Commission H (Waves in Plasmas) Activity Report

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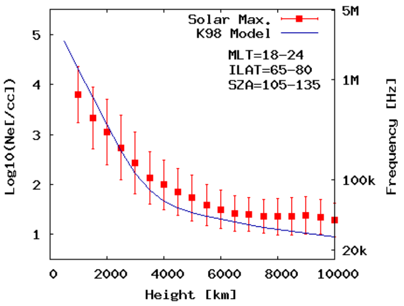
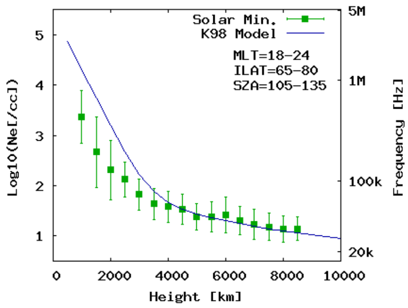
Research Topics

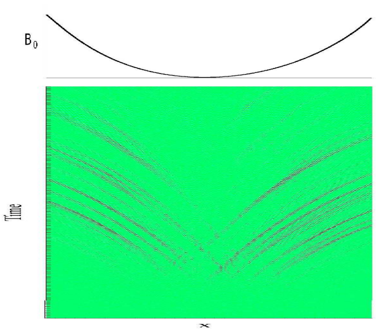
<**AKEBONO**>

Kumamoto et al. [2004] investigated Long-term variations of ambient electron number density in the nightside auroral region based on auroral hiss data observed by the PWS. The electron number density in the nightside auroral region shows clear dependence on solar activity. The figures show the altitude profiles of electron number density during solar maximum (left figure) and during solar minimum (right figure). The number density during solar maximum is 3-10 times larger than that during solar minimum. The vertical profile of scale height, which is associated with plasma composition and temperature, also depends on the solar activity.





Hikishima et al.[2005] investigated the generation and propagation mechanisms of the chorus emissions by the cyclotron interaction between whistler mode waves and anisotropic electrons.X This is the result by one-dimensional particle simulation with dipole type inhomogeneous magnetic field. The whistler mode waves are generated from back ground noise in the region where the magnetic field is the weakest and are propagating to the direction away from the region. This is much like the theory and observation of the chorus emissions.



<**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 2005.The 24 hour plots of the observed wave spectrum data are opened in the PWI web site http://www.rish.kyoto-u.ac.jp/gtlpwi, and http://www.stp.isas.jaxa.jp/geotail.

Shin K. et al. (2005) observed the electrostatic quasi-monochromatic (EQM) waves which frequency range is near 1 kHz. Geotail spacecraft observations show good correlation of EQM wave activities with the existence of cold electron beam-like component which correspond to the electrons accelerated in the bow shock. They show that under the existence of the cold beam-like component and background electrons with different temperatures, most plausible wave mode of the EQM waves is electron acoustic wave.

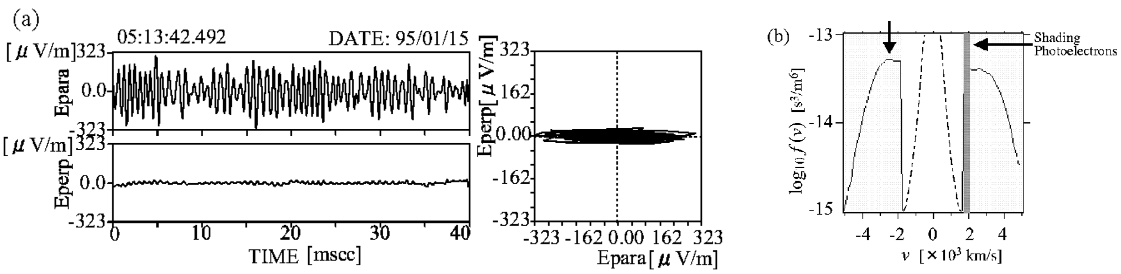


Figure: (a) Waveforms of the EQM waves of the parallel and the perpendicular components with respect to the ambient magnetic field (left panel) and corresponding hodograph (right panel) for the period of 40 milliseconds from 5:13:42.492 UT on January 15, 1995. (b) Electron velocity distribution for the January 15, 1995 event observed at 5:13:29 UT. Figure shows the cut through *f*(v) along the ambient magnetic field The positive velocity is referred to the ambient magnetic field direction. The beam-like component is displayed by arrow.

