Optical observation of neutral helium distribution in interplanetary space by Hisaki

*Atsushi Yamazaki[1], Go Murakami[1], Tomoki Kimura[2], Kazuo Yoshioka[3], Fuminori Tsuchiya[4], Masato Kagitani[4], Takeshi Sakanoi[4], Naoki Terada[4], Yasumasa Kasaba[5], Ichiro Yoshikawa[6]

1.Institute of Space and Astronautical Science / Japan Aerospace Exploration Agency, 2.Nishina-Center for Accelerator Based Science, RIKEN, 3.Department of Earth & Planetary Science, Graduate School of Science, The University of Tokyo, 4.Planetary Plasma and Atmospheric Research Center, Graduate School of Science, Tohoku University, 5.Dep. Geophysics Graduate School of Science Tohoku University, 6.The University of Tokyo

The Hisaki (SPRINT-A) satellite has a main scientific topic of the planetary continous observation for a long term, but carried out the non-planet observation at the time when no planet during a good observation opportunity phase exists. One case of those is observation of helium atom resonance scattering from the interplanetary space.
A material in the local interstellar medium (LISM) travels into the heliosphere over the heliopause by the relative velocity of the heliosphere and the interstellar medium. The helium atom moves into about 0.5Au from the neighboring of the sun without ionizing because of its high ionization energy. The travelling orbit is bent by sun gravity and forms a high density region on the down wind side. It is called helium cone. The distribution of helium atoms in the helium cone can estimate the speed and direction of the interstellar wind, and the density and the temperature of the helium atom in interstellar space. Such a study was carried out from the 1970s, but the recent IBEX satellite observation results into gradual changes of the interstellar wind direction for several decades (Frisch+13).
The Hisaki satellite carried out the observaiont of the resonance scattering from helium corn. In this season, Hisaki observed the helium cone for two months including a ecliptic longitude with the maximum density of the helium corn. In this presentation, the helium cone observation result and the change of the wind direction are reported.

Keywords: Interplanetry helium, EUV observation, Interstellar wind

Solar neutron observations with ChubuSat-2 satellite

*Kazutaka Yamaoka[1], Takuya Miyazawa[1], Shinji Oseki[1], Yasunori Babazaki[1], Yuki Hayashi[1], Daisuke Ishihara[1], Kazuya Itoh[1], Hidehiro Kaneda[1], Hiroaki Kawahara[1], Shin Kubo[2], Koji Matsushita[1], Kikuko Miyata[1], Hosei Nagano[1], Yasutaka Narusawa[1], Masaki Nishino[1], Sosuke Noda[1], Daeil Park[1], Masaaki Sadamoto[2], Hiroyasu Tajima[1], Keisuke Tamura[1], Hidetaka Tanaka[1], Tam Dao[1], Toyoki Watabe[1], Qidong Zhou[1]

1.Nagoya University , 2.Clear Pulse Co Ltd.

Solar neutron observation is a key in understanding of ion accerelation mechanism in the Sun surface since neutrons are hardly affected by magnetic field around the Sun and intersteller mediums unlike charged particles. However, there was only a few tenth detections so far since its discovery in 1982. Actually SEDA-AP Fiber detector (FIB) onboard the International Space Station (ISS) was suffered from a high neutron background produced by the ISS itself.
ChubuSat is a series of 50-kg class microsatellite jointly depeloped by universities (Nagoya university and Daido university) and aerospace companies at the Chubu area of central Japan. The ChubuSat-2 is the second ChubuSat following the ChubuSat-1 which was launched by Russian DNEPR rocket on November 6, 2014. It was selected as one of four piggyback payloads of the X-ray astronomy satellite ASTRO-H in 2014 summer, and will be launched by the H-IIA launch vehcles from from JAXA Tanegashima Space Center (TNSC) in February 2016. The ChubuSat-2 carries a mission instrument,
radiation detector (RD). The main mission of ChubuSat-2 is devoted for monitoring neutrons and gamma-rays which can be background source for ASTRO-H celestrial observations with the RD. The mission also involves a function of solar neutron observations which were originally proposed by graduate students who join the leadership development program for space exploration and research, program for leading graduate schools at Nagoya University. The RD has a similar detection area and efficiency to those of the SEDA-AP FIB, but is expected to have lower backgrounthan the ISS thanks to much smaller mass of the micro-satellite. In this paper, we will describe details of ChubuSat-2 satellite and RD, and in-orbit performance of RD.

