Japanese URSI Commission H (Waves in Plasmas)
Activity Report
January 2016 - May 2016

[1] Status of projects related with plasma wave observation

1. BepiColombo/MMO

http://global.jaxa.jp/projects/sat/bepi/
http://www.stp.isas.jaxa.jp/mercury/p_mmo.html
BepiColombo is a Mercury exploration project jointly planned by JAXA and the European Space Agency (ESA). It consists of two orbiters; the Mercury Planetary Orbiter (MPO) and the Mercury Magnetosphere Orbiter (MMO). JAXA is responsible for development of the MMO.
MMO is at ESA/ESTEC (European Space Research and Technology Centre, Netherlands) from April 2015. For the plasma wave, Plasma Wave Investigation (PI: Y. Kasaba [Tohoku Univ.]) is aboard this spacecraft. The recent activation was done in Nov. 30 – Dec. 1 and its good health was confirmed. PWI Science Team is now shifting to prepare the telemetry data pipelines and operation planning for the real science execution which will be realized in 2020s.

2. JUICE

http://sci.esa.int/juice/
JUICE (JUpiter ICy moons Explorer) is the L-class mission of ESA, planned for launch in 2022 and arrival at Jupiter in 2030s. It will spend at least three years making detailed observations of the Jovian system including Ganymede, Callisto and Europa, and finally be on the orbit around Ganymede. For the plasma wave, Radio and Plasma Wave Investigation (PI: J.-E. Wahlund [IRF Uppsala, Sweden]) is aboard this spacecraft and covers the information of the exospheres, surfaces, and conducting subsurface oceans of icy satellites and their interactions with surrounding Jovian magnetosphere. From Japan, High Frequency part (Preamp and Receiver) will be supplied (Co-PI: Y. Kasaba [Tohoku Univ.]), and provide the highly resolved information of Jovian radiation emitted from Jupiter and Ganymede by the first 3-axis E-field measurement. For the access to the conductive subsurface ocean, RPWI will first observe cold plasma and electric fields, in order to separate the global conductivity and current from the ionospheres. As a byproduct, reflected Jovian radio emission can be expected from the boundary of crust (ice) and subsurface ocean (conductive water).
In 2015, RPWI EM1 (BBM) was developed and integrated into one system. In 2016, RPWI EM2 (EM) will be developed.

3. The ERG project

http://ergsc.stelab.nagoya-u.ac.jp/index.shtml.en
The ERG (Exploration of energization and Radiation in Geospace) project is a mission to study acceleration and loss mechanisms of relativistic electrons around the Earth. To achieve comprehensive observations of plasma/particles, fields, and waves, the Plasma Wave Experiment (PWE, PI: Y. Kasahara [Kanazawa Univ.]) is installed onboard the ERG satellite to measure electric field in the frequency range from DC to 10 MHz, and magnetic field in the frequency range from a few Hz to 100 kHz. Besides the PWE, the Software-Wave Particle Interaction Analyzer (SWPIA) (PI: H. Kojima, [Kyoto. Univ.]) is equipped onboard the ERG to realize direct measurements of interactions between energetic electrons and whistler-mode chorus in the Earth's inner magnetosphere.
Flight model of the mission instruments are installed into the spacecraft and now in the system test at ISAS/JAXA. Its launch is planned at the end of 2016.

4. Hisaki spacecraft

http://global.jaxa.jp/projects/sat/sprint_a/
Hisaki satellite with the EUV spectrometer (Extreme Ultraviolet Spectroscope for Exospheric Dynamics: EXCEED) is the UV/EUV space telescope dedicated to planetary sciences.

In 2015 winter season, Hisaki provided continuous observations of Jovian system in UV aurora total flux and EUV Io torus plasma distributions and plasma diagnostics, which connected the solar wind information and ground-based radio (Decameter [aurora] - VHF [radiation belt]) and IR (aurora and airglows) observations.
This activity will be extended to the observational campaign with NASA Juno spacecraft, which will enter the Jovian orbit in July 2016. Associated with this, international ground-based observation networks are also formed.

5. 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 color 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 make the color spectrum plots in flexible time scales in the NICT web page http://geotail.nict.go.jp/.

6. NICT Science Cloud

http://sc-web.nict.go.jp/
With the tremendous development of plasma wave observation technologies, large-scale data sets are collected from environmental detectors and sensors. An edge computing for the large-scale data sets is hard to be conducted in real-time, thus a data transfer to cloud system and concurrent data processing plays an important role. One of the barriers in such system is the data transfer on long fat networks (LFNs) with high latency; even low packet loss leads to decrease in throughput of data transfer protocols. National Institute of Information and Communications Technology (NICT) Science Cloud has recently developed a high-speed data transfer protocol named HpFP which works on LFN. In this paper, we propose a tool for quality measurement of data transfer in LFNs. This tool allows a user not only to monitor a network but also to transfer data on a network.

