Commission H (Waves in Plasmas) Activity Report

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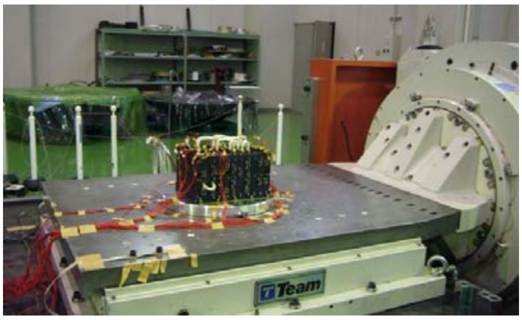
Research Topics

GEOTAIL>

GEOTAIL spacecraft has been operated since 1992. The Plasma Wave Instrument (PWI) is continuously collecting spectrum data and high time-resolution waveform data. It is expected to be in a good condition at least until the next long eclipse in 2010. 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>

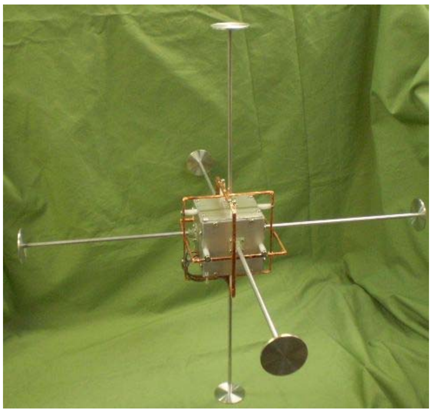
The BepiColombo is the science mission to Mercury. It is the first collaborative science mission between JAXA and ESA. The BepiColombo mission consists of two individual spacecraft called MPO (Mercury Planetary Orbiter) and MMO (Mercury Magnetospheric Orbiter). Scientists in Japan and Europe jointly proposed the plasma wave observation system called PWI (Plasma Wave Investigation). The proposal was successfully accepted and the development of the PWI component started. The MMO launch is scheduled in 2014. The Principal Investigator of the PWI is Prof. Yasumasa Kasaba of Tohoku University.



PWI engineering model installed on the vibration test facility.

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 thermal vacuum test and the vibration test of the PWI have been completed by the beginning of January, 2010. We have not seen any serious problems in these tests. We have been summarizing the results of the EM tests, which have conducted for one year, and submit the report to the JAXA for the preparation of the Critical Development Review (CDR) process. The CDR of the PWI is now scheduled in the middle of April, 2010.



Prototype of the sensor node [Kojima et al., 2009]

<Development of the small sensor node for the sensor network system in space>

The prototype of the small sensor node has been developed by RISH, Kyoto University and Kanazawa University. It will be used for the sensor network system for monitoring the space electromagnetic environment. The size of the body is 7cm x 7cm x 7cm. The small sensors for picking up plasma waves of electric field and magnetic field components are installed outside of the body. The preamplifiers for these sensors and power supply units are contained inside the cubic body. In the near future, the tiny plasma wave receiver developed by RISH, Kyoto University will be installed inside the body.

Reference

Kojima, H., H. Fukuhara, Y. Mizuochi, S. Yagitani, H. Ikeda, Y. Miyake, H. Usui, H. Iwai, Y. Takizawa, Y. Ueda and H. Yamakawa, Miniaturization of plasma wave receivers onboard scientific satellites and its application to the sensor network system for monitoring the electromagnetic environments in space, Accepted for publication in *Advances in Geosciences,* 2009.

< KAGUYA (SELENE) >

The Japanese lunar explorer “KAGUYA” was launched on September, 14, 2007 and the operation was successfully performed until KAGUYA was impacted to the south-east of near side of the moon on June 10, 2009. The Lunar Radar Sounder (LRS) is one of the scientific instruments onboard the KAGUYA main orbiter (Ono et al., 2008; 2009).

The LRS consists of two orthogonal 30 m tip-to-tip antennas and three subsystems; the sounder observation (SDR), the natural plasma wave receiver (NPW), and the waveform capture (WFC). The SDR is designed to investigate the surface and subsurface structures of the moon using an HF radar technique (Ono et al., 2009a; 2009), and the NPW and WFC are designed to measure natural plasma waves around the moon and in interplanetary space (Kumamoto et al. 2008; Kasahara et al., 2008). The Level-2 data has been disclosed for scientific utilization from “SELENE data archive system” and several data analyses are now in progress.

