문 관측 시설을 갖춘 기관의 수가 점점 늘어나고 있다. 하지만 대부분의 천문 교육은 밤하늘의 천체를 육안으로 관측하는 데에 초점을 맞추고 있어 최신 천문우주 분야의 내용을 공유하는 데에 한계가 있다. 과학동아천문대는 서울의 용산전자상가에 위치한 사설 천문대로서 2013 년에 개관한 이래로 도심 속에서 밤하늘을 만날 수 있는 공간으로서 역할을 하고 있다. 우리는 그동안 쌓은 커뮤니티와 자사의 네트워크를 기반으로 천문대가 현재와 같이 단순히 별을 보는 장소에 그치지 않고 천문우주문화를 확산하는 플랫폼이 되도록 변화 시키려고 한다. 이를 통하여 천문우주에 관심 있는 사람들은 더 쉽게 최신 소식을 접하고, 연구자들은 자신의 연구를 수시로 알릴 수 있는 소통의 장을 마련하려고 한다. 이번 발표를 통해 동아사이언스 미래세대 C 플랫폼 본부와 함께하는 과학동아천문대의 새로운 비전을 외부에 처음으로 소개하며 관계자들의 관심과 참여를 요청드린다.

태양/태양계

[구 SS-01] Generation of modern satellite data from Galileo sunspot drawings by deep learning

Harim Lee[1], Eunsu Park[1], Young-Jae Moon[1,2]
[1]*Department of Astronomy and Space Science, College of Applied Science, Kyung Hee University*
[2]*School of Space Research, Kyung Hee University*

We generate solar magnetograms and EUV images from Galileo sunspot drawings using a deep learning model based on conditional generative adversarial networks. We train the model using pairs of sunspot drawing from Mount Wilson Observatory (MWO) and their corresponding magnetogram (or UV/EUV images) from 2011 to 2015 except for every June and December by the SDO (Solar Dynamic Observatory) satellite. We evaluate the model by comparing pairs of actual magnetogram (or UV/EUV images) and the corresponding AI-generated one in June and December. Our results show that bipolar structures of the AI-generated magnetograms are consistent with those of the original ones and their unsigned magnetic fluxes (or intensities) are well consistent with those of the original ones. Applying this model to the Galileo sunspot drawings in 1612, we generate HMI-like magnetograms and AIA-like EUV images of the sunspots. We hope that the EUV intensities can be used for estimating solar EUV irradiance at long-term historical times.

Note: This work was supported by Institute for Information & communications Technology Promotion (IITP) grant funded by the Korea government (2018-0-01422, Study on analysis and prediction technique of solar flares).

[구 SS-02] Generation of He I 1083 nm Images from SDO/AIA 19.3 and 30.4 nm Images by Deep Learning

Jihyeon Son[1], Junghun Cha[2], Yong-Jae Moon[1,2], Harim Lee[2], Eunsu Park[2], Gyungin Shin[3], Hyun-Jin Jeong[1]
[1]*School of Space Research, Kyung Hee University, Yongin, 17104, Republic of Korea,*
[2]*Department of Astronomy and Space Science, Kyung Hee University, Yongin, 17104, Republic of Korea,*
[3]*Department of Engineering Science, University of Oxford*

In this study, we generate He I 1083 nm images from Solar Dynamic Observatory (SDO)/Atmospheric Imaging Assembly (AIA) images using a novel deep learning method (pix2pixHD) based on conditional Generative Adversarial Networks (cGAN). He I 1083 nm images from National Solar Observatory (NSO)/Synoptic Optical Long-term Investigations of the Sun (SOLIS) are used as target data. We make three models: single input SDO/AIA 19.3 nm image for Model I, single input 30.4 nm image for Model II, and double input (19.3 and 30.4 nm) images for Model III. We use data from 2010 October to 2015 July except for June and December for training and the remaining one for test. Major results of our study are as follows. First, the models successfully generate He I 1083 nm images with high correlations. Second, the model with two input images shows better results than those with one input image in terms of metrics such as correlation coefficient (CC) and root mean squared error (RMSE). CC and RMSE between real and AI-generated ones for the model III with 4 by 4 binnings are 0.84 and 11.80, respectively. Third, AI-generated images show well observational features such as active regions, filaments, and coronal holes. This work is meaningful in that our model can produce He I 1083 nm images with higher cadence without data gaps, which would be useful for studying the time evolution of chromosphere and coronal holes.