7. Measurements of ELF/VLF waves at Athabasca, Canada

http://stdb2.stelab.nagoya-u.ac.jp/vlf/index.html
Routine measurements of ELF/VLF waves at Athabasca, Canada have been continued since September 2012. The sampling rate is reduced from 100 kHz to 40 kHz on November 12, 2015.

8. Study of Jovian auroral radio waves by ground-based radio observation

http://ariel.gp.tohoku.ac.jp/~jupiter/
In order to develop integrated data archive with data from Nancay Decametric Array and Radio Jove stations, a repository server for Virtual Observatory (VO) was set up at Tohoku University with the support of Paris Observatory team.

9. Measurements of VHF to UHF radio waves by using the Iitate Planetary Radio Telescope (IPRT)

http://pparc.gp.tohoku.ac.jp/data/iprt/index.html
Measurements of VHF to UHF radio waves have been made by using the Iitate Planetary Radio Telescope (IPRT) in Fukushima, Japan by Tohoku University. IPRT has dual rectangular parabolas with the total aperture area of about 1000 square meters, and is mainly dedicated to the investigations of fine structures of solar radio bursts and variations of Jupiter's radiation belt by the synchrotron radio emission.

10. Accurate measurement of multiscale structures of shock waves in a laser plasma

S. Matsukiyo [Kyushu University] started a laboratory experiment using large lasers as a collaborative research with Institute of Laser Engineering, Osaka University in 2016. [2016A1-MATSUKIYO].

[2] Recent Meetings

1. Symposium on Environment of Terrestrial Planets, Tokyo, Japan, Dec. 21-22, 2015.
2. Symposium on Planetary Science 2016, Sendai, 22-24 Feb, 2016
3. Workshop on Frontiers in Space Physics: Beyond the Heliosphere, Nagoya, Japan, 2-4, March, 2016.
   https://sites.google.com/site/heliosphericphysics/symposium
4. The Astronomical Society of Japan, Spring Meeting 2016, Tokyo, 14-15, March, 2016.
   http://www.asj.or.jp/nenkai/archive/2016a/
   Plannedl Session: Plasma Astrophysics
5. International GEMSIS and ASINACTR-G2602 Workshop, 22-25 March, 2016
6. European Geosciences Union (EGU) General Assembly 2016, Vienna, Austria, 17-22 April, 2016.
   http://www.egu2016.eu/
7. Japan Geoscience Union Meeting 2016, Chiba, Japan, 22-26 May, 2016.
   http://www.jpgu.org/meeting_e2016/

[3] Future Meetings

1. The 18th International Congress on Plasma Physics (ICPP 2016), Taiwan, 27 June – 1 July, 2016
   http://www.isaps.ncku.edu.tw/ICPP2016/
2. Asia Oceania Geosciences Society (AOGS) 13th Annual Meeting, Beijing, China, 31 July – 5 Aug., 2016.
   http://www.asiaoceania.org/aogs2016/
   Sessions related to plasma waves:
   ST11-28 ULF, ELF, and VLF waves and their effects on particles in the inner magnetosphere
   Conveners:
   Dr. Xin Tao (Univ. of Science & Technology of China, China) xtao@ustc.edu.cn
   Dr. Yuto Katoh (Tohoku University, Japan) yuto@stpp.gp.tohoku.ac.jp
   Prof. Lei Dai (Chinese Academy of Sciences, China) ldai@spaceweather.ac.cn
   Prof. Kyung-Chan Kim (Daegu University, Korea, South) kckim@daegu.ac.kr
   Dr. Masahito Nose (Kyoto University, Japan) nose@kugi.kyoto-u.ac.jp
3. 7th workshop of the VLF/ELF Remote Sensing of Ionospheres and Magnetospheres (VERSIM) working group, Hermanus, South Africa, 19-23 September, 2016.
4. Symposium on Planetary Science 2017, Sendai, Japan, Feb. 20-22, 2017.

[4] Recently Published Papers

"Low-Frequency Waves in Space Plasmas", edited by A. Keiling, D.-H. Lee and V. Nakariakov, John Wiley & Sons, Inc, Hoboken, NJ.
http://onlinelibrary.wiley.com/book/10.1002/9781119055006

Chapter 11:

Shinohara, I., Fujimoto, M., Nagai, T., Zenitani, S. and Kojima, H., Low-Frequency Waves in the Tail Reconnection Region, in Low-Frequency Waves in Space Plasmas, doi: 10.1002/9781119055006.ch11, 2016.

