into lower-L shell during geomagnetically active periods. The plasma density in the inner magnetosphere at solar minimum is higher than that at solar maximum even though the geomagnetic condition is almost same.

Keywords: plasmasphere, plasmapause, electron density, akebono satellite

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Nonlinear evolution of electrostatic solitary waves in the Earth's boundary layers: two-fluid warm plasma simulations

Amar Kakad[1*], Yoshiharu Omura[1]

[1]Research Institute for Sustainable Humanosphere, Kyoto University, Japan

A two-fluid warm plasma model of electrostatic solitary waves propagating parallel to the magnetic field in magnetospheric boundary layer plasma is presented. The model uses the approach of stationary-profile traveling coordinate transformation; as a result it provides only time-stationary solutions that represent the electrostatic solitary waves in stationary frame. These solutions do not provide information on the evolutionary characteristics of solitary structures. Such models failed to provide information about the sources responsible for the generation of electrostatic solitary waves. To address these issues, we carry out one-dimensional fluid simulation of electrostatic solitary waves propagating parallel to the magnetic field in electron-ion plasmas. The role of various perturbations in the generation of electrostatic solitary structures is investigated in detail. Enlightened by our simulation results, we speculate that the solitary structures observed in magnetospheric boundary layer plasma may have similar generation mechanism.

Keywords: Electrostatic solitary waves, plasma waves, Fluid simulation