Nature of Prominences and their role in Space Weather
Proceedings IAU Symposium No. 300, 2013
B. Schmieder, J.-M. Malherbe & S. T. Wu, eds.

doi:10.1017/S1743921313011307

Kappa-distributions and Temperature Structure of the Prominence-Corona Transition Region

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Abstract. The influence of the electron κ - distributions on the differential emission measure (DEM) of the prominence-corona transition region (PCTR) derived from observed line intensities has been investigated. An important consequence of the κ - distribution is formation of the emission lines in much wider temperature ranges. The implications for the formation temperature of the observed SDO/AIA band emissions are shown.

Keywords. DEM, PCTR, SUMER spectral lines, SDO/AIA

A strong gradient of temperature and density in the PCTR can form non-Maxwellian distributions with an enhanced number of particles with high energies - the κ-distribution. Therefore we have studied the influence of the κ-distributions on calculated DEM. The observed line intensities from SOHO/SUMER spectrometer listed in Parenti & Vial (2007) as A_1 were used in our analysis. The ionization equilibria for κ-distributions were taken from Dzifčáková & Dudík (2013) and the excitation equilibrium was calculated for atomic data corresponding to the CHIANTI 6 (Dere *et al.*, 2009). The Withbroe-Sylwester method (Withbroe, 1975; Sylwester *et al.*, 1980) was employed for the calculation of DEM. The differences between our reconstructed DEM for the Maxwellian distribution with original DEM by Parenti & Vial (2007) (Fig. 1, top left) should be a result of different calculation methods only. The DEM's calculated for the κ-distributions are wider and flatter in comparison with DEM for the Maxwellian distribution (Fig. 1, top right; bottom left). This is mainly the result of changes in the ionization equilibrium for the κ-distributions, where the ionization peaks are wider and shifted in comparison with the Maxwellian distribution (Dzifčáková & Dudík, 2013). For the κ-distributions, the spectral lines are formed in wider temperature ranges and the maxima of contribution to the line intensities can be substantially shifted to lower T, especially in transition region (Fig. 1, bottom right). These changes could affect the temperature region that is visible in SDO/AIA filters. For the AIA 171 and 193 filters, and Fe X - XII lines (Fig. 2), the maxima of contributions to the line intensity have similar positions for both Maxwellian and κ-distributions. However, the Fe IX and Fe VIII lines show enhanced low-temperature contributions and the contributions from O V and O VI lines, formed at even lower temperatures, are significantly widened. We can conclude that the κ-distributions allow to see wider temerature range in AIA filters than the Maxwellian one.

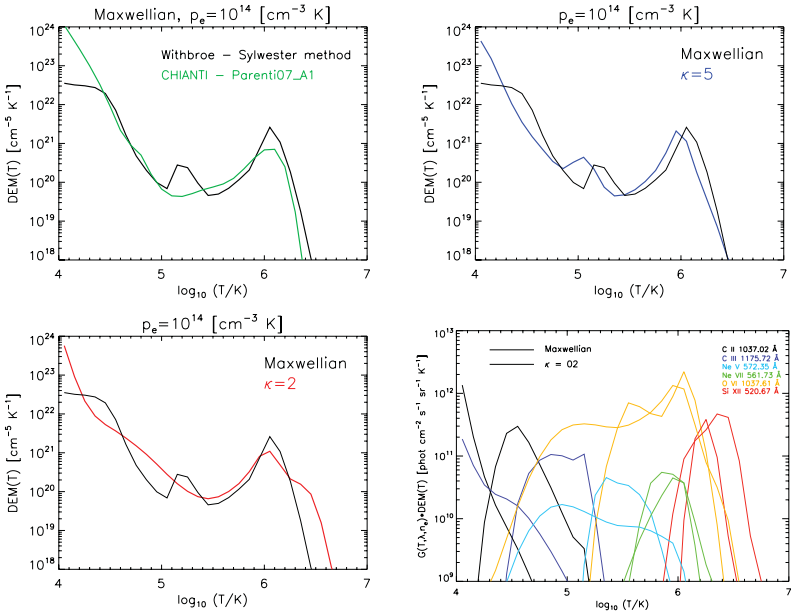

Figure 1. *Top left:* The PCTR DEM for the Maxwellian distribution by Parenti & Vial (2007) (green line) and by Withbroe-Sylwester method (black line). *Top right:* DEM for the κ-distribution with $\kappa = 5$ (blue line). *Bottom left:* DEM for the κ-distribution with $\kappa = 2$ (red line). *Bottom right:* $G(T,\lambda,n_e) * \mathrm{DEM}$ for the Maxwellian (full lines) and for the κ-distributions with $\kappa = 2$ (dot-dot-dot dashed lines) for six lines formed in different temperature ranges.

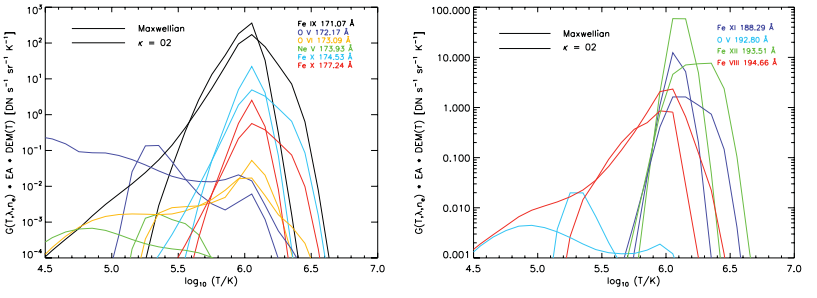

Figure 2. $G(T,\lambda,n_e) * \mathrm{DEM}$ multiplied by the effective area (EA) of 171 (*left*) and 193 band (*right*) for the Maxwellian (full lines) and κ-distribution with $\kappa = 2$ (dot-dot-dot dashed lines).

Acknowledgements

This work has been supported by Grant No. 209/12/1652 of the Grant Agency of the Czech Republic, grant No. 1/0240/11 of Scientific Grant Agency VEGA Slovakia, and the bilateral project APVV CZ-SK-0153-11 (7AMB12SK154) involving the Slovak Research and Development Agency and the Ministry of Education of the Czech Republic.

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https://doi.org/10.1017/S1743921313011307 Published online by Cambridge University Press