Chapter 17:

Nakagawa, T., ULF/ELF Waves in Near-Moon Space, in Low-Frequency Waves in Space Plasmas, doi: 10.1002/9781119055006.ch17, 2016.

✓ Low frequency waves observed in the vicinity of the moon were reviewed in association with modified distribution function of the plasma velocity.

Chapter 18:

Harada, Y. and Halekas, J. S., Upstream Waves and Particles at the Moon, in Low-Frequency Waves in Space Plasmas, doi: 10.1002/9781119055006.ch18, 2016

Bando, Y., A. Kumamoto, and N. Nakamura, Constraint on subsurface structures beneath Reiner Gamma on the Moon using the Kaguya Lunar Radar Sounder, Icarus, 254, 144-149, doi:10.1016/j.icarus.2015.03.020, 2015.
- ✓ This study examines subsurface stratifications below Reiner Gamma, albedo feature in Oceanus Procellarum with a high crustal magnetic field, using the LRS onboard Kaguya.
- ✓ Taking into account the LRS-determined dielectric constants, the influence of surface clutter, and the energy loss of the LRS radar pulses in the high frequency band (5 MHz), no evidence was found of subsurface boundaries down to a depth of 1000-m at Reiner Gamma.
- ✓ Given the LRS range resolution of 75-m, the source of the magnetic anomaly is considered to be either strongly magnetized thin breccia layers at depths shallower than 75-m, or less magnetized thick layers at depths deeper than 1000-m.

Endo, K., A. Kumamoto, and Y. Katoh, Observation of plasma waves around the wake of an ionospheric sounding rocket, J. Geophys. Res. Space Physics, 120, 5160-5175, doi:10.1002/2014JA020047, 2015.
- ✓ Plasma waves generated around the plasma wake of a supersonically moving rocket are studied using data from an impedance probe and a wave receiver on the sounding rocket S-520-26.
- ✓ Three types of plasma waves were observed: short-wavelength electrostatic waves, upper hybrid resonance mode waves, and whistler mode waves.
- ✓ The wave generation mechanisms are discussed by calculating the linear growth rates of electrostatic waves.

Engebretson, M. J., J. L. Posch. J. r. Wygant, C. A. Kletzing, M. R. Lessard, C. L. Huang, H. E. Spence, C. W. Smith, H. J. Singer, Y. Omura, R. b. Horne, G. D. Reeves, D. N. Baker, M. Gkioulidou, K. Okasavik, I. r. Mann, T. Raita, and K. Shiokawa, Van Allen probes, NOAA, GOES, and ground observations of an intense EMIC wave event extending over 12 h in magnetic local time, J. Geophys. Res. Space Physics, 120, 5465-5488, doi:10.1002/2015JA021227, 2015.
- ✓ Compression-induced EMIC waves were observed across 12 h of local time.
- ✓ EMIC-triggered emissions appeared during the strongest compression.
- ✓ Intense EMIC waves outside the plasmasphere depleted the radiation belts.

Hashimoto, K., Y. Goto, Y. Kasahara, H. Matsumoto, and R. R. Anderson, Auroral Kilometric Radiation, : Polarization and Spectra Observed far from the Earth, American Geophysical Union Monograph (eds Y. Zhang and L. J. Paxton), John Wiley & Sons, Inc, Hoboken, NJ. doi:10.1002/9781118978719.ch17, 2015.
- ✓ Auroral kilometric radiation (AKR) polarizations observed by Kaguya far from the Earth (approximately 60RE) were introduced.
- ✓ The lunar occultation technique was applied to determine the source hemisphere.
- ✓ The results are examined by ray tracing from Earth to the Moon.
- ✓ This ray tracing is also applied to banded AKR, which is observed far from Earth and in which emissions around 200 kHz are missing.

Ishikawa, T., Y. Sakawa, T. Morita, Y. Yamaura, Y. Kuramitsu, T. Moritaka, T. Sano, R. Shimoda, K. Tomita, K. Uchino, S. Matsukiyo, A. Mizuta, N. Ohnishi, R. Crowston, N. Woolsey, H. Doyle, G. Gregori, M. Koenig, C. Michaut, Thomson scattering measurement of a collimated plasma jet generated by a high-power laser system, Journal of Physics: Conference Series, 688, 012098, 2016
- ✓ High power laser experiment of plasma jet production was performed.
- ✓ Electron density, electron and ion temperatures, charge state, and drift velocity of the plasma jet were measured by collective Thomson scattering measurement.

