Contribution ID: **22** Type: **Oral talk**

Probing Solar Chromosphere Through Mg II h and k Wings at 280 nm

Tuesday, 22 December 2020 11:50 (20 minutes)

The Chromospheric Layer Spectro-Polarimeter (CLASP2) was launched on April 11, 2019, from White Sands Missile Range on a sounding rocket and reached an altitude of 274 km above the sea level in the thermosphere. For five minutes in operation, it observed three different targets on the Sun: a quiet disc center, an active plage, and a quiet limb. One-dimensional slit spectra were taken in all four Stokes parameters in the vicinity of the resonance doublet of Mg II, the so-called h and k lines at 280 nm in the ultraviolet. A weak signal, although at the noise level, of linear polarization due to spatial symmetry breaking on atmospheric granulation was detected at the disc center target. The plage target showed strong signatures of the longitudinal Zeeman effect, as expected. The limb target revealed Q/I profile shapes due to the J-state interference in a two-term atom. This was the first observational confirmation of a theoretical effect predicted by Belluzzi and Trujillo Bueno (2012).
In order to interpret these observations, we developed two numerical modules for the radiative transfer code PORTA (Stepan and Trujillo Bueno, 2013). One module solves the polarized transfer equations neglecting effects due to magnetic fields, while the other includes the Faraday rotation via selected magneto-optical terms. Both modules account for the J-state interference as well as the partial redistribution of photons, scattered in the resonance doublet. As the general treatment of resonance scattering is too expensive, we approximated it by applying the atomic coherent scattering function in the observer's frame. This approximation kept the essential magnetic sensitivity in the wings and dramatically reduced computational costs. With both modules, we numerically solved the transfer problem in the wings of the Mg II doublet for a two-term model atom and using a model chromosphere from the so-called "enhanced network simulations" produced by the radiation-MHD code Bifrost (Carlsson et al. 2016). We generated both synthetic images as well as slit spectra in all four Stokes parameters for different positions on the solar disk, which we compared against observations.

In this talk, I'll describe the observational experiment, the theoretical method, the complexity and computational demands of resonance scattering and how it can be approximated, which quantum effects define the observed shapes of the Stokes profiles, how sensitive to magnetic fields are the line wings, and why there are discrepancies between observed and calculated spectra.

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Session Classification: Astrophysics and Cosmology

Track Classification: Astrophysics and Cosmology