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Forward Modeling of Solar and Stellar Coronal Magnetic-field Measurements Based on a Magnetic field-induced Transition in Fe X

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It was recently proposed that the intensity ratios of several extreme ultraviolet spectral lines from Fe X ions can be used to measure the solar coronal magnetic field based on magnetic-field-induced transition (MIT) theory. To verify the suitability of this method, we performed forward modeling with a three-dimensional radiation magnetohydrodynamic model of a solar active region. Intensities of several spectral lines from Fe X were synthesized from the model. Based on MIT theory, the intensity ratios of the MIT line Fe X 257 Å to several other Fe X lines were used to derive magnetic-field strengths, which were then compared with the field strengths in the model. We also developed a new method to simultaneously estimate the coronal density and temperature from the Fe X 174/175 and 184/345 Å line ratios. Using these estimates, we demonstrated that the MIT technique can provide reasonably accurate measurements of the coronal magnetic field in both on-disk and off-limb solar observations. Furthermore, we performed forward modeling with a series of global stellar magnetohydrodynamics models to investigate the possibility of extending this method to other late-type stars, and concluded that this method can be used to measure at least the magnetic field. strengths at the coronal bases of stars with a mean surface magnetic flux density more than five times higher than that of the Sun. Our investigations of forward modeling have demonstrated that the MIT technique could provide reasonably accurate magnetic field measurements in the solar and stellar coronae.

References

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