

Supernovae classes have been defined phenomenologically, based on spectral features and time series data, since the specific details of the physics of the different explosions remain unrevealed. However, the number of these classes is increasing as objects with new features are observed, and the next generation of large-surveys will only bring more variety to our attention. We apply the machine learning technique of multi-label classification to the spectra of supernovae. By measuring the probabilities of specific features or 'tags' in the supernova spectra, we can compress the information from a specific object down to that suitable for a human or database scan, without the need to directly assign to a reductive 'class'. We use logistic regression to assign tag probabilities, and then a feed-forward neural network to filter the objects into the standard set of classes, based solely on the tag probabilities. We present STag, a software package that can compute these tag probabilities and make spectral classifications.

## 태양/태양계

### [구 SS-01] F-Coronal Polarized Brightness Diagnostics using a Filter Ratio (필터비를 이용한 F코로나 편광량 측정방법)

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태양으로부터 3Rs보다 높은 코로나 밝기의 대부분은 먼지에 의해 산란된 F코로나로부터 나온다. F코로나와 자유전자의 톰슨산란에 의한 K코로나를 분리하는 효과적인 방법은 편광을 이용하는 것으로 알려져 있고 현재 NASA와 천문연간 협력개발 중인 K코로나 관측 기기 COOronal Diagnostic EXperiment(CODEX)도 편광을 이용한 분류를 기본으로 자유전자의 온도와 속도를 측정한다. 문제는 F코로나도 약간의 편광도를 가져서 K코로나와 구별이 불가능해지는데다 F코로나의 편광량은 먼지입자의 구성물질, 모양, 산란 위치 등에 따라 달라서 거의 예측이 불가능하고 지금까지 제대로 알려진 바도, 연구된 바도 없다. 우리는 CODEX에서 F코로나 편광량을 산출하기 위해 한 개의 협대역 필터(Narrow Bandpass Filter)를 추가장착하는 것을 제안하였고 그 중심파장과 밴드폭을 결정하였다. 몬테카를로 계산 결과 10장의 393.55nm 중심의 1.4nm폭 협대역필터와 393.5nm 중심의 10nm 협대역 필터비를 이용해 1Rs 화소의 해상도로 F코로나 편광량을 결정할 수 있을 것으로 예상된다. 2023년 CODEX 발사 후 본 관측이 성공적으로 수행된다면 F코로나의 편광량의 시간, 공간적 변화를 확인할 수 있으며 추가적으로 K코로나를 보다 정밀하게 분리해낼 수 있을 것으로 기대된다.

### [구 SS-02] DeepSDO: Solar event detection using deep-learning-based object detection methods

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We present solar event auto detection using deep-learning-based object detection algorithms and DeepSDO event dataset. DeepSDO event dataset is a new detection dataset with bounding boxed as ground-truth for three solar event (coronal holes, sunspots and prominences) features using Solar Dynamics Observatory data. To access the reliability of DeepSDO event dataset, we compared to HEK data. We train two representative object detection models, the Single Shot MultiBox Detector (SSD) and the Faster Region-based Convolutional Neural Network (R-CNN) with DeepSDO event dataset. We compared the performance of the two models for three solar events and this study demonstrates that deep learning-based object detection can successfully detect multiple types of solar events. In addition, we provide DeepSDO event dataset for further achievements event detection in solar physics.