Keywords: Sun, Neutron, Satellite observations

Statistical characteristics of spectral fine structures in solar radio type II bursts

Hirotaka Kashiwagi[1], *Hiroaki Misawa[1], Fuminori Tsuchiya[1], Takahiro Obara[1], Satoshi Masuda[2], Kazumasa Iwai[3]

1.Planetary Plasma and Atmospheric Research Center, Graduate School of Science, Tohoku University, 2.Institute for Space-Earth Environmental Research, Nagoya University, 3.National Institute of Information and Communications Technology

Type II bursts are one of the solar radio bursts associated with flare and coronal mass ejections (CMEs). They are thought to be a plasma emission from non-thermal electrons accelerated in and/or around a shock wave. A type II burst appeared as a group of spectral fine structures with the typical duration of a few hundreds msec is reported recently [e.g. Sato et al. in the JpGU2014 meeting]. Such spectral fine structures can be interpreted as the motion of non-thermal electron beams accelerated in the shock region.
In this study, we performed a statistical analysis to investigate generality of spectral fine structures of type II bursts by using the meter wave band solar radio telescope AMATERAS developed by Tohoku University [Iwai et al., 2012]. AMATERAS enables us to observe solar radio bursts in the frequency range between 150 and 500 MHz with the 10 msec accumulation time and 61 kHz bandwidth. We identified occurrence of totally 13 type II bursts for the period of Oct. 2010 to Sep. 2014, which were all associated with solar flare events. As the result, we revealed that all of them were accompanied by spectral fine structures. This fact strongly suggests a possibility that the spectral fine structures are general characteristic of type II bursts. The drift rates of the spectral fine structures were analyzed for all type II events. It is found that they showed both positive and negative senses and were in the time scale of tens to hundreds MHz/s. By assuming a general coronal plasma density model, for example the Newkirk model [Newkirk, 1961], particle speeds for some fine structures are estimated to be unrealistically high; i.e., faster than the light speed. The drift rates are faster than those of the well known spectral fine structure in type II burst 'herringbone structure', therefore, it is notable that the spectral fine structure identified in this study is a 'newly identified type' in type II bursts. And the unrealistically high drift rate implies the existence of denser plasma structure than general coronal plasma possibly near the shock regions. In the presentation, we will show the general characteristics of the fine structures of type II bursts and also discuss possible source regions.

Keywords: Solar type II burst, spectral fine structure

Relationship between solar flare level and occurrence characteristics of type III bursts

*Saho Matsumoto[1], Hiroaki Misawa[1], Fuminori Tsuchiya[1], Takahiro Obara[1]

1.Planetary Plasma and Atmospheric Research Center, Graduate School of Science, Tohoku University

Type III bursts are impulsive radio bursts generated in association with solar flare. Their occurrence frequency has wide band and changes fast from higher to lower. As for their generation process, it is generally considered that the electron beams accelerated by magnetic reconnection excites plasma waves (Langmuir waves), then the waves are converted to electromagnetic waves. The detailed conversion processes and electromagnetic environment required for the generation have been studied for a long time, but they have been still discussed. Type III bursts have been commonly studied with X-ray flares because the X-ray emission is also generated by accelerated particles associated with flares. Soft X-ray is considered to have considerable energy of flare and used as a value to indicate a size of flare.
In this study, we have analyzed spectral structures of type III bursts observed with AMATERAS, the meter wave range radio spectro-polarimeter for solar radio observations at Tohoku University. We have compared frequency spectral with time variation of GOES soft X-ray flux, and found that type III bursts often appeared in the non soft X-ray flare period having almost same structure as in the soft X-ray flare period. This fact indicates some particle acceleration processes occurred even in the non flare period. We have investigated spectral characteristics, such as drift rates and intensities, of type III bursts for the periods of both flare and non flare to reveal difference of particle acceleration processes.
In the presentation, we will show the relation between occurrence characteristics of type III bursts observed in 2014 with AMATERAS and GOES soft X-ray flux level, and will discuss particle acceleration processes particularly in the non flare periods.

