Chromospheric magnetic field: A comparison of He I 10830 Å observation with nonlinear force-free field extrapolation

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Magnetic field structures in the solar corona are essential to understand the dynamical nature of the plasmas responsible for occurrence of flares and coronal mass ejections. The coronal magnetic field, however, is difficult to be directly observed because of the weak polarization signal in thermally broadened spectral lines. To overcome the difficulty, the nonlinear force-free field (NLFFF) modeling has been extensively used to infer the three-dimensional (3D) magnetic field in the solar corona. The assumption in the NLFFF extrapolation is that the plasma beta is low, but this condition is considered to be incorrect in the photosphere.

We attempt to reveal the non-potential magnetic field distribution in the chromosphere through spectropolarimetric observations and how significantly the magnetic field at the chromospheric height derived by the current NLFFF modeling with photospheric magnetic field is deviated from the measured chromospheric magnetic field. We examine the direct measurements of the chromospheric magnetic field in the whole active regions through the spectropolarimetric observations at He I 10830 Å. In addition, the photospheric magnetic field is measured with Hinode and Solar Dynamics Observatory. The results of NLFFF extrapolation from the photosphere are compared with the direct measurements. Our analysis shows that chromospheric magnetic field may have larger non-potentiality compared to the photospheric magnetic field at some locations. Moreover, the large non-potentiality in the chromospheric height may not be reproduced by the NLFFF extrapolation from the photospheric magnetic field. The magnitude of the underestimation of the non-potentiality at the chromospheric height may reach 30-40 degree in signed shear angle. We conclude that the magnetic field in the upper atmosphere may have higher non-potentiality than previously thought based on the NLFFF.

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