Kaneda, K., H. Misawa, K. Iwai, F. Tsuchiya, and T. Obara, Frequency dependence of polarization of zebra pattern in type-IV solar radio bursts, Astrophys. J. Lett., 808, 2, doi: 10.1088/2041-8205/808/2/L45, 2015.
- ✓ Polarization characteristics of a zebra pattern (ZP) in a type-IV solar radio burst observed with AMATERAS on 2011 June 21 was investigated.
- ✓ We suggest that the ZP emission was originally generated in a completely polarized state in the O-mode and was partly converted into the X-mode near the source.

Kasaba, T. Sakanoi, K. Uemizu, I. Yoshikawa, Local electron heating in the Io plasma torus associated with Io from HISAKI satellite observation, J. Geophys. Res. Space Physics, 120, 12, 10,317-10,333, DOI:10.1002/2015JA021420, 2015.

- ✓ The extreme ultraviolet spectrograph on board the HISAKI satellite continuously observed the Io plasma torus (IPT) brightness. Its variation is caused by the increase in the hot electron population in the region downstream of Io.
- ✓ The electron heating process is related to the plasma density around Io.
- ✓ The interaction between Io and the IPT continuously produces a large amount of energy around Io, and 140 GW of that energy is immediately converted to hot electron production in the IPT.

Kita, H., H. Misawa, A. Bhardwaj, F, Tsuchiya, T. Sakanoi, Y. Kasaba, C. Tao, Y. Miyoshi, A. Morioka, Relation between the short-term variation of the Jovian radiation belt and thermosphere derived from radio and infrared observations, J. Geophys. Res. Space Physics, 120, doi:10.1002/2015JA021374, 2015.

- ✓ We report the first comprehensive observations of Jovian synchrotron radiation (JSR) and H3+ emission from the Jovian thermosphere to investigate the generation process of short-term (days to weeks) variations in the Jovian radiation belt.
- ✓ Variations of the total JSR flux density and thermospheric temperature seem consistent with the scenario, and the brightness distribution of JSR can be explained by the increase in radial diffusion accompanied by internal loss processes.

Kubota, Y., Y. Omura, and D. Summers, Relativistic electron precipitation induced by EMIC-triggered emissions in a dipole magnetosphere, J. Geophys. Res. Space Physics, 120, 4384?4399, doi:10.1002/2015JA021017, 2015.

- ✓ Electrons at 0.5-6 MeV are precipitated efficiently by EMIC-triggered emissions.
- ✓ Electrons are guided to lower pitch angles by nonlinear trapping.
- ✓ Precipitation is modulated by the subpacket wave periods.

Kuramitsu, Y., S. Matsukiyo, S. Isayama, D. Harada, T. Oyama, R. Fujino, Y. Sakawa, T. Morita, Y. Yamaura, T. Ishikawa, T. Moritaka, T. Sano, K. Tomita, R. Shimoda, Y. Sato, K. Uchino, A. Pelka, R. Crowston, N. Woolsey, Spherical shock in the presence of an external magnetic field, Journal of Physics: Conference Series, 688, 012056, 2016

- ✓ High power laser experiment of a spherical shock propagating in an external magnetic field was performed. A preliminary result of shadow graphy measurement is reported.

Kurita, S., A. Kadokura, Y. Miyoshi, A. Morioka, Y. Sato, and H. Misawa, Relativistic electron precipitations in association with diffuse aurora: Conjugate observation of SAMPEX and the all-sky TV camera at Syowa Station, Geophys. res. Lett., 42, 12, 4702-4708, 2015.

- ✓ Based on a conjugate observation between SAMPEX and the all-sky TV camera at Syowa Station, we report a case in which relativistic electron precipitations are associated with diffuse aurora.
- ✓ The result supports the idea that whistler mode waves contribute to both generation of diffuse auroras and relativistic electron precipitations.

Matsuda, S., Y. Kasahara, and Y. Goto, M/Q = 2 Ion Distribution in the Inner Magnetosphere Estimated from Ion Cyclotron Whistler Waves Observed by the Akebono Satellite, Journal of Geophysical Research, doi:10.1002/2014JA020972, 120(4), 2783–2795, 2015.

- ✓ We studied spatial occurrence distributions of H+, He+, and M/Q=2 ion band ion cyclotron whistler waves observed by Akebono below an altitude of 10,500 km.
- ✓ Statistical analysis showed that H+ band ion cyclotron whistlers is rarely generated, while M/Q = 2 ion band ion cyclotron whistlers are frequently observed in the equatorial region.
- ✓ Generation model of several bands of ion cyclotron whistlers was proposed.
- ✓ Magnetic local time dependence of the observed ion cyclotron whistlers was also examined.

