XV Serbian Conference on Spectral Line Shapes in Astrophysics, June 9 - 13, 2025, Niš, Serbia
Book of Abstracts, Eds. P. Marziani, M. S. Dimitrijević, L. Č. Popović and Đ. Savić
Astronomical Observatory Belgrade, Special Issues No. 2
https://doi.org/10.69646/15scslsa33

HIGH-RESOLUTION, HIGH-SPECTRAL FIDELITY SPECTROPOLARIMETRY OF THE LOWER SOLAR ATMOSPHERE

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Over the last decade, we have witnessed the development of several techniques that allow us to perform spectropolarimetric imaging of the lower solar atmosphere (photosphere and lower chromosphere) at the diffraction limit while sampling the shapes of the spectral lines in detail. Namely, the slit spectrum reconstruction technique and the integral field unit solutions like MiHI prototype and HeSP at SST delivered unique sets of data that set new standards for the upcoming solar observations. The properties of these datasets necessitate the development of new analysis techniques (i.e. spectropolarimetric inversion codes) to use their full potential.

This talk will focus on the current state-of-the-art techniques used to collect and analyze solar data with very high spatial and spectral resolution. We will review the current inversion techniques and recent progress, and challenges in the field. As an example of recent science results we will present several solar plage observations in the Na I D1 and Fe I 630nm spectral lines and several interesting findings we have uncovered. Namely, we focus on the plage magnetic topology, time dependence of the plage structure, and a detailed insight into the convective velocities. Finally, will discuss physics-constrained spectropolarimetric inversions using conventional inversion codes and newly developed Physically-informed neural networks (PINNs).