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

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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

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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

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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

corona region relatively higher than the flaring site. In this study, we analyzes 54 SPEs observed in the energy band over 25 MeV from 2009 to 2013, where STEREO observations as well as SOHO can be utilized. From the multi-positional observation, we determine the exact time at which the Sun-Earth magnetic field line meets the CME shock structure by considering 3-dimensional structure of CME. Also, we determine the path length by considering the solar wind velocity for each event, so that the SPE onset time near the sun is obtained more accurately. Based on this study, we can get a more understanding of the correlation between CME progression and proton acceleration in the solar coronal region.

[구 SS-08] Comparison of CME mean density based on a full ice-cream cone structure and its corresponding ICME one

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For space weather forecast, it is important to determine three-dimensional parameters of coronal mass ejections (CMEs). To estimate three-dimensional parameters of CMEs, we have developed a full ice-cream cone model which is a combination of a symmetrical flat cone and a hemisphere. By applying this model to 12 SOHO/LASCO halo CMEs, we find that three-dimensional parameters from our method are similar to those from other stereoscopic methods. For several geoeffective CME events, we determine CME mass by applying the Solarsoft procedure (e.g., cme_mass.pro) to SOHO/LASCO C3 images. CME volumes are estimated from the full ice-cream cone structure. We derive CME mean density as a function of CME height for these CMEs, which are approximately fitted to power-law functions. We find that the ICME mean densities extrapolated from the power law functions, are correlated with their corresponding ICME ones in logarithmic scales.

[구 SS-09] Magnetic and kinematic characteristics of very fast CMEs

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It is important to understand very fast CMEs which are the main cause of geomagnetic storms and solar particle events (SPEs). During this solar cycle 24, there are 10 very fast CMEs whose speeds are over 2000 km/s. Among these, there were only two fronside events (2012 January 23 and 2012 March 7) and they are associated with two major flares (M8.7 and X5.4) and the most strong SPEs (6310 pfu and 6530 pfu). They have a similar characteristics: there were successive CMEs within 2 hours in the same active region. We analyze their magnetic properties using SDO HMI magnetograms and kinematic ones from STEREO EUVI/COR1/COR2 observations. We can measure their speeds and initial accelerations without projection effects because their source locations are almost the limb. Additionally, we are investigating magnetic and kinematic characteristics of 8 backside events using AI-generated magnetograms constructed by deep learning methods.

[구 SS-10] Statistical study on the kinematic classification of CMEs from 4 to 30 solar radii

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In this study, we perform a statistical investigation on the kinematic classication of 4264 coronal mass ejections (CMEs) from 1996 to 2015 observed by SOHO/LASCO C3. Using the constant acceleration model, we classify these CMEs into three groups; deceleration, constant velocity, and acceleration motion. For this, we devise four dierent classication methods by acceleration, fractional speed variation, height contribution, and visual inspection. Our major results are as follows. First, the fractions of three groups depend on the method used. Second, about half of the events belong to the groups of acceleration and deceleration. Third, the fractions of three motion groups as a function of CME speed classied by the last three methods are consistent with one another. Fourth, according to the last three methods, the fraction of acceleration motion decreases as CME speed increases, while the fractions of other motions increase with speed. In addition, the acceleration motions are dominant in low speed CMEs whereas the constant velocity motions are dominant in high speed CMEs.

[구 SS-11] Estimation of Halo CME's radial speeds using coronal shock waves based on EUV observations

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