The magnetic sensitivity of the Ca II resonance and subordinate lines in the solar atmosphere

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Over the last two decades, novel theoretical investigations have allowed to decipher the key physical mechanisms that control the polarization of strong chromospheric lines, such as hydrogen Ly-α and Mg II h k around 280 nm, as well as to develop advanced plasma diagnostic techniques for their radiative transfer modeling and interpretation. The polarization signals of the resonant H and K lines and of the infrared triplet of Ca II are also of great interest for probing the magnetism of the solar chromosphere, as well as its thermal and dynamic conditions. Recently, the Sunrise III stratospheric telescope has provided high- quality spectropolarimetric observations in most of these chromospheric lines, thanks to its SUSI and SCIP instruments, and GRIS at the GREGOR telescope is now ready for unprecedented observations in the Ca II 854.2 nm line. However, a reliable modeling and interpretation of such observations is not an easy task. The polarization of solar chromospheric lines results from complex physical mechanisms: radiative transfer under non-equilibrium conditions in a plasma (the solar chromosphere) that is highly inhomogeneous and dynamic, anisotropic radiation pumping and the Hanle and Zeeman effects, partial frequency redistribution (PRD) in the scattering events, and quantum-mechanical interference between magnetic sublevels pertaining to different atomic levels. An important first step for a reliable interpretation of the Sunrise III and GRIS/GREGOR observations is to solve the problem of the generation and transfer of polarized radiation in the Ca II spectral lines, taking into account the joint action of scattering processes with PRD and J-state interference and the Hanle and Zeeman effects, but using one dimensional models of the solar atmosphere. We show the results of such an investigation, presenting the dominant physical mechanisms that control the polarization signals in each of the Ca II chromospheric lines and their magnetic sensitivity