Antenna in Space Plasma

Higashi et al. (2005) studied the characteristics of dipole antenna or probe antenna, namely the antenna impedance and effective length using the AKEBONO and GEOTAIL observation data. The impedance of the wire dipole antennas onboard the Akebono satellite is estimated by using the electromagnetic field observations for Omega navigational signals. The estimated capacitance and resistance exhibit specific spin variation, which would be caused by the plasma sheath formation around the antenna wires depending on the angle between the antenna direction and the geomagnetic field line. The figure shown below indicates a dependence of antenna impedance to the angle on the geomagnetic field. The effective lengths of two orthogonal sets of wire dipole antennas are estimated to be nearly the half of its tip-to-tip length of 60 m, which is consistent with the conventional assumption of the effective lengths of the dipole.

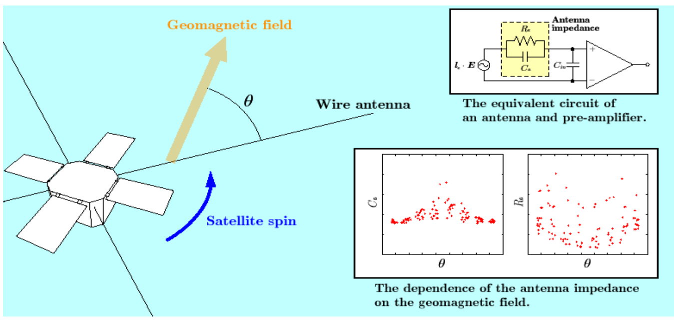
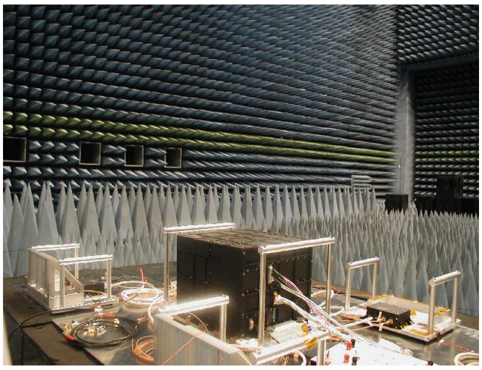


Figure: Experimental results showing the dependence of antenna impedance on the geomagnetic field (Higashi et al., 2004).

<SELENE>

The Lunar Radar Sounder (LRS) experiment onboard the SELENE consists of three subsystems; SDR (sounder), NPW (natural plasma wave) and WFC (waveform capture). SDR will provide subsurface stratification and tectonic features in the shallow part (several km depth) of the lunar crust, by using an FM/CW radar technique in HF frequency range. NPW and WFC will observe planetary radio waves and natural plasma waves in the frequency range from 20kHz to 30MHz and from 100Hz to 1MHz, respectively.

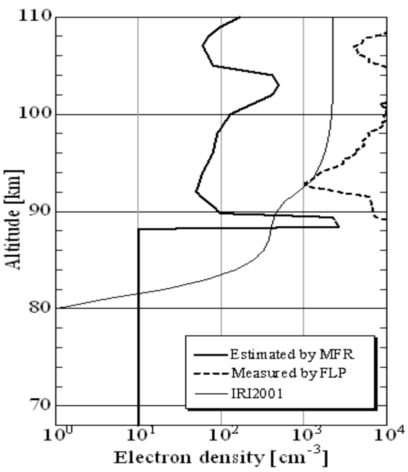


The mission instruments are now in the stage of 1.5th system function test at Tsukuba Space center. The system function tests and EMC (Electromagnetic Compatibility) tests are scheduled from March to September. After the system function test, the instruments will have last opportunity for final adjustments. Figure @ shows the LRS instrument in the RF test at the Tsukuba Space Center in December 2004 (report by Ono and Kumamto).

<Rocket Experiment>

Application of MF waves to Ionospheric Plasma measurement

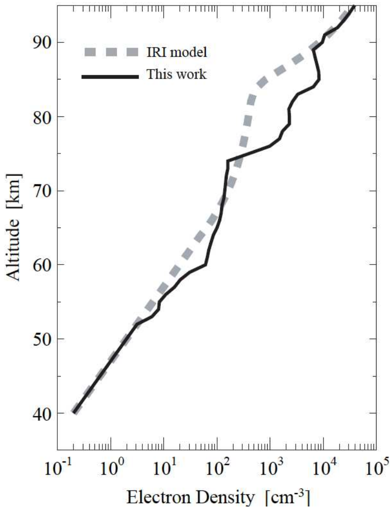
Ashihara et al. (2005) measured the electron number density in the mid-latitude D-regeon ionosphere and found an thin layer of enhanced electron density by using the MF radio absorption method. The S-310-33 rocket was launched at 0:30 JST on 18th January, 2004.



