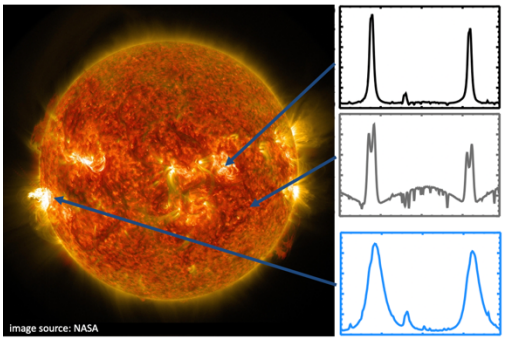


UNIVERSITÄT BERN

Philosophisch-Naturwissenschaftliche Fakultät

**Astronomisches Institut**

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# Masterarbeit Astronomie, Gruppe Spaceweather:

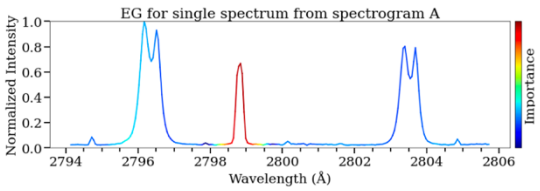
## Investigating Flare Precursors with Explainable Artificial Intelligence (AI)

### 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.

Most of the physics that we can derive from stars is encoded in their spectra. Spectral lines capture the stratification of the solar atmosphere in a specific height range. In recent studies, our group has used machine learning models on spectral data from NASA's IRIS satellite to predict flares based on the shape of individual spectra. With explainable AI we are additionally able to determine what part of the spectra the models pay most attention to for flare prediction. The goal of this thesis is to use clustering algorithms, such as k-means and others, to statistically find explanations for why a particular spectrum was flagged as likely to be flare-predicting, or vice versa, and find physical explanations for the reason why these types of spectra appear before flares. In a second step, the project could be expanded to various spectral lines, or other instruments.

### TASKS




- Become familiar with machine learning and explainable AI.
- Investigate flare-predicting spectra statistically using clustering and explainable AI models.
- Interpret the different clusters and derive physical explanations for the state of the pre-flare solar atmosphere from basic radiative transfer arguments.
- Expand the study to different spectral lines, or compare with data from other instruments.

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.

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