Matsuda, S., Y. Kasahara, and C. A. Kletzing, Variation in crossover frequency of EMIC waves in plasmasphere estimated from ion cyclotron whistler waves observed by Van Allen Probe A, Geophys. Res. Lett., doi:10.1002/2015GL066893, 43(1), 28–34, 2016.

- ✓ 3461 H+ band ion cyclotron whistlers were observed from 572 km to 5992 km in altitude by Van Allen Probe A.
- ✓ The crossover frequencies of the observed events decreased with increasing altitude.

- ✓ 96% of observed H+ band ion cyclotron whistler wave events had crossover frequencies above $0.5f_{cH+}$ suggesting a frequency gap around $0.5f_{cH+}$ in the EMIC dispersion relation.

Matsukiyo, S., Y. Matsumoto, Electron Acceleration at a High Beta and Low Mach Number Rippled Shock, Journal of Physics: Conference Series, 642, 012017, 2015

- ✓ Two dimensional microstructures of a high beta and low Mach number quasi-perpendicular collisionless shock and the associated particle acceleration process are investigated.

Matsukiyo, S., Y. Kuramitsu, K. Tomita, Collective scattering of an incident monochromatic circularly polarized wave in an unmagnetized non-equilibrium plasma, Journal of Physics: Conference Series, 688, 012062, 2016

- ✓ Collective Thomson scattering of a monochromatic laser light in non-equilibrium plasmas, which may occur in the vicinity of a collisionless shock, is investigated.

Miyake, Y., Y. Nishimura, and Y. Kasaba, Asymmetric electrostatic environment around spacecraft in weakly streaming plasmas, J. Geophys. Res. Space Physics, 120, doi:10.1002/2015JA021064, 2015.

- ✓ We developed 3D particle-in-cell simulations including long and extremely thin wire booms as well as a spacecraft chassis, and investigated an electrostatic environment.
- ✓ Even subsonic ion flows can produce an appreciable potential difference between the upstream and downstream sides of the spacecraft, and the potential difference would be detected as a spurious field of a few mV/m.
- ✓ The necessary condition for the spurious field is a relatively high (a few tens of V) spacecraft potential, and also the spacecraft potential hump needs to be expanded by thin wire booms biased at the spacecraft potential. The analysis also reveals that the presence of a heavy ion flow and a field-aligned ion upflow can further enhance the spurious field up to 5 mV/m.

Morioka, A., Y. Miyoshi, K. Iwai, Y. Kasaba, S. Masuda, H. Misawa, and T. Obara, Solar micro-type III burst storms and long dipolar magnetic field in the outer corona, Astrophys. J., 808, 191, doi:10.1088/0004-637X/808/2/191, 2015.

- ✓ In solar micro-type III radio bursts, their frequency of occurrence with respect to radiation power is quite different from that of ordinary type III bursts.
- ✓ Micro-type III bursts occur near the edge of coronal streamers. Electron beams are trapped along closed dipolar field lines in the outer coronal region, which arise from the interface region between the active region and the coronal hole.
- ✓ A 22 year statistical study reveals that the apex altitude of the magnetic loop ranges from 15 to 50 R_S. The apex altitude has a sharp upper limit around 50 R_S suggesting that an unknown but universal condition regulates the upper boundary of the streamer dipolar field.

Nakagawa, T., T. Nakashima, T. Wada, H. Tsunakawa, F. Takahashi, H. Shibuya, H. Shimizu, M. Matsushima and Y. Saito, ELF magnetic fluctuations detected by Kaguya in the deepest wake associated with the type-II protons, Earth, Planets and Space, 67:50, doi:10.1186/s40623-015-0196-0, 2015.

http://earth-planets-space.springeropen.com/articles/10.1186/s40623-015-0196-0

- ✓ ELF waves were found by Kaguya in the center of the lunar wake accompanied by electron beam associated with the type-II entry solar wind protons.

Nakamura, S., Y. Omura, M. Shoji, M. Nose, D. Summers, and V. Angelopoulos, Subpacket structures in EMIC rising tone emissions observed by the THEMIS probes, J. Geophys. Res. Space Physics, 120, 7318?7330, doi:10.1002/2014JA020764, 2015.

- ✓ EMIC rising tone emissions comprise smaller subpackets with rising tones.
- ✓ Frequency sweep rates and growth rates agree with nonlinear theory.
- ✓ Amplitudes of the subpackets agree with the theoretical optimum amplitude.

Nomura, R., K. Shiokawa, Y. Omura, Y. Ebihara, Y. Miyoshi, K. Sakaguchi, Y. Otsuka, and M. Connors, Pulsating proton aurora caused by rising tone Pc1 waves, J. Geophys. Res. Space Physics, 121, doi:10.1002/2015JA021681, 2016.