The Medium Frequency Receiver (MFR) was installed onthe to measure the intensities of radio waves at 238 kHz and 873 kHz transmitted from the ground stations. The electron density profile was estimated from absorption of these radio waves. It is found that there was a thin layer of high electron density of 2.4×10^{3} cm^{-3} at the altitude of 89 km. The thickness of its layer is about 0.9 ～ 1.0 km.

The left figure shows the electron density profiles estimated by three different methods: The thick line indictes the one estimated by the rocket experiment using MFR, the broken line by probe method, and the thin line is by the IRI 2001 model. The MFR rocket experiment gives the existence of thin layer of high electron density.

Ishisaka et al. (2005) measured the electron density in the very low altitude as low as 50km by the MF radio absorption method. The SRP-4 rocket was launched at 12:07 LT on 18 March 2002. The Low frequency and Medium frequency band radio Receiver (LMR) and the DC Probe System (DPS) were installed on-board the rocket to estimate the D-region electron density. The LMR measured theintensities of radio waves received from ground-based stations operating at 257 kHz, 660 kHz and 820 kHz, respectively.



The electron density profile at altitudes below 90 km was estimated from the measured absorption of these radio waves. It was found that the electron density began to increase at the altitude of 52 km and was larger than that estimated by the International Reference Ionosphere model at altitudes from 74 km to 89 km. The estimated electron density profile from 40 km to 95 km is shown in the figure, where the broken line is the one obtained by the IRI model

<Polar Region Experiments>

•Polar Patrol Balloon (PPB) Experiment

Miyake et al. [2004] carried out successfully the PPB experiment in Antarctica in January 2003, and recently reported the observational results such as the Pc1 pulsations, ELF hiss, polar chorus and auroral hiss. In the PPB experiment, two challenging techniques for the data transmission were carried out. First, all the observed data were transmitted directly from the balloons to National Institute of Polar Research in Japan, by way of the IRIDIUM satellites for the world-wide mobile telephone. We could get the new observed data within 30 minutes due to this satellite data transmission system. Second, the electromagnetic wave receiver (EMW) in sub gondola were placed just beneath the balloon, 100m away from the main gondola, in order to avoid electromagnetic noises emitted from the various instruments onboard the main gondola. The data observed by EMW are transmitted from the sub gondola to the main gondola by use of wireless modem. The observation times of receivers between onboard multiple balloons are synchronized in 10ms by using the 1pps pulse signals emitted from GPS satellites. Both data transmission systems have been worked properly, and contributed to obtaining precious scientific data in the Antarctic region.

