Non-LTE Inversion of the H-Beta 4861Å Line for Chromospheric Magnetic Field measurement

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The chromosphere is a complex solar atmosphere that hosts variety of dynamic transients and transports a critical amount of free energy to heat the corona, with mechanisms such as magnetoacoustic wave heating and small-scale transients (nano-flares and spicules) proposed by observational evidence. However, due to the limited sensitivity of polarization measurement and the influence of spectral line broadening, the basic magnetic field configuration in chromosphere has not yet been fully revealed to correspond with the observed phenomena. In this work, we investigated the validity and application of the magnetic field inversion method for the H-beta 4861 Å spectral line with non-local thermodynamic equilibrium (NLTE) approximations. The formation height of H-beta line in the chromosphere is 1200 km, with a stratification of 200 km. We generated synthetic spectra by incorporating magnetic fields into semi-empirical VAL models for quiet Sun and sunpots, and then performed inversions to obtain the magnetic fields, which were then compared with the magnetic fields in the models. In addition, we evaluated the accuracy of the magnetic fields obtained using the weak-field approximation (WFA) and the impact of using these WFA results as the initial guess model for NLTE inversion on the final results. Our work validates the effectiveness of the inversion method applied to the measurement of line-of-sight magnetic field components in both weak-field (0-1200 Gauss) and strong-field (>2000 Gauss) regions, while maintaining accuracy of WFA in the field range of 1000-2000G. This demonstrates that the inversion techniques we employed are capable of resolving Zeeman-sensitive spectral lines in the chromosphere, which can be applied to the H-beta observational data from the Solar Magnetism and Activity Telescope at the Huairou Solar Observing Station to provide full-disk chromospheric magnetic field information.