[구 SS-03] Toward accurate synchronic magnetic field maps using solar frontside and AI-generated farside data

Hyun-Jin Jeong[1], Yong-Jae Moon[1,2] and Eunsu Park[2]
[1]*School of Space Research, Kyung Hee University,*
[2]*Department of Astronomy and Space Science, College of Applied Science, Kyung Hee University*

Conventional global magnetic field maps, such as daily updated synoptic maps, have been constructed by merging together a series of observations from the Earth's viewing direction taken over a 27-day solar rotation period to represent the full surface of the Sun. It has limitations to predict real-time farside magnetic fields, especially for rapid changes in magnetic fields by flux emergence or disappearance. Here, we construct accurate synchronic magnetic field maps using frontside and AI-generated farside data. To generate the farside data, we train and evaluate our deep learning model with frontside SDO observations. We use an improved version of Pix2PixHD with a new objective function and a new configuration of the model input data. We compute correlation coefficients between real magnetograms and AI-generated ones for test data sets. Then we demonstrate that our model better generate magnetic field distributions than before. We compare AI-generated farside data with those predicted by the magnetic flux transport model. Finally, we assimilate our AI-generated farside magnetograms into the flux transport model and show several successive global magnetic field data from our new methodology.

This work was supported by Institute for Information & communications Technology Promotion (IITP) grant funded by the Korea government (MSIP) (2018-0-01422, Study on analysis and prediction technique of solar flares).

[구 SS-04] Visual Explanation of a Deep Learning Solar Flare Forecast Model and Its Relationship to Physical Parameters

Kangwoo Yi, Yong-Jae Moon, Daye Lim, Eunsu Park and Harim Lee

School of Space Research, Kyung Hee University

In this study, we present a visual explanation of a deep learning solar flare forecast model and its relationship to physical parameters of solar active regions (ARs). For this, we use full-disk magnetograms at 00:00 UT from the Solar and Heliospheric Observatory/Michelson Doppler Imager and the Solar Dynamics Observatory/ Helioseismic and Magnetic Imager, physical parameters from the Space-weather HMI Active Region Patch (SHARP), and Geostationary Operational Environmental Satellite X-ray flare data. Our deep learning flare forecast model based on the Convolutional Neural Network (CNN) predicts "Yes" or "No" for the daily occurrence of C-, M-, and X-class flares. We interpret the model using two CNN attribution methods (guided backpropagation and Gradient-weighted Class Activation Mapping [Grad-CAM]) that provide quantitative information on explaining the model. We find that our deep learning flare forecasting model is intimately related to AR physical properties that have also been distinguished in previous studies as holding significant predictive ability. Major results of this study are as follows. First, we successfully apply our deep learning models to the forecast of daily solar flare occurrence with TSS = 0.65, without any preprocessing to extract features from data. Second, using the attribution methods, we find that the polarity inversion line is an important feature for the deep learning flare forecasting model. Third, the ARs with high Grad-CAM values produce more flares than those with low Grad-CAM values. Fourth, nine SHARP parameters such as total unsigned vertical current, total unsigned current helicity, total unsigned flux, and total photospheric magnetic free energy density are well correlated with Grad-CAM values. This work was supported by Institute for Information & communications Technology Promotion (IITP) grant funded by the Korea government (MSIP) (2018-0-01422, study on analysis and prediction technique of solar flares).

[구 SS-05] Selection of Three (E)UV Channels for Solar Satellite Missions by Deep Learning

Daye Lim[1]. Yong-Jae Moon[1,2], Eunsu Park[1] and Jin-Yi Lee[1]

[1]Department of Astronomy and Space Science, Kyung Hee University, [2]School of Space Research, Kyung Hee University

We address a question of what are three main channels that can best translate other channels in ultraviolet (UV) and extreme UV (EUV) observations. For this, we compare the image translations among the nine channels of the Atmospheric Imaging Assembly on the Solar Dynamics Observatory using a deep learning model based on conditional generative adversarial networks. In this study, we develop 170 deep learning models: 72 models for single-channel input, 56 models for double-channel input, and 42 models for triple-channel input. All models have a single-channel output. Then we evaluate the model results by pixel-to-pixel correlation coefficients (CCs) within the solar disk. Major results from this study are as follows. First, the model with 131 Å shows the best performance (average CC = 0.84) among single-channel models. Second, the model with 131 and 1600 Å shows the best translation (average CC = 0.95) among double-channel models. Third, among the triple-channel models with the highest average CC (0.97), the model with 131, 1600, and 304 Å is suggested in that the minimum CC (0.96) is the highest. Interestingly they are