Reference

KAGUYA(SELENE) Data Archive System, https://www.soac.selene.isas.jaxa.jp/archive/

Kasahara, Y., Y. Goto, K. Hashimoto, T. Imachi, A. Kumamoto, T. Ono, and H. Matsumoto, Plasma Wave Observation Using Waveform Capture in the Lunar Radar Sounder on board the SELENE Spacecraft, Earth, Planets and Space, 60(4), 341-351, 2008.

Kumamoto, A., T. Ono, Y. Kasahara, Y. Goto, Y. Iijima, and S. Nakazawa, Electromagnetic Compatibility (EMC) Evaluation of the SELENE Spacecraft for the Lunar Radar Sounder (LRS) Observations, Earth, Planets and Space, 60(4), 333-340, (2008).

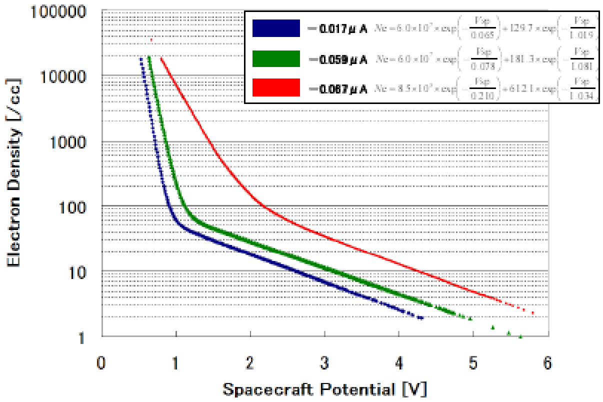
Ono, T., A. Kumamoto, Y. Yamaguchi, A. Yamaji, T. Kobayashi, Y. Kasahara, and H. Oya, Instrumentation and Observation Target of the Lunar Radar
Sounder (LRS) Experiment on-board the SELENE Spacecraft, Earth, Planets and Space, 60(4), 321-332, (2008).

Ono, T., A. Kumamoto, H. Nakagawa, Y. Yamaguchi, S. Oshigami, A. Yamaji, T. Kobayashi, Y. Kasahara, and H. Oya, Lunar Radar Sounder Observations
of Subsurface Layers under the Nearside Maria of the Moon, Science, 323, 909-912, doi:10.1126/science.1165988, 2009.

<AKEBONO>

Single Probe Application

Toomi (2010) investigated the relationship between the AKEBONO spacecraft potential and the electron number density in the plasmasphere during the period from May 1989 to August 1990. The empirical formula shown the relationship between the spacecraft potential and electron number density was obtained. Figure 1 shows the approximate formula of relationship between spacecraft potential and electron number density in the range of electron number density from 10^0 to 10^5 cm^{-3} each bias current (red: -0.67μA, green: -0.059μA, blue: -0.017μA). We found that the characteristic is changed when the bias current is changed. Therefore it is important to feed a proper bias current to the probe in order to be set nearly zero to the probe potential for the ambient plasma.



-0.059μA, blue: -0.017μA). We found that the

Figure 1. Characteristic between spacecraft potential electron number density each bias current

Figure 2. Spatial distribution of electron density and along the AKEBONO satellite orbit

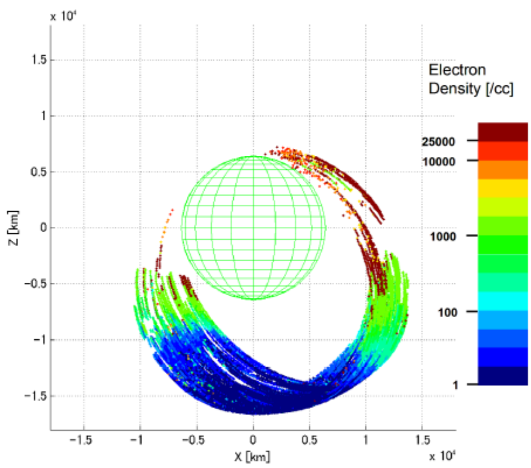
Using this correlation, a map is drawn which shows the spatial distribution of electron density. Figure 2 shows spatial distribution of electron density in the period from May 1989 to August 1990 plotted on the X-Z plane of the terrestrial magnetism coordinate system. The amount of electron density is indicated by color code. From the distribution of the electron density, we find that the density is high near the earth region, and that the regions of low-density are inside of the magnetosphere. Thus, we can determine the regions along the AKEBONO orbit from the spacecraft potential.

