Japanese URSI Commission H (Waves in Plasmas) Activity Report

October, 2012

1. Spacecraft Missions

<GEOTAIL>

GEOTAIL spacecraft has been operated since 1992. The Plasma Wave Instrument (PWI) is continuously collecting the high resolution waveform data as well as the spectrum data. The 24 hour plots of the observed wave spectrum data have been opened in the PWI web site http://www.rish.kyoto-u.ac.jp/gtlpwi, and http://www.stp.isas.jaxa.jp/geotail. Furthermore, one can easily also access the PWI 2 hour plots with full time and frequency resolution through the above web page.

<BepiColombo>

The BepiColombo is the science mission to Mercury. It is the first collaborative science mission of JAXA and ESA. It will be launched in 2015. The BepiColombo mission consists of two individual spacecraft called MPO (Mercury Planetary Orbiter) and MMO (Mercury Magnetospheric Orbiter). Scientists in Japan and Europe jointly are developing the plasma wave observation system called PWI (Plasma Wave Investigation). The PWI investigates plasma/radio waves and DC electric field in Mercury magnetosphere. It consists of two components of receivers, two sets of electric field sensors, two kinds of magnetic field sensors, and the antenna impedance measurement system. The final Flight Model integration tests of the PWI were conducted in Research Institute for Sustainable Humanosphere of Kyoto University. The tests finished in the middle of September, 2012. The environment tests such as the thermal cycle, vibration, shock and thermal-vacuum, are now ongoing in ISAS.

<ERG>

The ERG satellite project, which explores geospace, especially electron acceleration/loss/transportation processes of the radiation belts, have been approved, and the satellite will be launched in 2015. The ERG satellite will measure plasma waves including both the spectral matrix and wave-form and will reveal the elementary process of wave-particle interactions in the inner magnetosphere.

2.Future Meetings

1. GEOTAIL 20th Anniversary Workshop, Tokyo Tec Front Kuramae-Kaikan, November 12-14, 2012.

2. JpGU (Japan Geoscience Uniton) Meeting 2013, Makuhari, Japan, May 19-24, 2013.
3. AOGS(Asia Oceania Geosciences Society) 2013, Brisbane, Australia, June 24-28, 2013.
4. 11th International School/Symposium for Space Simulations (ISSS-11), Jhongli City, Taiwan, July 21-27, 2013.
5. IAGA 2013, Mérida, Yucatán, México, August 26-31, 2013.
6. AP-RASC 2013, Taipei, Taiwan, September 3-7, 2013.
7. COSPAR Symposium on "Planetary Systems of our Sun and other Stars, and the Future of Space Astronomy", Bangkok, Thailand, November 11-15, 2013.
8. International CAWSES (Climate and Weather of the Sun-Earth System)-II Symposium, Nagoya, Japan, November 18-22, 2013.

Recently Published Papers (Oct 2011 – Sep. 2012)

1. **Fukuhara, H., H. Kojima, K. Ishii, S. Okada, and H. Yamakawa, Tiny waveform receiver with a dedicated system chip for observing plasma waves in space, *Measurement science and technology*, doi: 10.1088/0957-0233/23/10/105903, 2012.**

For future scientific missions, reduction in the resource requirements of plasma wave receivers without loss of performance is important. This paper introduces a miniaturized on-board instrument for the observation of plasma waves using analogue application-specific integrated circuit (ASIC) techniques. The developed ASIC functions as a system chip to filter and amplify signals detected by plasma wave sensors. Miniaturization of the analogue circuit using the ASIC leads to the realization of a tiny plasma wave receiver. The overall size of the developed plasma wave receiver circuit board is less than 1/20 that of a conventional receiver used in previous scientific missions. The power consumptions of the system chip and the plasma wave receiver are 165 and 525 mW, respectively.

2. **Miyake, Y., H. Usui, H. Kojima, and H. Nakashima, Plasma particle simulations on stray photoelectron current flows around a spacecraft, J. Geophys. Res., 117, A09210, doi:10.1029/2012JA017673, 2012.**

Photoelectron flows around a spacecraft and a double-probe electric field sensor are studied by means of plasma particle simulations. The stray photoelectron current flowing from a spacecraft into a probe can be reduced by operating the probe nearly at the plasma potential. The analysis also revealed side effects of a guard electrodeenhancing a stray photoelectron current from the electrode itself.

