Since Voyager 1 passed the Heliopause in 2012, it has provided the observations of the charged particles in the local interstellar medium. However, Voyager 1 only provides the information along with its trajectory. In order to understand the global view of the interstellar plasma flow surrounding the Heliopause, we need another tool. When the interstellar plasmas approach the Heliopause, the ions are deflected around the Heliopause due to the draping of the interstellar magnetic field. The draping of the interstellar magnetic field is strongly connected with the shape of the Heliopause. A fraction of the diverted ions exchanges their charges with the undisturbed primary interstellar neutral atoms, and then the ions become neutral atoms called the secondary interstellar neutral atoms. The newly created neutral atoms carry information on the diverted flow of the interstellar ions, and a fraction of them can travel to the Sun. Therefore, the secondary component of the interstellar neutrals is an excellent diagnostic tool to provide important information to constrain the shape of the Heliopause. The secondary interstellar neutrals are observed by Interstellar Boundary Explorer (IBEX) at Earth's orbit. Since 2009, two energetic neutral atom cameras on IBEX have measured neutral atoms and it has provided sky maps of neutral atoms. In this presentation, we will discuss the directional distribution of the secondary interstellar neutrals at Earth's orbit. In the sky maps, the primary interstellar neutral gas is seen between 200°and 260°in ecliptic longitude and the secondary components are seen in the longitude range of 160°-200°. We also present a simplified model of the outer heliosheath to help interpret the observations of interstellar neutrals by the IBEX-Lo instruments. We extract information on the large-scale shape of the Heliopause by comparing the neutral flux measured at IBEX along four different look directions with simple models of deflected plasma flow around hypothetical obstacles of different aspect ratios to the flow. Our comparisons between the model results and the observations indicate that the Heliopause is very blunt in the vicinity of the Heliospheric nose, especially compared to a Rankine half-body or cometary shape.

[구 SS-03] The role of heliospheric current sheet on solar energetic particles with enhanced Fe/O

Jinhye Park[1], R. Bucik[2,3], Yong-Jae Moon[1,4],and S. W. Kahler[5]
[1]*Department of Astronomy and Space Science, Kyung Hee University, Yongin 446-701, Korea*
[2]*Max Planck Institute for Solar System Research, Justus-von-Liebig-Weg 3, D-37077, Göttingen, Germany*
[3]*Institute for Astrophysics, University of Göttingen, Friedrich-Hund-Platz 1, D-37077, Göttingen, Germany*
[4]*School of Space Research, Kyung Hee University, Yongin 446-701, Korea*
[5]*Air Force Research Laboratory, Space Vehicles Directorate, 3550 Aberdeen Avenue, Kirtland AFB, NM 87117, USA*

We investigate initial Fe/O enhancements for 44 large gradual solar energetic particles events from 2010 to 2014 and examine the associations of the Fe/O enhancements with the structures of the heliospheric current sheet (HCS). For this study, we use STEREO SIT Fe and O data in 0.32-0.45 MeV channel as well as ACE ULEIS Fe and O data in 0.32-0.64 MeV channel. We determine 1) the magnetic polarities of the SEP source regions using the potential field source surface (PFSS) model of the coronal field and 2) the spacecraft magnetic footpoints with Parker spiral approximation of interplanetary magnetic field using the in-situ measurements of STEREO and ACE. We find that 29 out of 44 events have initial Fe/O enhanced more than 5 times of the typical gradual event values. In the 6 events, the enhancements are simultaneously observed by two spacecraft. There is a tendency that the high Fe/O enhancements are observed near SEP source regions. It is also noted that the Fe/O enhancements are associated with the polarity of the magnetic footpoints. The high Fe/O enhancements are usually observed where their footpoints lie in the same polarity regions of SEP sources rather than the opposite polarity regions. Although Fe/O enhancements could be due to a transport effect and/or a flare contribution, our result implies that the structure of HCS is likely to affect particle propagations in the interplanetary space.