Reference

Toomi,H., Study on characteristic of relationship between Akebono satellite potential and electron density, Toyama prefectural university Master’s thesis, 2010.

< Techniques of Data Analysis and Computer Experiments >

As the total amount of data measured by scientific spacecraft is drastically increasing, it is necessary for researchers to develop new computation methods for new algorithm for similar data retrieval was proposed key descriptors that represent characteristics of the VLF/E ased on these key descriptors, an algorithm for similar ıally demonstrated that the developed algorithm works we mall amount of CPU load.



A general-purpose database (DB) system that manag data was introduced by Takata et al. (2010). This platfor hich databases can be easily managed without special skill data manager, the proposed system defines a flexible acc ısets under the control of these managers. They demons ıtely integrated under one management system in such si user interface in its search and data distribution functions and is designed with a different language (or script) and connection method to its DB. In spite of the diversity of web-DBs, the proposed system is highly suitable for practical use.

Reference
Y. Kasahara, A. Hirano and Y. Takata, Similar Data Retrieval from Enormous Datasets on ELF/VLF Wave Spectrum Observed by Akebono, Data Science Journal, (10pages, advance publication), doi:10.2481/dsj.SS_IGY-002, 2010.

Y. Takata, Y. Kasahara, and T. Matsuhira, Development of a Science Database System Applicable to Various Access Restrictions, Data Science Journal, 8, IGY32-IGY43, doi:10.2481/dsj.SS_IGY-008, 2010.

<Lightning-generated sferics observations>

Ozaki et al. [2010] have investigated the technique for estimating lightning current by using the sferic wave fields. They have successfully obtained information on the discharge duration of the return stroke that was impossible to know only from the conventional wave field observation. They have also found that it is possible to estimate the waveform of the return stroke current by using a nonlinear least-squares method applied to the wave field. Figure 1 shows the estimated current moment waveforms by using the direct waveforms of the observed sferic wave field. As a result, their method has shown that the error in the estimation of the current moment is less than 10 % for the horizontal distances of the lightning over 100 km.

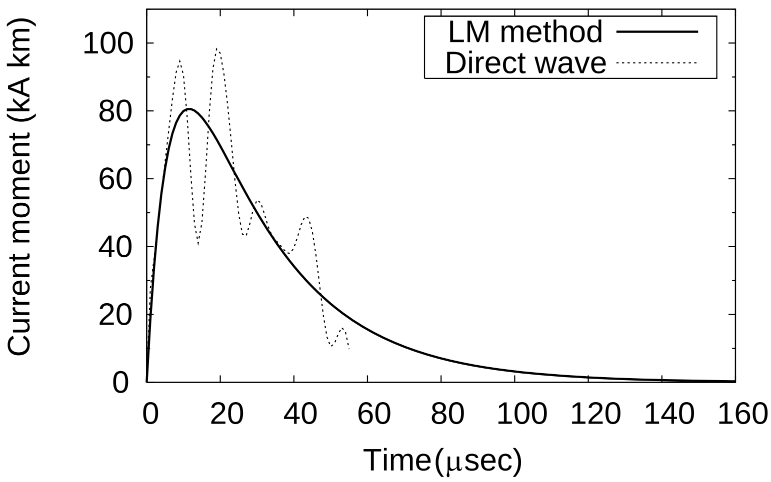


Figure 1: Estimated current moment waveforms (solid line) and the direct waveforms of the observed sferics (dotted line).

