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Solar spectropolarimetry : a brief introduction and machine learning applications

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Today's solar telescopes deliver data with high spatial (~0.1 arcsec) and spectral (~10^5) resolution, while simultaneously providing information on the polarization state of the light. This allows us to resolve the shapes of spectral lines formed in the solar atmosphere, and to, in turn, estimate its physical parameters (temperature, magnetic field, velocity) at various depths. Thus, high spatial resolution observations of various spectral lines allow us to map three-dimensional thermodynamic and magnetic structure of the solar atmosphere.

However, relationship between the atmospheric parameters and the emergent spectrum is highly non-linear and non-local, making the forward calculation of the spectra from the given atmospheric model complicated and numerically demanding, and the inverse problem even more so. This is an excellent problem for the application of machine learning techniques, namely convolutional neural networks. This type of neural network is particularly adept at recognizing features and learning complicated, non-linear relationships between the input and the output data.

In this talk we will briefly discuss the spectral line formation, Zeeman effect and spectropolarimetric diagnostic. Focus will be on fitting a model atmosphere to the observed polarized spectrum, also known as spectropolarimetric inversion. Finally, we will discuss possible applications of convolutional neural networks to this problem and present some preliminary results.