3. **Y. Goto, Y. Kasahara, and T. Ide, Improvement of Equatorial Density Distribution of the Global Core Plasma Model using GPS-derived TEC, *Radio Science,* 47(RS0F12), doi:10.1029/2011RS004763, 2012.**

Goto et al.(2012) examined the accuracy of the global core plasma model (GCPM) in the equatorial region by using long-term total electron content (TEC) data obtained from several GPS tracking stations along the equator and a low Earth orbit satellite. According to the statistical analysis of the GPS TEC, they found a remarkable feature in bias errors in the GCPM-derived TEC. Most of the errors are found to distribute in the topside ionosphere due to the simple representation of the density there.

4. **Ozaki, M., S. Yagitani, K. Ishizaka, K. Shiokawa, Y. Miyoshi, A. Kadokura, H. Yamagishi, R. Kataoka, A. Ieda, Y. Ebihara, N. Sato, and I. Nagano, Observed correlation between pulsating aurora and chorus waves at Syowa Station in Antarctica: A case study, J. Geophys. Res., 117, A08211, doi:10.1029/2011JA017478, 2012.**

A high correlation between a pulsating auroral patch and grouped chorus waves was observed at Syowa Station in Antarctica. The generation region of the chorus waves was estimated from the latitude and longitude dependence of the equatorial electron gyrofrequencies using the IGRF geomagnetic field model. The extent of the estimated latitude and longitude was consistent with the spatial distribution of the high-correlation aurora–chorus region. This study supports the hypothesis that pulsating aurora is caused by pitch angle scattering of high-energy electrons by whistler mode chorus waves, via a cyclotron resonance at the equator.

5. **Ozaki, M., S. Yagitani, K. Miyazaki, and I. Nagano, Development of a new portable lightning location system, IEICE TRANSACTIONS on Communications, Vol.E95-B, No.1, pp.308--312, 2012.**

Using a single-site lightning location technique, a new portable lightning location system was developed. The system incorporated an attitude detection technique using inertial sensors to detect an accurate electromagnetic field vector of sferics by palm-sized electromagnetic sensors which can have arbitrary attitude. The palm-sized system detected the sferics within about several hundred km with the attitude detection technique

6. **Sakaguchi, K., T. Nagatsuma, T.Ogawa, T. Obara, and O. A. Troshichev, Ionospheric**

Pc5 plasma oscillations observed by the King Salmon HF radar and their comparison with geomagnetic pulsations on the ground and in geostationary orbit, J. Geophys. Res, 117, A03218, doi:10.1029/2011JA016923, 2012.

We analyzed Pc5 (1.7–6.7 mHz) oscillations of ionospheric Doppler plasma velocity observed on a westward pointing beam 3 of the SuperDARN King Salmon HF radar in Alaska during the solar maximum in 2002 and the minimum in 2007. Local time distributions of the ionospheric Pc5 oscillations showed peculiar asymmetric characteristics in both years; that is, the occurrence probability had a maximum around the magnetic midnight, whereas backscatter echoes exhibited almost no oscillation on the dayside. We compared these ionospheric Pc5 events with magnetic field variations on the ground under the radar beam at Pebek and King Salmon and the geostationary ETS-8 satellite at almost conjugate longitude. We found only a few nightside events where both the radar and magnetometers detected similar sinusoidal oscillations.

7. **Sakaguchi, K., Y. Miyoshi, E. Spanswick, E. Donovan, I. R. Mann, V. Jordanova, K. Shiokawa, M. Connors, and J. C. Green, Visualization of ion cyclotron wave and particle interaction in the inner magnetosphere via THEMIS-ASI observations, J. Geophys. Res, 117, A10204, doi:10.1029/2012JA018180, 2012.**

Interaction with EMIC (electromagnetic ion cyclotron) waves is thought to be a key component contributing to the very rapid loss of both ring current and radiation belt particles into the atmosphere. Estimated loss rates are heavily dependent on the assumed spatial distribution of the EMIC wave. Statistical maps of the spatial distribution have been produced using in-situ satellite data. However, with limited satellite data it is impossible to deduce the true spatial distribution. In this study, we present ground-based observations using all-sky imager and search coil magnetometer networks, which provide the large-scale distribution and motion of the EMIC wave-particle interaction regions.