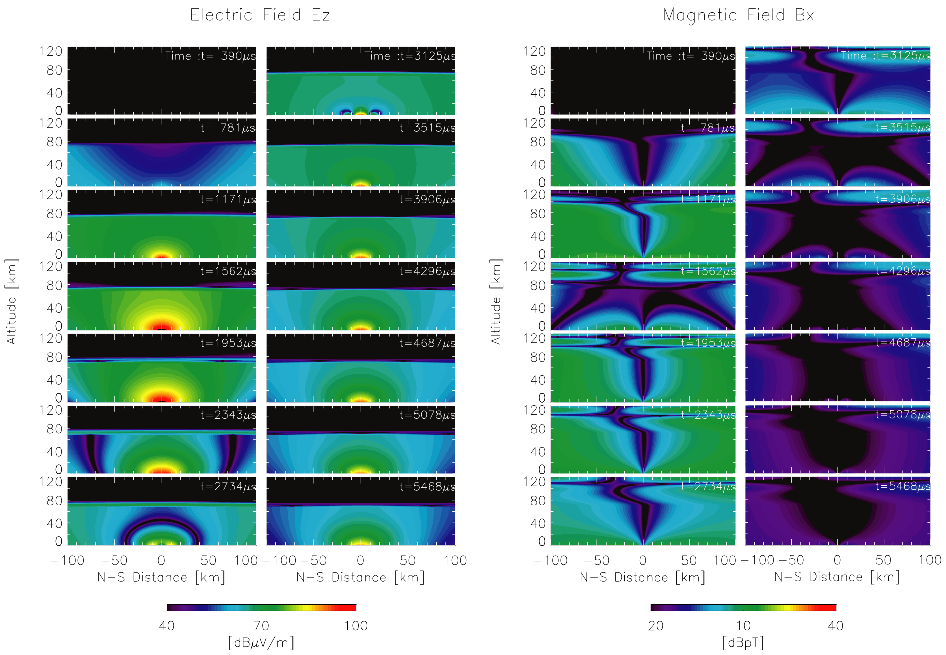
Ground Observation

Ozaki et al. [2005] plan to make the multipoint observations of ELF/VLF waves by low power magnetometer systems in Antarctica for the study of whistlers and ELF/VLF emissions in December 2005 to December 2006. The magnetometer systems will be placed at three sites, West Ongul (69 ° 01'06"S 39 ° 30'28"E), Skallen (69 ° 40'24"S 39 ° 24'07"E), and H100 (69 ° 17'44"S 41 ° 19'15"E) unmanned stations. Each system consists of two crossed vertical loop antennas and a multi-channel analyzer which measures continuously with 1 minute resolution the mean power and polarization of NS and EW magnetic components in 4 spaced frequency bands (500, 1 k, 2 k and 6 kHz). The recorded data are sent back to Kanazawa through IRIDIUM satellite communication. With this system, we will be able to investigate the dynamic structure of ionospheric exit points of natural ELF/VLF waves.

Seismic Radio Emissions

Higashi et al.,{2005} studied the anomalous electromagnetic signals onboard satellite in the ionosphere and the lower magnetosphere over seismic areas. In order to estimate the wave intensities related with seismic activity, they performed a numerical analysis of the electromagnetic waves in the lower ionosphere radiated from an underground transient dipole source.

Figure 1 (a) shows the spatial evolution of the horizontal (north-south component of) electric field E_y. Each figure shows the intensity distribution of the E_y over the horizontal north-south range of $\pm$100-km and at the altitude range of 0- to 120-km above the epicenter. Also the spatial evolution of the horizontal (east-west component of) magnetic field B_x is shown in Figure 1 (b). The waves are slightly reflected at the altitude of about 80 km. It is seen that a specific null appears above the epicenter in both Figures 1 (a) and (b), and the electromagnetic field intensities have a north-south asymmetric distribution above the altitude of 70 km in the lower ionosphere, due to the whistler-mode propagation along the geomagnetic field lines.

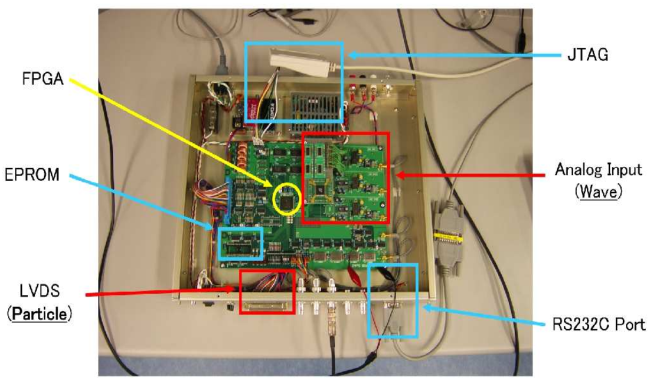


(a) (b)

<New Technology>

Ueda et al. [2004]developed a Digital Wave Particle Correlator (DWPC) system. The designed system is assembled in one FPGA (Field Programmable Gate Array) IC. For a new electron instrument in the development stage, FPGA is installed in many latest rocket and spacecraft to combine multi-channel, multi-frequency range array of correlators with technical improvements.

They realized 3-channel of variable waveform filter and data synchronization with waveform and particle in the DWPC system. In FPGA, the algorithm controls waveform data, particle data, and magnetic field data. A practical application of such a wave-particle correlation system is important in the space science mission. For example, the electron bunching generates plasma waves, packet-like langmuir waves generated in the polar aurora or in the solar wind. This instrument can observe wave-particle interactions by onboard calculation of the cross correlation functions between the obtained waveforms and detected particles.



Picture shows the test board of
Digital Wave Particle Correlator

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Reference

Ashihara Y., K. Ishisaka, T. Okada, T. Miyake, and Y. Murayama, “Estimation of electron density with MF radio receiver (MFR)€,35JAXA Special Report SP-04-007, 2005

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Hikishima M, Satoshi Yagitani, Isamu Nagano, Yoshiharu Omura, Hiroshi Matsumoto, “Particle simulation of cyclotron interaction of chorus in a nonuniform magnetic field€,35XXVIIIth URSI General Assembly, New Delhi, India, October 23-29, 2005.

Ishisaka K., T. Okada, J. Hawkins, S. Murakami, T. Miyake, Y. Murayama, I. Nagano, and H. Matsumoto, “ Investigation of Electron Density Profile in the Lower Ionosphere by SRP-4 Rocket Experiment€,35 Accepted in Earth, Planets and Space.