Reference
Ozaki, M., S. Yagitani, T. Koide, and I. Nagano, "Estimation of lightning return stroke current waveforms by nonlinear least squares method applied to sferics," IEICE Transactions on Communications, Vol.J93-B, No.4, (in print), April 2010.

<ULF Waves>

By using MHD simulations, Ugai (2009) showed how reconnection jets drive ionospheric electrojets and Pi 2 pulsations at substorms. When a large-scale plasmoid, directly generated by the reconnection jet, collides with the magnetic loop of the closed field lines in the inner magnetosphere, strong electrojets are impulsively driven in a finite extent of the ionospheric footpoint of the magnetic loop. On the other hand, Alfven waves, which were generated simultaneously with the plasmoid generation, reaches the ionospheric electrojet layer and are reflected, interact (or resonate) with the waves traveling toward the footpoint, leading to impulsive Pi 2 pulsations.

Uozumi et al. (2009) examined Pi 2 wave oscillations that showed a high correlation between high- and low-latitude MAGDAS/CPMN ground magnetometer stations. They examined the magnetic local time (MLT) dependence of the delay time from the low-latitude station to the high-latitude station; as a result, they found that the H-component delay time showed a remarkable MLT dependence, especially in the premidnight sector: They found, in the premidnight sector, that the high-latitude H oscillation tends to delay from the low-latitude H oscillation by ≤100s. On the other hand, the D-component delay time was not significant (<10s) in the entire nighttime sector. They proposed a Pi 2 propagation model, which explained these observed features. They also examined the spatial distribution of the Pi 2 events relative to the center of auroral breakups; they found that the high-correlation Pi 2 events tend to occur away from the center of auroral breakups by more than 1.5hr MLT. They suggested that the high-correlation H-component Pi 2 oscillations at high latitudes are a manifestation of forced Alfven waves excited by fast magnetosonic waves.

References

Ugai M, Impulsive magnetic pulsations and electrojets in the loop footpoint driven by the fast reconnection jet, Physics of Plasmas, 16(11), 112902, Nov. 2009.

Uozumi, T., S. Abe, K. Kitamura, T. Tokunaga, A. Yoshikawa, H. Kawano, R. Marshall, R. J. Morris, B. M. Shevtsov, S. I. Solovyev, D. J. McNamara, K. Liou, S. Ohtani, M. Itonaga, and K. Yumoto (2009), Propagation characteristics of Pi 2 pulsations observed at high□ and low□latitude MAGDAS/CPMN stations: A statistical study, J. Geophys. Res., 114, A11207, doi:10.1029/2009JA014163.

Kataoka, Ryuho, Yoshizumi Miyoshi, and Akira Morioka, Hilbert-Huang Transform of geomagnetic pulsations at auroral expansion onset, The 33rd Symposium on Space and Upper Atmospheric Sciences in the Polar Region, National Institute of Polar Research, Japan, Nov. 12-13, 2009.

H. Kawano, V. Pilipenko, S. Saita, K. Yumoto, and I. Mann, Application of the improved hodograph method (to identify the field-line resonance) to ground magnetometer data, The 33rd Symposium on Space and Upper Atmospheric Sciences in the Polar Region, National Institute of Polar Research, Japan, Nov. 12-13, 2009.

Conferences and Meetings

1) 126th SGEPSS (Society of Geomagnetism and Earth, Planetary and Space Sciences) Fall Meeting, Kanazawa, Japan, Sep. 27-30, 2009.
2) The 33rd Symposium on Space and Upper Atmospheric Sciences in the Polar Region, National Institute of Polar Research, Japan, Nov. 12-13, 2009.
3) 2009 AGU Fall Meeting, 14–18 December San Francisco, California, USA
4) MEETING: 19th Cluster Workshop, Multi-point Investigations of Magnetosphere-Ionosphere Coupling and Aurora, May 18-21, 2010, Poiana Brasov, Romania
5) 2010 Western Pacific Geophysics Meeting22-25 June 2010, Taipei, Taiwan
   Meeting web site: http://www.agu.org/meetings/wp10/
6) Second International Symposium on Radio Systems and Space Plasma, August 25-27, 2010, Sofia, Bulgaria

Acknowlegement

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