- ✓ Rising tone emissions with a dispersion of 1 Hz per tens of seconds were found in a Pc1 on the ground
- ✓ Pulsations of the proton aurora have one-to-one correspondences with Pc1 rising tones Pc1 rising

tones and associated pulsating proton auroras are due to EMIC-triggered emissions
- ✓ Rising tone emissions with a dispersion of 1 Hz per tens of seconds were found in a Pc1 on the ground.
- ✓ Pulsations of the proton aurora have one-to-one correspondences with Pc1 rising tones.
- ✓ Pc1 rising tones and associated pulsating proton auroras are due to EMIC-triggered emissions.

Nosé, M., S. Oimatsu, K. Keika, C. A. Kletzing, W. S. Kurth, S. De Pascuale, C. W. Smith, R. J. MacDowall, S. Nakano, G. D. Reeves, H. E. Spence, and B. A. Larsen, Formation of the oxygen torus in the inner magnetosphere: Van Allen Probes observations, J. Geophys. Res., 120: 1182–1196, doi:10.1002/2014JA020593, 2015.
- ✓ The formation process of an oxygen torus during the 12–15 November 2012 magnetic storm is studied by using the magnetic field and plasma wave data obtained by Van Allen Probes. We estimate the local plasma mass density from the resonant frequencies of standing Alfvén waves.

Nosé, M., Long-term variations in the plasma sheet ion composition and substorm occurrence over 23 years, Geosci. Lett., doi:10.1186/s40562-015-0033-0, 2016.
- ✓ We study the long-term variations of substorm occurrences in 1992–2015 that are evaluated with the number of Pi2 pulsations detected at the Kakioka observatory. The results suggest no clear correlation between the substorm occurrence and the Mg II index.

Nunn, D., and Y. Omura, A computational and theoretical investigation of nonlinear wave-particle interactions in oblique whistlers, J. Geophys. Res. Space Physics, 120, 2890-2911, doi:10.1002/2014JA020898, 2015.
- ✓ Develops relativistic electron equations of motion for oblique whistlers.
- ✓ Computes resonant distribution function and nonlinear growth rates.
- ✓ Calculates nonlinear growth and damping rates for rising chorus element.

Obana, Y., C. L. Waters, M. D. Sciffer, F. W. Menk, R. L. Lysak, K. Shiokawa, A. W. Hurst, and T. Petersen, Resonance structure andmode transition of quarter-wave ULF pulsations around the dawn terminator, J. Geophys. Res. Space Physics, 120, doi:10.1002/2015JA021096, 2015.
- ✓ Resonance structure of four events of quarter-wave modes was examined. They also exhibited evidence of mode conversion from quarter- to half-wave mode. These experimental results were compared with the ULF wave fields obtained from a 2.5-dimensional simulation model.

Obara, T., and H. Matsumoto, Large enhancement of highly energetic electrons in the outer radiation belt and its transport into the inner radiation belt inferred from MDS-1 satellite observations, Sun and Geosphere, ISSN 2367-8852,Vol.11, No.11, 61-64, 2016
- ✓ We have examined a large increase of relativistic electrons in the outer radiation belt and its penetration into the inner radiation belt over slot region using the MDS-1 satellite observations.
- ✓ A large increase took place in the spring and autumn seasons, and we have newly confirmed that the penetration of outer belt electrons to the inner radiation zone took place during the big magnetic storms by examining a pitch angle distribution of the penetrating electrons.
- ✓ In both processes, strong wave-particle interaction should take important roles.

Omura, Y., S. Nakamura, C. A. Kletzing, D. Summers, and M. Hikishima, Nonlinear wave growth theory of coherent hiss emissions in the plasmasphere, J. Geophys. Res. Space Physics, 120, 7642?7657, doi:10.1002/2015JA021520, 2015.
- ✓ Nonlinear theory of chorus waves can explain observations of coherent hiss emissions.
- ✓ Optimum wave amplitudes for triggering rising and falling tone emissions are derived
- ✓ Upper limit of hiss is determined by optimum and threshold amplitudes for rising tones.

Omura, Y., Y. Miyashita, M. Yoshikawa, D. Summers, M. Hikishima, Y. Ebihara, and Y. Kubota, Formation process of relativistic electron flux through interaction with chorus emissions in the Earth's inner magnetosphere, J. Geophys. Res. Space Physics, 120, 9545?9562, doi:10.1002/2015JA021563, 2015.
- ✓ Chorus emissions can accelerate electrons from tens of keV to several MeV within a few minutes.
- ✓ A dumbbell distribution of relativistic electrons is formed by nonlinear trapping (RTA + URA).
- ✓ A numerical Green’s function method for chorus wave-particle interaction is formulated.

