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A robust temperature diagnostic for coronal loops

Coronal loops emit light in the EUV range as observed by optically thin spectral lines with instruments such as SOHO/CDS or Hinode/EIS. The plasma observed by such spectral lines has a temperature range meaning that the observed plasma does not have the temperature of the spectral line at the peak of emission. Therefore, can we determine the mean temperature of a coronal loop from spectroscopic observations? To address this question, we forward-model the emission of EUV spectral lines covering a broad range of temperature, from 0.1 MK to 10 MK. The coronal loop and its plasma properties are derived from a 1D multi-stranded magnetohydrodynamic model heating by random deposition of energy of the nanoflare scale (Sarkar and Walsh, 2008, 2009). We study the effects of energy injection on the plasma evaporation and condensation processes using intensity and Dopplershift distributions. The analysis led to observe that those quantities are strongly dependent on the mean temperature of the loop, i.e., the total amount of energy injected in the system. We thus establish a diagnostic to estimate the temperature of a coronal loop using a series of EUV spectral lines covering a broad range of temperature: the temperature of the loop is obtained when the mean Dopplershift vanishes. Using the Hinode/EIS spectrometer as a benchmark instrument, we validate and test the robustness of the temperature diagnostic in a variety of experiments: (i) change in the viewing angle, (ii) variation of the frequency of heating events, from low to high frequency, (iii) dense and sparse rasters mimicking Hinode/EIS capabilities. They all provide an accurate diagnostic of the coronal loop temperature. For few selected spectral lines, we also provide an account on the possible temperature diagnostic with Solar Orbiter/SPICE and IRIS.