

Scientific Results

The Sakura project team met 3 times during 2016:

- May 2016, Tokyo, Japan [JpGU];
- July 2016, Sendai, Japan [JUICE-RPWI];
- October 2016, Graz, Austria [PRE8].

The team worked on several projects in 2016:

- Study of long term variation of Saturn kilometric auroral radio emission. This work was conducted mainly by Ayumu Sasaki, graduate student at Tohoku. The main original result of this study is the observation of a seasonal variation of the Northern and Southern auroral radio sources at sources, as well as a correlation with the EUV solar flux fluctuation. LESIA provided the data (Cassini/RPWS) and helped on the data analysis.
- Juno-Ground-Radio collaboration. This activity is a world-wide support of the NASA/JUNO mission, providing the Juno science team with observations of Jovian radio emissions between 10 and 40 MHz from observatories all over the world. This support is led by LESIA, and the two first observatories connected to the network are the Iitate Radio observatory (Tohoku) and Nançay Decameter Array (Nançay, Obs Paris).
- Study of passive subsurface radar using natural decametric Jovian radio emissions. This activity is ongoing in the frame of the JUICE mission. BC and YK are co-PI of the RPWI instrument onboard JUICE. The observation concept was proposed by the team inspiring from a paper using Kaguya data (Ono et al 2012). The LESIA expertise on Jovian radio bursts, and especially S-bursts is necessary to adjust the future observation modes developed by the Japanese team.
- Connection to the Europlanet/VESPA infrastructure. The LESIA team is leading VESPA, a large work package of the EPN2020RI project. Its goal is to setup an interoperable infrastructure for sharing planetary science data. Data access servers have been setup in Japan (Tohoku) and in France (Nançay), following the recommendations of VESPA. The Tohoku server is sharing Iitate decametric data. A few other data collections are now prepared for distribution using that server (Hisaki data, Iitate decimetric data, Iitate waveform data)
- Update of Solar Wind propagation model. Chihiro Tao has developed in the previous years a 1D MHD propagation model for the solar wind. It is used by the LESIA and IRAP teams. It is distributed by the CDDP, in IRAP. CT updated his model, adding inputs from the STEREO-A spacecraft beacon data. This new version is more accurate. Laurent Lamy is using the prediction of solar wind parameters at the outer planets for planning of observation of Saturn's and Uranus' aurorae.
- Hisaki observations in support of Juno. The Hisaki instrument onboard the Exceed spacecraft is used for monitoring of the Io torus density. This is mainly a Japanese team activity, with discussions with the French team.
- Catalogue of jovian radio emissions. This catalogue is built upon 26 years of daily observations of Jupiter at NDA. It has just been submitted for publication. It is very rich and complete. The team could discover Ganymede and Europa controlled radio emissions, in addition to those controlled by Io. This discovery is new, and has been confirmed on 2 other datasets (Voyager data and Cassini data, during their jovian flybys). This is mainly a French activity.

During the last meeting in Graz, 4 main projects Projects:

- Linking Io-torus density with radio emission characteristics. The Hisaki instrument observed a significant increase of the Io-Torus density during the first months of 2015. According to our understanding of the Io-Jupiter interaction, such a phenomenon should modify the magnetic connectivity of this interaction, and in turn modify also the Io-controlled radio emission properties. The proposed work plan is to model the observed Io-DAM radio bursts during the Jan-March 2015 period. The datasets to be used are the NDA/routine, litate, LWA and possibly RadioJOVE observations. CT will use the ExpRES modeling tool, which outputs are the “lead-angle” and the “electron kinetic energy” of the radio source. KI also proposes to you his “modulation lane model”. Correlations between the resulting datasets will then be studied.
- TK has already setup a prototype VESPA server for Hisaki data (level 2). He is plans to update the data collection with recent data and higher level products. The goal is also to connect his data collection with APIS (database in LESIA, LL). In order to do so, TK will update his data product catalogue, with keywords to be provided by LL and BC.
- The catalogue of jovian radio emission is using the NDA data only (over 26 years). The Tohoku team is proposing to extend the catalogue with litate spectrograms. It is understood that the same identification criteria must be used for both data sets, in order to ensure the catalogue consistency.
- The VESPA server in Tohoku has been setup and can be used for including new dataset very easily. Several data collections are already being prepared, but other will be studied. The same will occur in Nançay.

