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Plasma Dynamics and Magnetic Fields Characterized by Photospheric Spectral Data

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Current high-resolution observations of the photosphere show small dynamic features at the resolving limit during emerging flux events. However, line-of-sight (LOS) magnetogram pixels only contain the net uncanceled magnetic flux, which is expected to increase for fixed regions as resolution limits improve. Using a new method with spectrographic images, we quantify distortions in photospheric absorption (or emission) lines caused by sub-pixel magnetic field and plasma dynamics in the vicinity of active regions and emerging flux events. Absorption lines—quantified by their displacement, width, asymmetry, and peakedness—have previously been used with Stokes I images from SOLIS/VSM to relate line distortions with sub-pixel plasma dynamics driven by solar flares or small-scale flux ropes. The method is extended to include the full Stokes parameters and relate inferred sub-pixel dynamics with small-scale magnetic fields. Our analysis is performed on several sets of spectrographic images taken by SOLIS/VSM and NST/NIRIS while observing eruptive and non-eruptive active regions. We discuss the results of this application and their relevance for understanding magnetic fields signatures and coupled plasma properties on sub-pixel scales.