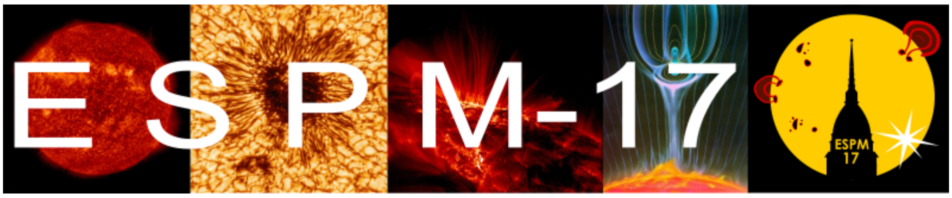
17th European Solar Physics Meeting ESPM-17



Contribution ID: **308** Type: **Talk**

Parametrization of SHARP Vector Magnetic Field Using Disentangled Representation Learning

Thursday 12 September 2024 12:20 (15 minutes)

Contemporary solar physics deals with the increasing amount of high-dimensional data, making it an excellent case for the application of machine learning (ML) algorithms. Synoptic full-disk observations with the Solar Dynamics Observatory (SDO) are one example, allowing us to follow the solar magnetic activity over more than one solar activity cycle and to study its local and global facets. The Space-weather HMI Active Region Patches (SHARP) vector magnetic field (VMF) maps and parameters, based on Helioseismic and Magnetic Imager (HMI) full-disk observations, are developed for studying the magnetic evolution of individual active regions and flare triggering mechanisms. We present a method for active region parametrization by combining empirical parameters and ML-extracted features based on SHARP maps. Time series of SHARP VMF maps are used as input for Disentangled Variational Autoencoder (VAE), a Disentangled Representation Learning (DRL) algorithm, which facilitates the extraction of low-dimensional feature representation. The power of the VAE model lies in its ability to encode generalized information about nonlinear dynamical systems, in this case a solar active region, where each feature represents a particular aspect of the input data. We demonstrate how the VAE-based features can be used to identify and study the stages of the magnetic patches evolution in combination with the SHARP empirical parameters, relating empirical and learned features. Furthermore, empirical dataset enhanced with ML features can be used to analyze the development of individual active regions and searching for eruption precursors.

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Session Classification: Diagnostic tools and numerical methods in solar physics

Track Classification: Diagnostic tools and numerical methods in solar physics