Publications and Conferences

Publications

- M. Imai et al. (2016) The Beaming Structures of Jupiter’s Decametric Common S-bursts Observed from the LWA1, NDA, and URAN2 Radio Telescopes, *ApJ*, 826:176
- Sanchez-Diaz, E., et al. (2016) The very slow solar wind: Properties, origin and variability, *J. Geophys. Res. Space Physics*, 121, 2830–2841, doi:10.1002/2016JA022433.
- Kimura, T. et al. (2016), Jupiter's X-ray and EUV auroras monitored by Chandra, XMM-Newton, and Hisaki satellite. *Journal of Geophysical Research Space Physics*, 121, 2308–2320, doi: 10.1002/2015JA021893.
- Kita, H., et al. (2016), Characteristics of solar wind control on Jovian UV auroral activity deciphered by long-term Hisaki EXCEED observations: Evidence of preconditioning of the magnetosphere?, *Geophys. Res. Lett.*, 43, 6790–6798, doi:10.1002/2016GL069481.
- Tao, C., et al. (2016), Variation of Jupiter's aurora observed by Hisaki/EXCEED: 1. Observed characteristics of the auroral electron energies compared with observations performed using HST/STIS, *Journal of Geophysical Research Space Physics*, 121, doi:10.1002/2015JA021271.
- Badman, S. V., et al. (2016), Weakening of Jupiter's main auroral emission during January 2014, *of Geophysical Research Letters*, 43, doi:10.1002/2015GL067366.
- Tao, C. et al. (2016), Variation of Jupiter's Aurora Observed by Hisaki/EXCEED: 2. Estimations of Auroral Parameters and Magnetospheric Dynamics, *Journal of Geophysical Research*, 120, 10.1002/2015JA021272.

- M. Marques et al. (2016) Statistical analysis of 26 years of observations of decametric radio emissions from Jupiter. A&A submitted.
- Kasaba, Y., et al. (2016), Back to Jupiter, with renovated point of view and focus on icy moons — Toward the Flight of Radio and Plasma Wave Instruments —, Japanese Soc. Planet. Sci., 25, 3, 96-107. (in Japanese)
- Kaneda, K., et al. (2016) Frequency Dependence of Polarization of Zebra Pattern in Type-IV Solar Radio Bursts, *Astrophys. J. Lett.*, 808, (2016), L45, 10.1088/2041-8205/808/2/L45
- Sasaki, Y. (2016) A study on the vertical distribution of Jovian decametric S-burst sources based on ground-based observations, Master's thesis, Tohoku University.

Conferences

EGU, April 2016, Vienna, Austria:

- Cecconi, B. et al. Virtual observatory tools and amateur radio observations supporting scientific analysis of Jupiter radio emissions,
- Lecacheux A. et al. Polarisation ellipse orientation of Jovian decametric radiation

JpGU, May 2016, Tokyo, Japan:

- Cecconi, B. et al. Juno-Ground-Radio Observation Support
- Sasaki, A. et al. North-south asymmetry of Saturn's auroral radio emissions: The seasonal variation of their fluxes.
- Kumamoto, A. Development status of Jovian radio wave data archive as a unit of integrated archives of data from multiple ground stations for collaboration with Juno,.
- Sasaki, Y. et al. Derivation of the vertical distribution of Jovian decametric S-burst sources based on ground-based observations for verification of the Jovian ionospheric Alfvén resonator model.
- Tao, C. et al. Jupiter's auroral observations by Hisaki/EXCEED and expectation toward collaborations with Juno,

AGS, August 2016, Beijing, China:

- ??

PRE8, Oct. 2016, Graz, Austria:

Oral talks:

- Imai M. et al. Analysis of Jovian low-frequency radio emissions based on the Juno Waves data and stereoscopic observations with Juno and Earth-based radio telescopes,
- Cecconi, B. et al. Juno-Ground-Radio Observation Support.
- Imai, K. et al. Io-C and Io-B source morphology of Jupiter's decametric emissions from LWA1 modulation lane data analysis.
- Kimura, T. et al. Continuous monitoring of Jupiter's aurora and Io plasma torus with the Hisaki satellite: Recent results and future coordination with Juno
- Zarka, P. et al. Radio emission from satellite-Jupiter interactions.
- Louis, C. et al. Detection of Jupiter Decametric (DAM) emissions controlled by Europa and Ganymede.
- Kumamoto, A. et al. Statistical analysis of periodicity of Jovian S-burst.

- Lamy, L. Saturnian Kilometric Radiation: current view and pending questions before the Cassini 'Grand Finale'.

