of the models have accuracies more than 0.7. Second, ResNet developed by Microsoft has the best accuracies : 0.77 for flare classification and 0.83 for flare occurrence. Third, the accuracies of these models vary greatly with changing parameters. We discuss several possibilities to improve the models.

[구 SS-05] A comparison of deep-learning models to the forecast of the daily solar flare occurrence using various solar images

Seulki Shin[1], Yong-Jae Moon[1,2], Hyoungseok Chu[3]
[1]School of Space Research, Kyung Hee University, [2]Department of Astronomy & Space Science, Kyung Hee University, [3]Software Policy & Research Institute

As the application of deep-learning methods has been succeeded in various fields, they have a high potential to be applied to space weather forecasting. Convolutional neural network, one of deep learning methods, is specialized in image recognition. In this study, we apply the AlexNet architecture, which is a winner of Imagenet Large Scale Virtual Recognition Challenge (ILSVRC) 2012, to the forecast of daily solar flare occurrence using the MatConvNet software of MATLAB. Our input images are SOHO/MDI, EIT 195Å, and 304Å from January 1996 to December 2010, and output ones are yes or no of flare occurrence. We consider other input images which consist of last two images and their difference image. We select training dataset from Jan 1996 to Dec 2000 and from Jan 2003 to Dec 2008. Testing dataset is chosen from Jan 2001 to Dec 2002 and from Jan 2009 to Dec 2010 in order to consider the solar cycle effect. In training dataset, we randomly select one fifth of training data for validation dataset to avoid the over-fitting problem. Our model successfully forecasts the flare occurrence with about 0.90 probability of detection (POD) for common flares (C-, M-, and X-class). While POD of major flares (M- and X-class) forecasting is 0.96, false alarm rate (FAR) also scores relatively high(0.60). We also present several statistical parameters such as critical success index (CSI) and true skill statistics (TSS). All statistical parameters do not strongly depend on the number of input data sets. Our model can immediately be applied to automatic forecasting service when image data are available.

[구 SS-06] FISS and SDO Observation of a Brightening Event Near a Pore

Juhyeong Kang, Jongchul Chae
Astronomy Program, Department of Physics and Astronomy, Seoul National University, Seoul 151-747, Korea

We report a fine scale transient brightening event near a pore boundary with the Fast Imaging Solar Spectrograph (FISS) of the 1.6m Goode Solar Telescope (GST), the Atmospheric Imaging Assembly (AIA) aboard the Solar Dynamics Observatory (SDO), and Helioseismic and Magnetic Imager (HMI) aboard SDO. The event appears in all AIA extreme ultraviolet bands, also in the two FISS lines, Hα and Ca II 8542 Å, and lasted for a minute. The brightening occurred at a footpoint of a loop. The conjugate brightening occurred at the other foot point outside the FISS field of view. The brightening near the pore exhibit a redshift of 4.3 km s-1 in the Hα and about 2.3 km s-1 in Ca II line. Differential emission measure derived from 6 AIA EUV passbands and cloud model fitting of the two FISS lines indicate the temperature increase of between 10,000 and 20 MK at the main event. After the brightening, the upward mass motion appears in the AIA images. We discuss the physical implication of this brightening in the context of magnetic reconnection and coronal heating.

[구 SS-07] Analysis of Ellerman Bomb Spectra Observed by FISS

Minju Seo, Jongchul Chae, and Jeongwoo Lee
Seoul National University

We have studied the high-resolution Hα and Ca II 8542Å line profiles of Ellerman Bombs (EBs) obtained with the Fast Imaging Solar Spectrograph (FISS) installed on the 1.6m Goode Solar Telescope (GST) in Big Bear Solar Observatory (BBSO). The FISS spectra of EBs are compared with synthetic profiles computed using RH non-LTE radiative transfer code and a set of 1D atmospheric models with local transient heating, the latter of which is modeled by varying local temperature enhancement in magnitude and height. We could reproduce each of the observed Hα and Ca II line profiles separately with different atmospheric models, but not with a single atmospheric model. To fit the observed Hα lines we often need much higher temperature enhancements than those needed for fitting Ca II lines. Possible causes for this temperature mismatch are briefly discussed.

