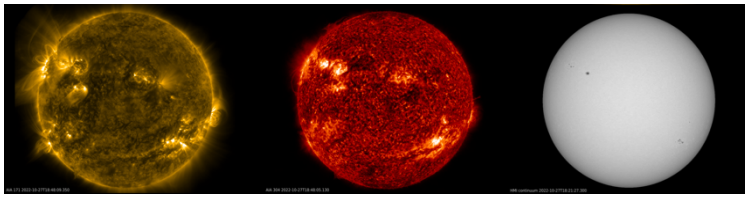

UNIVERSITÄT BERN

Philosophisch-Naturwissenschaftliche Fakultät

Astronomisches Institut

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Masterarbeit Astronomie, Gruppe Spaceweather:

Solar Flare Prediction with Full Disk Images

MOTIVATION

Solar flares are extremely powerful eruptions that affect space weather, which on Earth can cause aurorae, power outages, and problems with satellites. Solar magnetism drives the evolution of solar activity, particularly the appearance and decay of sunspots, but also of flares. Yet so far, we are unable to predict when the next active region may form, or the next flare occur, which indicates that our understanding of their physics is incomplete. The goal of this project is use observations of the full Sun, in contrast to often used single regions, and derive machine learning models to predict solar flares in the different active regions.

NASA's Solar Dynamics Observatory (SDO) with its two major instruments on board, the Helioseismic Magnetic Imager (HMI) and the Atmospheric Imaging Assembly (AIA) takes images of the Sun in different wavelengths and maps the plasma of the solar atmosphere at different temperatures. While many studies have focused on deriving machine learning algorithms attempting to predict solar flares, only have focused on full Sun predictions and investigated the connections between active regions across the Sun. In some cases, flares occur temporally close and likely related in different regions of the Sun, yet the statistics and exact mechanisms are not fully understood. In this thesis you will investigate the connections between active regions in terms of flares.

TASKS

- Build a pipeline to download full disk images from HMI and from different AIA channels in sequence based on a flare catalog. Determine in which active region flares occur.
- Investigate correlations between different active regions and flaring activity.
- Create machine learning models to forecast flares on different timescales
- Interpret the models with tools from explainable artificial intelligence and derive explanations for the forecasting capabilities of the models.

You will learn dealing with large data sets and sophisticated computational and statistical methods in python or IDL; analyzing, and interpreting results in relation to complex physical processes. Depending on the preferences, this thesis can include more or less machine learning and/or be more focused on statistics.

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