Ota, M., Y. Kasahara, and Y. Goto, A new method for direction finding based on Markov random field model, Radio Science, doi:10.1002/2014RS005635, 50(7), 598–613, 2015.

- ✓ A new method for direction finding of the plasma waves was proposed based on the assumption that the wave distribution function (WDF) can be represented by a Markov random field model.
- ✓ Using computer-generated spectral matrices, we evaluated the performance of the model and compared the results with those obtained from two conventional methods.

Ozaki, M., S. Yagitani, K. Sawai, K. Shiokawa, Y. Miyoshi, R. Kataoka, A. Ieda, Y. Ebihara, M. Connors, I. Schofield, Y. Katoh, Y. Otsuka, N. Sunagawa, and V.K. Jordanova, A direct link between chorus emissions and pulsating aurora on timescales from milliseconds to minutes: A case study at subauroral latitudes, J. Geophys. Res. Space Physics, 120, 9617–9631, doi:10.1002/2015JA021381, 2015.

- ✓ A direct link between discrete chorus elements and pulsating aurora (PA) was observed.
- ✓ The temporal features of discrete chorus elements were related to PA.
- ✓ The magnetic field inhomogeneity plays a crucial role in the generation of PA.

Pal, S. and Y. Hobara, Mid-latitude atmosphere and ionosphere connection as revealed by Very Low Frequency signals, Journal of Atmospheric and Solar-Terrestrial Physics, Vol. 138-139, 227-232, 2016.

- ✓ To investigate the relationship between the lower atmosphere and UMLI region, we compared the amplitude of VLF signals with the atmospheric parameters (TCO density, stratospheric temperatures etc.) for the first time for three different latitudinal regions.

Parrot, M., J. J. Berthelier, J. Blecki, J. Y. Brochot, Y. Hobara, D. Lagoutte, J. P. Lebreton, F. Němec, T. Onishi, J. L. Pinçon, D. Píša, O. Santolík, J. A. Sauvaud, E. Slominska , Unexpected Very Low Frequency (VLF) Radio Events Recorded by the Ionospheric Satellite DEMETER, Surveys in Geophysics, 36(3), 483-511, 2015.

- ✓ This paper shows both expected and unusual events recorded by DEMETER. These events are rare or even have never been observed before, because they have a very high intensity, or they are related to abnormalities of the experiments under particular plasma conditions.

Sato, Y., A. Kadokura, Y. Ogawa, A. Kumamoto, and Y. Katoh, Polarization observations of 4fce auroral roar emissions, Geophys. Res. Lett., 42, 249-255, doi:10.1002/2014GL062838, 2015.

- ✓ We report on the first polarization measurement of auroral roar emissions near 4 fce by a ground-based passive receiver installed in Iceland.
- ✓ In 9 of 11 cases, 4 fce roar was left-handed elliptically polarized waves. The O-mode 4 fce roar was observed under both sunlit and dark ionospheric conditions during geomagnetic storms. For O-mode 4 fce roar generation during darkness, the condition fUH = 4 fce might be satisfied by a high-density F region ionosphere due to auroral precipitation or tongue of ionization. In two cases, right-handed elliptically polarized 4fce roar was observed during darkness hours and the main phase of a geomagnetic storm. This polarization indicates that nonlinear coupling of two upper hybrid waves may also work to generate X-mode 4fce roar.

Sato, Y., A. Kumamoto , Y. Katoh , A. Shinbori , A. Kadokura, Y. Ogawa, Simultaneous ground- and satellite-based observation of MF/HF auroral radio emissions, J. Geophys. Res. Space Physics, in print, doi:10.1002/2015JA022101, 2016.

- ✓ We compared medium-high frequency (MF/HF) auroral radio emissions (above 1 MHz) measured in the same period by the ground-based passive receivers in Iceland and Svalbard, and by the Plasma Waves and Sounder experiment (PWS) mounted on the Akebono satellite.
- ✓ In most cases, MF/HF auroral radio emissions were observed only by the ground-based detector, or by the satellite-based detector. This can be explained that Akebono can detect THR emissions coming from a wider region, and because a considerable portion of auroral radio emissions generated in the bottomside F region are masked by ionospheric absorption and screening in the D/E regions associated with ionization which results from auroral electrons and solar UV radiation.