Posters:

- Tsuchiya, F. et al. Total flux measurement of Jupiter's synchrotron radiation during the HISAKI and JUNO campaign periods,
- Misawa, H. et al. Variation characteristics of Jupiter's hectometric radiation during the Iogenic plasma enhancement period.
- Kumamoto A., et al. Feasibility of the exploration of the subsurface structures of Jupiter's icy moons by Jovian hectometric radiation.
- Lamy, L. et al. Search for Io, Ganymede and Europe induced radio emissions from Cassini/RPWS integrated power time series
- Lamy, L. et al., 1977-2017: 40 years of observations of Jupiter and the Sun with the Nançay Decameter Array.
- Hess, S. et al. ISaAC, a Jupiter magnetic field model constrained by the auroral footprints of the Galilean satellites
- Lecacheux, A. et al. Jovian DAM linear polarization study from coordinated, distant, ground-based radio telescopes.
- Cecconi, B. et al. Re-processing and re-analysis of Planetary Radio Astronomy (PRA) of Voyager 1 & 2.
- Kasaba, Y. et al. Characteristics of Saturn's short-term kilometric radio bursts in 2005-2006 when Cassini stayed close to the equatorial plane.
- Sasaki, A. et al. The seasonal variation of Saturn's auroral radio emissions in 2004-2015: The correlation with solar wind activity and solar EUV flux.
- Tao, C. et al. A diagnosis for the auroral field-aligned acceleration processes at Saturn using the brightness ratio of H Lyman- α /H₂ bands in FUV auroral emission
- Katoh, Y. et al. Science objectives and implementation of Software-type Wave-Particle Interaction Analyzer (SWPIA) by RPWI for JUICE
- Tsuchiya, F. et al. Database of solar radio bursts observed by solar radio spectropolarimeter AMATERAS.

SGEPPS, Nov 2016, Tokyo, Japan:

- Sasaki, A. et al. The seasonal variation of Saturn's auroral radio emissions in 2004-2015: The correlation with solar wind activity and solar EUV flux
- Tao, C. et al., Jupiter's auroral energy input and its modulations by Io's volcanic activity observed by Hisaki/EXCEED.

AGU-FM, Dec 2016, San Francisco, CA, USA:

- Tao, C. et al. Jupiter's Auroral Energy Input Observed by Hisaki/EXCEED and its Modulations by Io's Volcanic Activity.

Education through Research

- **Corentin Louis:** PhD student at LESIA. Working on simulation code for planetary radio emissions (ExpRES). Japanese team very interested. Online interface to be ready in 2017, with a tutorial. Data from Iitate radio observatory may be used to constrain model.

- **Ayumu Sasaki:** Graduate Student at Tohoku University. Working on seasonal variations of Saturn auroral radio emissions. The LESIA team interacted with him to consolidate his results. The expertise of LESIA was important as the data are built there, by L. Lamy and B. Cecconi.
- **Ryoichi Koga.** He is a master course student in Tohoku Univ. and studying about spatial distribution and time variability of atomic oxygen around a Jovian moon Io (corona and extended cloud) using HISAKI observation data.
- **Mika Shishido.** She is a master course student in Tohoku Univ. and studying about ion temperature parallel to magnetic field derived from emission scale height of Io plasma torus observed by HISAKI satellite and its time variability during the spring of 2015.
- **Kazutaka Kaneda.** He is a doctor course student in Tohoku Univ. and studying about fine spectral structure, "Zebra pattern", in the solar type IV burst observed by litate planetary radio telescope (IPRT) in Japan.

International Opportunities

- **Juno** During this 1st year, a collaboration on ground based radio observations supporting the NASA Juno mission was engaged. B. Cecconi (LESIA) is the coordinator of this activity for the Juno team. The data recorded at the litate radio observatory (science lead is A. Kumamoto, from Tohoku Univ.), are now available in this international network of observatories, gathering the largest instruments in the world in that spectral range (France, EU, USA, Ukraine). Furthermore, T. Kimura (Riken) works with the Hisaki space telescope (UV spectrometer) and is observing Jupiter and the Io torus. He allowed the access to the french team, opening the way for many joint studies. Discussions have also been initiated to participate to and share IRTF observations by Glenn Orton and Y. Kasaba.
- **Europlanet** LESIA is the coordinator of VESPA (Virtual European Solar and Planetary Access), the data distribution section of Europlanet-H2020-RI. IRAP also participate through the CDPP (Centre de Données de la Physique des Plasmas). The Japanese team installed and configured the data server compliant with VESPA, and is now distributing litate data to the whole community using that server. A data service dedicated to Hisaki data is also under development, together with other databases from Tohoku. The setup of this server has been a significant part of the activity. It allows a real knowledge transfer from the French team (world leader on the topic) to the Japanese one.