DEM Study of Selected Quiet Sun Regions

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Abstract. In the present work EUV spectra of quiet Sun regions, observed with the Coronal Diagnostic Spectrometer (CDS) on SOHO, are analysed in order to determine the Differential Emission Measure (DEM) of selected areas of the field of view. The purpose of the present work is to study the differences between the DEM curves of the quiet Sun cell centers areas, intermediate areas and network boundaries.

1. Introduction

Extreme UV spectral data can give us information about the temperature/density structure as well as the energy balance in the upper solar atmosphere. A method to study the rich and diverse information provided by the complex solar spectrum is to calculate the Differential Emission Measure (DEM) as a function of the electron temperature. The shape of the DEM curve, for temperatures between $10^5 - 10^6$ K, is interpreted in terms of the thermal conduction of energy from the corona to the transition region balanced by radiative losses (Gabriel 1976). As it is known, the supergranular network, which appears in the quiet sun, can be detected up to the upper transition region (Reeves 1976). The existence of this network may differentiate the energy balance at the network boundaries and inside the cell centers and this effect can have important consequences on the DEM shape. The aim of the present work is to determine the DEM in the network and non-network regions of the quiet sun, in an effort to investigate any differences.

2. Observations and data reduction

We study a set of EUV spectra, observed with the CDS/NIS (Harrison et al. 1995) on board the SOHO satellite, on July 28, 1996, during a SOHO/VLA joint observing campaign. The dataset includes a series of four rasters (s3842-

45) pointed at a wide area in the quiet sun, centered at $460''$ E, $580''$ N. In the field of view a filament is observed (Chiuderi Drago et al. 2001), together with a small loop, stronger in coronal lines, and the characteristic supergranular network of the quiet sun. The data were cleaned from cosmic ray effects and calibrated using the standard CDS software. We analyzed the data from rasters s3842 and s3845 only, since they have a larger field of view and the network can be better detected. We created intensity masks which isolate: 30% of the brightest pixels (network plasma), 25% of the faintest pixels (cell plasma) and 30% of the intermediate intensities (intermediate plasma); the filament and the coronal loop were masked out. We spatially averaged the data according to these masks and measured the intensities of the resulting lines. These have been used to determine the corresponding DEM curves using the Arcetri Spectral Code (Landi & Landini 1998) and the CHIANTI atomic data base (Dere et al. 1997). Since we observed a quiet solar region we used the photospheric chemical composition given by Grevesse & Anders (1992). For the ion fractions, we used the results of Mazzotta et al. (1998).

The lines included in the DEM calculation are, with increasing temperature: He I 584 Å, O IV 554 Å, O V 630 Å, Ne VI 563 Å, Ne VII 562 Å, Si VIII 320 Å, Mg IX 368 Å, Mg X 625 Å, Fe XII 365 Å, Fe XIV 334 Å and Si XII 520 Å. The computation was carried out under the assumption of constant electron density for coronal lines ($\log N_e = 8.1$, where N_e is in cm^{-3}). We used this typical coronal value of the electron density to calculate the contribution functions $G(T, N_e)$ of the coronal lines which are density sensitive, while the transition region lines are insensitive to electron density. Due to the small number of lines we could not do any correction for the abundance variation, resulting from the First Ionization Potential effect, especially for the Mg relative to the Ne abundance.

3.   Results and discussion

The curves from the two rasters (s3842 and s3845) are similar. In Figure 1 we show DEM curves for the network and the cell centers. We can describe the curves using 3 parameters: The slope S in the interval $\log T = 5.5$ to 6 (where T is in K), the peak emission P at $\log T = 6$ and the emission at $\log T = 5.2$.

Table 1. $\log(\mathrm{DEM}(T))$ $(cm^{-5}\ K^{-1})$

raster	region	slope	logT=5.2 K	logT=6 K
	cell centers	3.4	20.4	21.2
s3842	intermediate	3.4	20.6	21.2
	network	2.9	20.9	21.3
	cell centers	3.8	20.6	21.3
s3845	intermediate	3.8	20.7	21.3
	network	3.6	20.8	21.4

As we see in Table 1, the slopes are steeper for the cell centers and intermediate regions curves, than for the bright network. A similar result has also been found by Griffiths et al. (1999) and O'Shea et al. (2000), who confirm that the DEM slope decreases with intensity at temperatures in the range $10^{5.5}$-10^6 K. The DEM is larger for low temperatures ($\log T = 5.2$, T in K) at the network due to the higher intensities. This could be explained by the emission
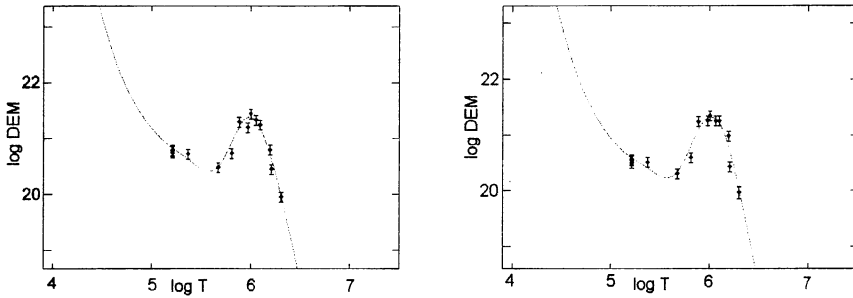
Figure 1.   DEM curves for the network (left) and the cell centers (right)

of spicules at lower temperatures (Raymond & Doyle 1981). It may also mean that there is less material in the cell centers than at the network boundaries for $5.2 < \log T < 6$. For $\log T \geq 6$, although there is some difference in certain spectral lines, the DEM curves look similar. The network is no longer detectable (Gontikakis et al. 1999), as the magnetic funnels are diverging with height and the supergranulation pattern disappears.

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