Emission Measure analysis of the transition region of solar flare structures

Costis Gontikakis[1], Spiro Antiochos[2], Peter Young[3]
[1]*Research Center For Astronomy And Applied Mathematics Of The Academy Of Athens,* [2]*CLaSP University of Michigan,* [3]*Goddard Space Flight Center, NASA*

We analyze an X1.6-class solar flare, observed on September 10, 2014, with the Interface Imaging Spectrograph (IRIS) and the Atmospheric Imaging Assembly onboard the Solar Dynamic Observatory (SDO/AIA). The purpose of study is to determine whether the lower transition region plasma is heated through classical thermal conduction described by Spitzer & Harm (1953) [1]. To achieve this the Emission Measure (EM) is computed for the chromosphere and low transition region spectral lines C II 1334.525Ang (formation temperature T~25000 K), Si IV 1402.770Ang (T~80000 K), and the Fe XXI 1354.066Ang flare line (T~10^7 K), all of them observed with IRIS, as well as the EM derived from the AIA 171Ang image, formed at low coronal temperatures (T<10^6K). Flare ribbons and flaring loop footpoints are sampled. The EM ratio of 1354.066 Ang over 171 Ang suggests that the energy flow from the hot ten million Kelvin plasma towards the low corona plasma is dominated by the standard thermal conduction. On the other hand, the EM ratio of 171Ang over Si IV 1402.770Ang is not compatible with a low transition region dominated by the standard thermal conduction. Moreover, the EM of the chromospheric line C II 1334.525Ang, when compared with the EM of the Si Iv 1402.770Ang is also not under the effect of the classical thermal conduction. The flare plasma is brighter than low transition region plasma structures, not thermally connected with the corona (small loops, spicules [2]). Therefore, the reason for the EM discrepancy must be found elsewhere. Effects such as variation of element abundances, ionization non-equilibrium, and the fact that Si IV 1402.770Ang is emitted by a Na-like ion are not able to explain our results. We discussed the possible influence of turbulence or non-Maxwellian free electros distributions on the thermal conduction mechanism [3-5] For more details, please consult Gontikakis, Antiochos and Young, 2023 [6].

References

[1] L. Spitzer, R. Harm, PhRv, 89, 977 (1953).
[2] S. K. Antiochos, G. Noci, G., ApJ, 301, 440 (1986).
[3] E. C. Shoub, ApJ, 266, 339 (1983).
[4] P. S. Cally, ApJ, 355, 693 (1990).
[5] A. G. Emslie, S. J. Bradshaw, ApJ, 939, 19 (2022).
[6] C. Gontikakis, S. K. Antiochos, P. R. Young, ApJ, 943, 120 (2023).