An iterative method in a probabilistic approach to the spectral inverse problem: Differential emission measure from line spectra and broadband data

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Inverse problems are of great importance in astrophysics for deriving information about the physical characteristics of hot optically thin plasma sources from their EUV and X-ray spectra. We describe and test an iterative method developed within the framework of a probabilistic approach to the spectral inverse problem for determining the thermal structures of the emitting plasma. We also demonstrate applications of this method to both high resolution line spectra and broadband imaging data. Our so-called Bayesian iterative method (BIM) is an iterative procedure based on Bayes' theorem and is used to reconstruct differential emission measure (DEM) distributions. To demonstrate the abilities of the BIM, we performed various numerical tests and model simulations establishing its robustness and usefulness. We then applied the BIM to observable data for several active regions (AR) previously analyzed with other DEM diagnostic techniques: both SUMER/SOHO (Landi and Feldman, 2008) and SPIRIT/CORONAS-F (Shestov et al., 2010) line spectra data, and XRT/Hinode (Reale et al., 2009) broadband imaging data. The BIM results show that this method is an effective tool for determining the thermal structure of emitting plasma and can be successfully used for the DEM analysis of both line spectra and broadband imaging data. The BIM calculations correlate with recent studies confirming the existence of hot plasma in solar ARs. The BIM results also indicate that the coronal plasma may have the continuous distributions predicted by the nanoflare paradigm.

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