Shoji, Y., R. Yamazaki, S. Tomita, Y. Kawamura, Y. Ohira, S. Tomiya, Y. Sakawa, T. Sano, Y. Hara, S. Kondo, H. Shimogawara, S. Matsukiyo, T. Morita, K. Tomita, H. Yoneda, K. Nagamine, Y. Kuramitsu, T. Moritaka, N. Ohnishi, T. Umeda, H. Takabe, Toward the

Generation of Magnetized Collisionless Shocks with High-Power Lasers, Plasma and Fusion Research, 11, 3401031, 2016

- ✓ Experimental design for producing a magnetized collisionless shock by using high power laser is proposed. A preliminary result of the experiment using Gekko XII laser facility at Osaka University was reported.

Sugiyama, H., S. Singh, Y. Omura, M. Shoji, D. Nunn, and D. Summers, Electromagnetic ion cyclotron waves in the Earth's magneto-sphere with a kappa-Maxwellian particle distribution, J. Geophys. Res. Space Physics, 120, 8426?8439, doi:10.1002/2015JA021346, 2015.

- ✓ EMIC wave instabilities in a kappa-Maxwellian are studied.
- ✓ Characteristics of higher harmonics of EMIC waves are identified.
- ✓ Technical description of KUPDAP dispersion solver is given.

Takahashi, N., Y. Kasaba, A. Shinbori, Y. Nishimura, T. Kikuchi, Y. Ebihara, and T. Nagatsuma, Response of ionospheric electric fields at mid-low latitudes during sudden commencements, J. Geophys. Res., 120, 6, 4849-4862, DOI:10.1002/2015JA021309, 2015.

- ✓ We investigated the time response and local time dependence of the ionospheric electric field at mid-low latitudes associated with geomagnetic sudden commencements (SCs) from 1999 to 2004 using in-situ observations from the Republic of China Satellite-1 spacecraft.
- ✓ Our analysis supports the global instant transmission of electric field from the polar region. In contrast, the peak time detected in the ionospheric electric field is earlier than that of the equatorial geomagnetic field (~20 s before in the PI phase).
- ✓ The electric potential distribution is asymmetric with respect to the noon-midnight meridian, explained by the divergence of the Hall current under nonuniform ionospheric conductivity.

Tatsuta, K., Y. Hobara, S. Pal, and M. Balikhin, Sub-ionospheric VLF signal anomaly due to geomagnetic storms:a statistical study, Ann. Geophys., 33, 1457-1467, 2015.

- ✓ We study quantitatively the effect of geomagnetic storms on the sub-ionosphericVLF/LF propagations for different latitudes based on 2-year nighttime data from Japanese VLF/LF observation network.

Teramoto M., N. Nishitani, Y. Nishimura and T. Nagatsuma, Latitudinal dependence on the frequency of Pi2 pulsations near the plasmapause using THEMIS satellites and Asian-Oceanian SuperDARN radars, Earth, Planets and Space, 68:22, DOI: 10.1186/s40623-016-0397-1, 2016.

- ✓ A Harmonic Pi2 wave that started at 09:12 UT on August 19, 2010 are reported. This event was observed simultaneously at 19:00–20:00 MLT by three mid-latitude Asian-Oceanian SuperDARN radars, three THEMIS satellites, and ground-based magnetometers at low and high latitudes.

Tsuchiya, F., M. Kagitani, K. Yoshioka, T. Kimura, G. Murakami, A. Yamazaki, H. Nozawa, Y. Tsugawa, Y., Y. Katoh, N. Terada, H. Tsunakawa, F. Takahashi, H. Shibuya, H. Shimizu, and M. Matsushima, Harmonics of whistler-mode waves near the Moon, Earth, Planets and Space, 67:36 doi:10.1186/s40623-015-0203-5, 2015.

- ✓ Harmonic spectral features of electromagnetic waves at several Hz around the Moon have been identified by Kaguya. The fundamental waves have almost the same properties as narrowband whistler-mode waves near 1 Hz observed around the Moon. The harmonic spectra are a result of the nonlinear steepening of narrowband whistler-mode waves. Since the harmonics are more frequently observed at lower altitudes of the Moon, they are possibly caused by lunar intrinsic environments including lunar dusts and local structures of lunar magnetic anomalies.

Watanabe, H., Kurosawa, T., Kimura, E., Mizuhara, T., Murata, Ken. T., Tatebe, O., A File Transfer Tool by UDT Multiple Streams for A Distributed File System (in Japanese), The IEICE Transactions of Information and Systems (Japanese Edition), vol. J99-D, no. 5, pp. 514-525, DOI:10.14923/transinfj.2015AIP0009, 2016

- ✓ We discuss a distributed file system of scale-out type is gradually being used in the high performance computing to store large scale data such as plasma simulations or observations. We proposed and developed a tool working in LFN between Japan and USA, where latencly (RTT: round trip time) was 152ms, and confirmed 7Gbps in reading and 5Gbps in writing.