Spectropolarimetric Observations of Solar Flares in the Lower Atmosphere

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Despite their importance for space weather, the physical mechanisms that trigger solar flares are still not fully understood. Polarimetric measurements offer a unique window into the evolving magnetic environment during flares, enabling us to observe rapid changes in magnetic structures and energy release. These observations play a crucial role in testing theoretical models and improving our capability to predict solar activity. Leveraging the diffraction-limited capabilities of the Swedish Solar Telescope on La Palma, we have acquired unprecedented high-resolution observations of multiple solar flares with varying intensities. Our data reveals intricate fine-scale dynamics and complex ribbon structures in the lower solar atmosphere. Spectropolarimetric data were obtained in the chromospheric CaII8542Å line, which is sensitive to magnetic fields and plasma conditions in the chromosphere, as well as the photospheric FeI6302Å line, a crucial diagnostic of the magnetic field in the lower atmosphere. Additionally, spectroscopic observations were taken in the CaIIK line to provide further chromospheric diagnostics. By applying codes such as STiC, the line profiles can be inverted under non-LTE conditions. This makes it possible to derive the height-dependent profiles of Doppler velocities, temperature, and magnetic field vectors across the field of view throughout the evolution of the flare. Polarimetric data may provide key insights into the still poorly understood aspects of flare activity, including the mechanisms that trigger flares, and may help clarify the role of the lower solar atmosphere in the processes leading up to and occurring during flares.