8. **Nomura, R., K. Shiokawa , K. Sakaguchi , Y. Otsuka , M. Connors, Polarization of Pc1/EMIC waves and related proton auroras observed at subauroral latitudes, J. Geophys. Res, 117, A02318, doi:10.1029/2011JA017241, 2012.**

We have investigated the polarization of Pc1 geomagnetic pulsations and related proton auroras at subauroral latitudes, using an induction magnetometer and an all-sky camera at Athabasca, Canada (54.7°N, 246.7°E, magnetic latitude (mlat) 61.7°N). Isolated proton auroras often appear in association with Pc1 pulsations, because of proton scattering by electromagnetic ion cyclotron (EMIC) waves in the magnetosphere.

9. **Tanaka, Y.-M., Y. Ebihara, S. Saita, A. Yoshikawa, Y. Obana, and A. T. Weatherwax, Poleward moving auroral arcs observed at the South Pole Station and the interpretation by field line resonances, J. Geophys. Res., 117, A09305, doi:10.1029/2012JA017899, 2012.**

Tanaka et al. [2012] investigated a relationship between poleward moving auroral arcs (PMAAs), quasi-stationary auroral patches (QSAPs), and Pc 5 geomagnetic pulsations observed at the South Pole Station (74.3 CGLAT) in the interval 0800-1100 MLT. It was demonstrated that the PMAAs, Pc 5 pulsations in the north-south component, and oscillations in the drift of the QSAPs in the east-west direction have similar dominant periods and are well correlated with each other.

10. **Fujita, S., T. Tanaka, and T. Motoba, Long-period ULF waves driven by periodic solar wind disturbances, in The Dynamic Magnetosphere, edited by W. Liu, and M. Fujimoto, IAGA Special Sopron Book Series 3, doi:10.1007/978-94-007-0501-2_3, Springer, pp. 39-45, 2011.**

The fundamental nature of ULF waves in the Pc5 range driven by periodic variation of solar-wind dynamic pressure is studied by using a global MHD simulation. It is shown that a spectrum of the magnetospheric ULF wave induced from the periodic variation has a harmonic structure due to nonlinear behavior of magnetospheric response to the solar wind variation.

11. **Teramoto, M., K. Takahashi, M. Nosé, D.-H. Lee, and P. R. Sutcliffe, Pi2 pulsations in the inner magnetosphere simultaneously observed by the Active Magnetospheric Particle Tracer Explorers/Charge Composition Explorer and Dynamics Explorer 1 satellites, J. Geophys. Res., 116, A07225, doi:10.1029/2010JA016199, 2011.**

We statistically studied the spatial characteristics of Pi2 pulsations using magnetic field observations in the magnetosphere at the equatorial - orbiting Active Magnetospheric Particle Tracer Explorers (AMPTE)/Charge Composition Explorer (CCE) and the polar-orbiting Dynamics Explorer 1 (DE 1) satellites and on the ground at the low-latitude station Kakioka (KAK, L=1.23).

12. **Nosé, M., K. Takahashi, R. R. Anderson, and H. J. Singer, Oxygen torus in the deep inner magnetosphere and its contribution to recurrent process of O+-rich ring current formation, J. Geophys. Res., 116, A10224, doi:10.1029/2010JA016651, 2011.**

Using the magnetic field and plasma wave data obtained by the Combined Release and Radiation Effects Satellite (CRRES), we search for enhancements of O+ ion density in the deep inner magnetosphere known as “the oxygen torus”. We examine 4 events on the dayside in which toroidal standing Alfvén waves appear clearly. From the frequency of the toroidal waves, the magnetospheric local mass density (□L) is estimated by solving the MHD wave equation for realistic models of the magnetic field and the field line mass distribution.

13. **Nosé, M., T. Iyemori, L. Wang, A. Hitchman, J. Matzka, M. Feller, S. Egdorf, S. Gilder, N. Kumasaka, K. Koga, H. Matsumoto, H. Koshiishi, G. Cifuentes-Nava, J. J. Curto, A. Segarra, and C. Çelik, Wp index: A new substorm index derived from high-resolution geomagnetic field data at low latitude, Space Weather, 10, S08002, doi:10.1029/2012SW000785, 2012.**

Geomagnetic field data with high time resolution (typically 1 s) have recently become more commonly acquired by ground stations. Such high time resolution data enable identifying Pi2 pulsations which have periods of 40–150 s and irregular (damped) waveforms. It is well-known that pulsations of this type are clearly observed at mid- and low-latitude ground stations on the nightside at substorm onset. Therefore, with 1-s data from multiple stations distributed in longitude around the Earth's circumference, substorm onset can be regularly monitored.