Kumamoto, A., T. Ono, and M. Iizima, “Seasonal and solar cycle dependences of ambient plasma density in the polar magnetosphere”, 35th COSPAR Scientific Assembly, Paris, France., p.3398, 2004

Miyake, T., T. Okada, H. Yamagishi, A. Chino, K. Ishisaka, T. Yamagami, "Development of ELF/VLF band wave receiver onboard Polar Patrol Balloon",IEICE Trans. on Communication B, vol.J87-B, No.5, pp.741-745, 2004

Ozaki M.,, Isamu Nagano, Satoshi Yagitani, Hisao Yamagishi, Natsuo Sato, and Akira Kadokura, “Ground based multipoint observations of natural ELF/VLF waves in Antarctica”, The 29th Symposium on Space and Upper Atmospheric Sciences in the Polar Regions, Tokyo, August 2005.

Ozaki M.,, Isamu Nagano, Satoshi Yagitani, and Kazutoshi Miyamura, “Time Evolution of Seismic Electromagnetic Wave Emission by Full-Wave Analysis”, XXVIIIth URSI General Assembly, New Delhi, India October 2005.

Shin K. , H. Kojima, H. Matsumoto, and T. Mukai **,** “Electrostatic quasi-monochromatic waves downstream of the bow shock: Geotail observations”, COSPAR COLLOQUIA SERIES Vol.16, Frontiers in Magnetospheric Plasma Physics, pp. 293-296, 2005.

Conferences and Meetings (February 2005 – July 2005)

1) Third International Symposium on the Arctic Research and eventh Ny-Alesund Scientific Seminar, Tokyo, Japan, February 22-24, 2005
2) International Workshop on Seismo Electromagnetics, Tokyo, Japan, March 15-17, 2005.

1) Magnetospheric ULF Waves (Chapman), San Diego, CA, USA, March 21-25, 2005
2) 7th International School/Symposium for Space Simulations, Kyoto, Japan, March 26-31, 2005
3) ISSS-7, Kyoto, March 26-31, 2005 http://www.rish.kyoto-u.ac.jp/isss7/
4) International Workshop on Space Weather - On the Causes of Southward Interplanetary Magnetic Field (IMF), Tokyo, Japan, April 4, 2005.
5) 9th Spacecraft Charging Technology Conference, Tsukuba, April 4-8, 2005,
6) European Geosciences Union General Assembly , Vienna, Austria, April 24-29, 2005
7) Joint meeting for Earth and Planetary Science 2005, Chiba, Japan, May 22-26, 2005.
8) Spring AGU Meeting New Orleans, May 23-27, 2005
9) AGU 2005 Joint Assembly, Louisiana, USA, May 23-27, 2005
10) Asia Oceania Geosciences Society's 2nd Annual Meeting (AOGS 2005), June 20-24, 2005, Singaporean (http://www.asiaoceania-conference.org/)

Future Conferences and Meetings

11) IAGA 2005 Scientific Assembly, Toulouse, France, July 18-29, 2005
12) International Symposium on Antenna and Propagation (ISAP2005), Seoul, Korea, August 3-5, 2005
13) Cluster and Double Star Symposium: 5th Anniversary of Cluster in Space, ESA/ESTEC, Noordwijk, The Netherlands, September 19-23 2005
14) 7th Asia Pacific Plasma Theory Conference (APPTC), July12-15, 2005 http://www.tcsc.nifs.ac.jp/icnsp
15) IAGA&ICMA, Tourouse, July 18-29, 2005 http://www.iugg.org/IAGA/index.htm http://www.copernicus.org/IAGA/2005/index.htm
16) 9th IAMAS Scientific Assembly, Beijing, August 2-11, 2005
17) The Magnetospheres of the Outer Planets University of Leicester August 7-12, 2005 http://ion.le.ac.uk/mop
18) CAWSES workshop September 12-13, 2005 http://www.stelab.nagoya-u.ac.jp/~scostep
19) SGEPSS, Kyoto Univ., September 28-October http://www.kurasc.kyoto-u.ac.jp/sgepss/LOC/
20) IAA International Conference on Low-Cost Planetary Missions Kyoto Research Park, 1 October 1-13, 2005 http://www.hayabusa.isas.jaxa.jp/iclcpm2005/
21) XXVIIIth International. Union of Radio Scnence [URSI], New Delhi, October 23-29, 2005 http://www.ursiga2005.org/
22) AGU fall meeting, San Fransisco, December 5-9, http://www.agu.org/meetings/fm05/
23) European Geosciences Union General Assembly, Vienna, April 2-7, 2006
24) 36th COSPAR, Beijing, July 16-23, 2005 http://www.copernicus.org/COSPAR/COSPAR.html
25) Western Pacific Geophysics Meeting, Beijing, 24-28 July, 2006 http://www.agu.org/meetings/wp06/