[구 SS-08] Statistical study on the kinematic distribustion of coronal mass ejections from

1996 to 2015

Seong-Gyeong Jeon, Yong-Jae Moon, Kangwoo Yi, and, Harim Lee
School of Space Research, Kyung Hee University, Korea,

In this study we have made a statistical investigation on the kinematic classification of coronal mass ejections (CMEs) using about 4,000 SOHO/LASCO CMEs from 1996 to 2015. For this we use their SOHO/LASCO C3 data and exclude all poor events. Using the constant acceleration model, we classify these CMEs into three groups: Acceleration group, Constant Velocity group, and Deceleration group. For classification we adopt four different methods: Acceleration method, Velocity Variation method, Height Contribution method, and Visual Inspection method. Our major results are as follows. First, the fractions of three groups depend on the method used. Second, the results of the Height Contribution method are most consistent with those of the Visual Inspection method, which is thought to be most promising. Third, the fractions of different kinematic groups for the Height contribution method are: Acceleration (35%), Constant speed (47%), and Deceleration (18%). Fourth, the fraction strongly depend on CME speed; the fraction of Acceleration decreases from 0.6 to 0.05 with CME speed; the fraction of Constant increases from 0.3 to 0.7; the fraction of Deceleration increases from 0.1 to 0.3. Finally we present dozens of CMEs with non-constant accelerations. It is found that about 40 % of these CMEs show quasi-periodic oscillations.

[구 SS-09] Estimation of CME 3-D parameters using a full ice-cream cone model

Hyeonock Na and Yong-Jae Moon
School of Space Research, Kyung Hee University

In space weather forecast, it is important to determine three-dimensional properties of CMEs. Using 29 limb CMEs, we examine which cone type is close to a CME three-dimensional structure. We find that most CMEs have near full ice-cream cone structure which is a symmetrical circular cone combined with a hemisphere. We develop a full ice-cream cone model based on a new methodology that the full ice-cream cone consists of many flat cones with different heights and angular widths. By applying this model to 12 SOHO/LASCO halo CMEs, we find that 3D parameters from our method are similar to those from other stereoscopic methods (i.e., a triangulation method and a Graduated Cylindrical Shell model). In addition, we derive CME mean density ($\bar{\rho}_{CME} = \frac{M_{total}}{V_{cone}}$) based on the full ice-cream cone structure. For several limb 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. For the first time, we derive average CME densities as a function of CME height for several CMEs, which are well fitted to power-law functions. We will compare densities (front and average) of geoeffective CMEs and their corresponding ICME ones.

[구 SS-10] Radial and azimuthal oscillations of 24 Halo Coronal Mass Ejections using multi spacecraft

Harim Lee[1], Yong-Jae Moon[1], V. M. Nakariakov[1,2]
[1]*School of Space Research, Kyung Hee University, Yongin, Korea,*
[2]*Centre for Fusion, Space & Astrophysics, Physics Department, Univ. of Warwick, UK*

We have made an investigation on the radial and azimuthal wave modes of full halo coronal mass ejections (HCMEs). For this, we consider 24 HCMEs which are simultaneously observed by SOHO and STEREO A & B from August 2010 to August 2012 when they were roughly in quadrature. Using the SOHO/LASCO C3 and STEREO COR2 A & B running difference images, we estimate the instantaneous apparent speeds of the HCMEs at 24 different position angles. Major results from this study are as follows. First, there are quasi-periodic variations of the instantaneous radial velocity with the periods ranging from 24 to 48 mins. Second, the amplitudes of instant speed variations are about a third of the projected speeds. Third, the amplitudes are found to have a weak anti-correlation with period. Our preliminary identification from SOHO observations shows that there are several distinct radial and azimuthal wave modes: m=0 (radial) for five events, m=1 for eleven events, m=2 for three events, and unclear for the other events. In addition, we are making a statistical investigation on the oscillation of 733 CMEs to understand their physical origins.

[구 SS-11] Competition between ICME and crustal magnetic field on the loss of Mars