[구 SS-04] A Solar Stationary Type IV Radio Burst and Its Radiation Mechanism

Hongyu Liu[1,2,3], Yao Chen[3], Kyungsuk Cho[1,2], Shiwei Feng[3], Veluchamy Vasanth[3], Artem Koval[3], Guohui Du[3], Zhao Wu[3], Chuanyang Li[3]
[1]*Korea Astronomy and Space Science Institute, Daejeon, Republic of Korea*
[2]*University of Science and Technology, Daejeon, Republic of Korea*
[3]*Shandong Provincial Key Laboratory of Optical Astronomy and Solar-Terrestrial Environment, and Institute of Space Sciences Shandong University, Weihai, China*

A stationary Type IV (IVs) radio burst was observed on September 24, 2011. Observations from the Nançay RadioHeliograph (NRH) show that the brightness temperature (TB) of this burst is extremely high, over 10^11K at 150 MHz and over 10^8K in general. The degree of circular polarization (q) is between −60%∼−100% , which means that it is highly left-handed circularly polarized. The flux-frequency spectrum follows a power-law distribution, and the spectral index is considered to be roughly −3∼−4 throughout the IVs. Radio sources of this event are located in the wake of the coronal mass ejection and are spatially dispersed. They line up to present a formation in which lower-frequency sources are higher. Based on these observations, it is suggested that the IVs was generated through electron cyclotron maser emission.

[구 SS-05] Investigation of the observed solar coronal plasma in EUV and X-rays in non-equilibrium ionization state

Jin-Yi Lee[1], John C. Raymond[2], Katharine K. Reeves[2], Chengcai Shen[2], and Yong-Jae Moon[1]
[1]*Kyung Hee University*
[2]*Harvard-Smithsonian Center for Astrophysics*

During a major solar eruption, the erupting plasma is possibly out of the equilibrium ionization state because of its rapid heating or cooling. The non-equilibrium ionization process is important in a rapidly evolving system where the thermodynamical time scale is shorter than the ionization or recombination time scales. We investigate the effects of non-equilibrium ionization on EUV and X-ray observations by the Atmospheric Imaging Assembly (AIA) on board Solar Dynamic Observatory and X-ray Telescope (XRT) on board Hinode. For the investigation, first, we find the emissivities for all the lines of ions of elements using CHIANTI 8.07, and then we find the temperature responses multiplying the emissivities by the effective area for each AIA and XRT passband. Second, we obtain the ion fractions using a time-dependent ionization model (Shen et al. 2015), which uses an eigenvalue method, for all the lines of ion, as a function of temperature, and a characteristic time scale, $n_e t$, where n_e and t are density and time, respectively. Lastly, the ion fractions are multiplied to the temperature response for each passband, which results in a 2D grid for each combination of temperature and the characteristic time scale. This is the set of passband responses for plasma that is rapidly ionized in a current sheet or a shock. We investigate an observed event which has a relatively large uncertainty in an analysis using a differential emission measure method assuming equilibrium ionization state. We verify whether the observed coronal plasmas are in non-equilibrium or equilibrium ionization state using the passband responses.

[구 SS-06] Determination of magneto-hydrodynamic quantities in umbrae and bright points using MHD seismology

Il-Hyun Cho, Yong-Jae Moon
Kyung Hee University

We perform seismological diagnostics of the physical parameters in umbral photospheres and G-band bright points. The technique is based on the theory of slow magneto-acoustic waves in a non-isothermally stratified photosphere with uniform vertical magnetic fields. For the seismology of sunspot umbrae, we calculate the weighted frequency of three-minute oscillations observed by SDO/HMI continuum and use it to estimate the Alfvn speed and plasma-beta, which range 7.5–10.5 km/s and 0.65–1.15, respectively. We identify and track bright points in the G-band movie by using a 3D region growing method. Then we apply the seismological diagnostics to the bright points in the Hinode/BFI Blue continuum. We will present the Alfvn speed and plasma-beta in the bright points.

태양 CME

[구 SS-07] CME propagation and proton acceleration in solar corona

Roksoon Kim[1,2], Ryunyoung Kwon[3,4], Jaeok Lee[1], David Lario[3]
[1]*Korea Astronomy and Space Science Institute,* [2]*University of Science and Technology,* [3]*Johns Hopkins University, Applied Physics Laboratory,* [4]*George Mason University*

Solar Proton Events (SPEs) are the energetic phenomena related particle acceleration occurred in solar corona. Conventionally, they have been classified into two groups as the impulsive and gradual cases caused by reconnection in the flaring site and by shock generated by CME, respectively. In the previous studies, we classified these into four groups by analyzing the proton acceleration patterns in multi-energy channel observation. This showed that acceleration due to the magnetic reconnection may occur in the