### [구 SS-03] Fast Spectral Inversion of the Strong Absorption Lines in the Solar Chromosphere Based on a Deep Learning Model

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Recently a multilayer spectral inversion (MLSI) model has been proposed to infer the physical parameters of plasmas in the solar chromosphere. The inversion solves a three-layer radiative transfer model using the strong absorption line profiles, H alpha and Ca II 8542 Å, taken by the Fast Imaging Solar Spectrograph (FISS). The model successfully provides the physical plasma parameters, such as source functions, Doppler velocities, and Doppler widths in the layers of the photosphere to the chromosphere. However, it is quite expensive to apply the MLSI to a huge number of line profiles. For example, the calculating time is an hour to several hours depending on the size of the scan raster. We apply

deep neural network (DNN) to the inversion code to reduce the cost of calculating the physical parameters. We train the models using pairs of absorption line profiles from FISS and their 13 physical parameters (source functions, Doppler velocities, Doppler widths in the chromosphere, and the pre-determined parameters for the photosphere) calculated from the spectral inversion code for 49 scan rasters (~2,000,000 dataset) including quiet and active regions. We use fully connected dense layers for training the model. In addition, we utilize a skip connection to avoid a problem of vanishing gradients. We evaluate the model by comparing the pairs of absorption line profiles and their inverted physical parameters from other quiet and active regions. Our result shows that the deep learning model successfully reproduces physical parameter maps of a scan raster observation per second within 15% of mean absolute percentage error and the mean squared error of 0.3 to 0.003 depending on the parameters. Taking this advantage of high performance of the deep learning model, we plan to provide the physical parameter maps from the FISS observations to understand the chromospheric plasma conditions in various solar features.

#### [구 SS-04] Spectroscopic Detection of Alfvénic Waves in the Chromosphere of Sunspot Regions

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Transverse magnetohydrodynamic waves often called Alfvénic (or kink) waves have been often theoretically put forward to solve the outstanding problems of the solar corona like coronal heating, solar wind acceleration, and chemical abundance enhancement. Here we report the first spectroscopic detection of Alfvénic waves around a sunspot at chromospheric heights. By analyzing the spectra of the H $\alpha$  line and Ca II 854.2 nm line, we determined line-of-sight velocity and temperature as functions of position and time. As a result, we identified transverse magnetohydrodynamic waves pervading the superpenumbral fibrils. These waves are characterized by the periods of 2.5 to 4.5 minutes, and the propagation direction parallel to the fibrils, the supersonic propagation speeds of 45 to 145 km s<sup>-1</sup>, and the close association with umbral

oscillations and running penumbral waves in sunspots. Our results support the notion that the chromosphere around sunspots abounds with Alfvénic waves excited by the mode conversion of the upward-propagating slow magnetoacoustic waves.

#### [구 SS-05] A self-consistent model for the formation and eruption of a solar prominence

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The present study is focused on origins of the flow and magnetic structure involved in the formation and eruption of a solar prominence. To clarify them, we performed an MHD simulation based on the 3-dimensional emerging flux tube (3DEFT) model, in which self-consistent evolution of a flow and magnetic field passing freely through the solar surface was obtained by seamlessly connecting subsurface dynamics with surface dynamics. By analyzing Lagrangian displacements of magnetized plasma elements, we demonstrate the flow structure which is naturally incorporated to the magnetic structure of the prominence formed via dynamic interaction between the flow and magnetic field.

#### [구 SS-06] Negative Turbulent Magnetic $\beta$ Diffusivity effect in a Magnetically Forced System

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We studied the large scale dynamo process in a system forced by helical magnetic field. The dynamo process is basically nonlinear, but can be linearized with  $\alpha$  &  $\beta$  coefficients and large scale magnetic field  $\overline{B}$ . This is very useful to the investigation of solar (stellar) dynamo. A coupled semi-analytic equations based on statistical mechanics are used to investigate the exact evolution of  $\alpha$  &  $\beta$ . This equation set needs only magnetic helicity  $\overline{H}_M (= \langle \overline{A} \cdot \overline{B} \rangle, \overline{B} = \nabla \times \overline{A})$  and magnetic energy  $\overline{E}_M (= \langle \overline{B}^2 \rangle / 2)$ . They are fundamental physics quantities that can be obtained from the dynamo simulation or observation without any artificial modification or assumption.  $\alpha$  effect is thought to be related to magnetic field amplification. However, in reality the averaged  $\alpha$  effect decreases very quickly without a