14. **Dimmock, A. P., M. A. Balikhin, V. V. Krasnoselskikh, S. N. Walker, S. D. Bale, and Y. Hobara, A statistical study of the cross-shock electric potential at low Mach number, quasi-perpendicular bow shock crossings using Cluster data, J. Geophys. Res., 117, A02210, doi:10.1029/2011JA017089, 2012.**

The cross-shock electrostatic potential at the front of collision-less shocks plays a key role in the distribution of energy at the shock front. Multipoint measurement in space such as by the Cluster II mission has an ability to derive the spatio-temporal variations at the shock front. A statistical study of the cross-shock potential calculated for around 50 crossings of the terrestrial bow shock is presented. The statistical dependency of the normalized cross-shock potential on the upstream Alfven Mach number is in good agreement with analytical results that predict decrease of the cross-shock potential with increasing Mach number.

15. **Umeda, T., S. Matsukiyo, T. Amano, and Y. Miyoshi, A numerical electromagnetic linear dispersion relation for Maxwellian ring-beam velocity distributions, Physics of Plasmas, Vol.19, No.7, 072107 (8pp.), 2012.**

Umeda et al.[2012] developed a numerical method for analyzing the linear dispersion relation for Maxwellian ring-beam velocity distributions. The obtained linear properties are confirmed by direct comparison with full particle simulation results.

16. **Summers, D., R. Tang, and Y. Omura, Effects of nonlinear wave growth on extreme radiation belt electron fluxes, J. Geophys. Res., 116, A10226, doi:10.1029/2011JA016602, 2011.**

We present new relativistic formulae for the self-limiting K-P flux. We compare our theoretical K-P limit with observed Radiation Belts fluxes. We include nonlinear wave growth effects in the calculation of extreme Radiation Belts fluxes.

17. **Hikishima, M., and Y. Omura, Particle simulations of whistler-mode rising-tone emissions triggered by waves with different amplitudes, J. Geophys. Res., 117, A04226, doi:10.1029/2011JA017428, 2012.**

Triggered emissions are excited with triggering wave amplitude above a threshold. The frequency sweep rate of emission does not depend on the triggering amplitude. An electromagnetic electron hole is found in generation of a triggered emission.

18. **Shoji, M., Y. Omura, and L.-C. Lee, Multidimensional nonlinear mirror-mode structures in the Earth's magnetosheath, J. Geophys. Res., 117, A08208, doi:10.1029/2011JA017420, 2012.**

Coalescence of mirror-mode structure results in magnetic peaks and dips. Magnetic dips are generated in 2D low ion beta models. Magnetic peaks are formed in 2D high ion beta models and all 3D models.

19. **Omura, Y. and Q. Zhao, Nonlinear pitch angle scattering of relativistic electrons by EMIC waves in the inner magnetosphere, J. Geophys. Res., 117, A08227, doi:10.1029/2012JA017943, 2012.**

Nonlinear interaction between EMIC triggered emissions and electrons is studied. Pitch angle scattering depends on rising frequency and magnetic field gradient. Rapid precipitation of electrons by EMIC waves is confirmed by simulations

20. **Nunn, D., and Y. Omura, A computational and theoretical analysis of falling frequency VLF emissions, J. Geophys. Res., 117, A08228, doi:10.1029/2012JA017557, 2012.**

Recently much progress has been made in the simulation and theoretical understanding of rising frequency triggered emissions and rising chorus. Both PIC and Vlasov VHS codes produce risers in the region downstream from the equator toward which the VLF waves are traveling. The VHS code only produces fallers or downward hooks with difficulty due to the coherent nature of wave particle interaction across the equator. With the VHS code we now confine the interaction region to be the region upstream from the equator, where inhomogeneity factor S is positive.

21. **Summers, D., Y. Omura, Y. Miyashita, and D.-H. Lee, Nonlinear spatiotemporal evolution of whistler mode chorus waves in Earth's inner magnetosphere, J. Geophys. Res., 117, A09206, doi:10.1029/2012JA017842, 2012.**

Equations of nonlinear convective growth of a chorus wave are obtained. The convective growth of a chorus wave is followed by saturation. The saturation is due to adiabatic effects and the decrease in resonant current.