Keywords: radio burst, flare, particle acceleration

Decrease of magnetic field strength in the foremoon solar wind for parallel IMF

*Masaki N Nishino[1], Yoshifumi Saito[2], Hideo Tsunakawa[3], Yuki Harada[4], Shoichiro Yokota[2], Futoshi Takahashi[5], Masaki Matsushima[3], Hidetoshi Shibuya[6], Hisayoshi Shimizu[7]

1.Institute for Space-Earth Environmental Research, Nagoya University, 2.ISAS/JAXA, 3.Tokyo Institute of Technology, 4.SSL, University of California, Berkeley, 5.Kyushu University, 6.Kumamoto University, 7.ERI, University of Tokyo

Interaction between the lunar surface and incident solar wind is one of the unsolved problems of the lunar plasma sciences. The Kaguya (SELENE) measurements revealed that about 1 percent of incident solar wind protons are scattered at the lunar dayside surface and re-picked up by the motional electric field to affect the ambient solar wind as well as the lunar wake. However, few studies have been performed for the parallel IMF case, except for wave observations by ARTEMIS spacecraft. Here we show an event where strength of the IMF decreases at 100 km altitude on the lunar dayside when the IMF is almost parallel to the incident solar wind flow, comparing the upstream solar wind data from ACE and WIND with Kaguya magnetometer data. The lunar surface below the Kaguya orbit is not magnetised, and the upward-going protons show signatures of those scattered at the lunar surface. We find that the decrease in the magnetic pressure is compensated by the thermal pressure of the back-scattered protons. We note that the observed phenomena are to some extent similar to those of bow-shock reflected ions in the terrestrial foreshock and may generally take place as a result of interaction between solar wind and non-magnetised body.

Keywords: Solar wind - Moon interaction, Interplanetary magnetic field, Kaguya (SELENE), Proton scattering

Hybrid simulations on the acceleration of pickup ions via the pump mechanism

*Ken Tsubouchi[1]

1.Tokyo Institute of Technology

Generation process of high energy particles, far beyond the background thermal energy, has been one of the key topics in space plasma physics. Acceleration by their interaction with shock waves is the major mechanism, where a power-law spectrum is derived in the energy distribution. The standard shock acceleration theory shows that the power-law index depends on the shock compression ratio. In contrast, in-situ plasma measurements by ACE, Ulysses, and Voyager spacecraft recently identified that particles in the heliosphere have a common spectrum in the suprathermal range (the order of tens to hundreds of keV), where $f(v) \sim v^{-5}$, indicating that the shock waves do not play a dominant role in particle acceleration. The pump acceleration proposed by Fisk and Gloeckler [e.g., 2014] is one of alternative mechanisms to account for the generation of this common spectrum. In this study, we verify the validity of this pump process by performing two-dimensional hybrid simulations including interstellar pickup ions. We demonstrate several parameter sets and identify the strong dependence of acceleration efficiency on the angle between the solar wind flow direction and the magnetic field, as well as the spatial scale of compression/expansion structures in the pump process. We confirm the formation of the power-law tail in the velocity distribution of pickup ions, where the shock is not the only site of acceleration. We will discuss the diffusion property of energetic particles within the pump structures in comparison with the theoretical description.

Keywords: particle acceleration, solar wind, pickup ion

