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Plasma Velocities in the Solar Corona and Transition Region

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Abstract. A short compilation of results of spectral observations of nonthermal velocities ξ in a wide range of temperatures in X-ray, EUV, UV and visual wave-lengths has been made. Relationship between the ξ and electron temperature T for chromosphere, quiet and active corona, coronal holes (CHs) and flaring plasma is considered.

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1. Data and analysis

Investigations of the directed V and random ξ velocities in the different layers of the solar atmosphere help us to understand better the energy transport into the corona. Spectral line profiles, forming in the temperature range from $1{\times}10^4$ K to $3{\times}10^7$ K, contain information of matter velocities in different layers and coronal structures. Literature data on observations, obtained from cosmic stations and on the ground, and results of interferometric observations during several solar eclipces (see Delone, Yakunina & Porfir'eva (2003b) have been used.

The relationship between the nonthermal velocity and temperature of the emitting plasma is shown in the Figure 1. The ξ values for the chromosphere, transition region and lower corona (symbol $\Box$) were taken from Chae *et al.* (1998). In addition the data for the quiet corona (symbol +) were taken from Delone, Yakunina & Porfir'eva (2003b), Doschek & Feldman (1977), and Raju et al. (2000). We can see that the nonthermal velocity increases when the temperature increases, reaching its maximum equal to ~ 30 km s^{-1} when T=3×10^5 K, and then begins to fall to the value of about 20 km s^{-1} in the lower corona. The ξ values for coronal holes (symbol $\times$) were taken from Doschek & Feldman (1977), Hassler & Moran (1994), Wilhelm et al. (1998), Raju et al. (2000), and Delone et al. (2003a). As it is discussed by Delone et al. (2003a) the random velocities in CHs in average are greater than in quiet corona. The values of ξ for nonflaring active regions (ARs)(symbol $\triangle$), being in a relatively quiet station, were taken from Delone, Yakunina & Porfir'eva (2003b), Saba & Strong (1991), Sterling (1997), and Harra, Matthews & Culhane (2001). We can see that the nonthermal velocities and temperature in the ARs are greater than in the lower quiet corona. For the flaring corona the data were taken from Delone, Yakunina & Porfir'eva (2003b) (symbol $\circ$), Harra, Matthews & Culhane (2001), Ranns et al. (2001), and Doschek, Mariska & Strong (1994) (symbol $\bullet$).

As it was shown in Delone, Yakunina & Porfir'eva (2003b), and Porfir'eva & Yakunina (2003) the $\overline{\xi}$ for the X-ray flares with T$\geqslant 10^7$ K is equal to ($161{\pm}5$) km s^{-1} but the values of ξ vary in the wide range from 90 to 300 km s^{-1}. For the weaker flares with T$\leqslant 10^7$ K $\overline{\xi} = (146 \pm 8)$ km s^{-1} (symbol $\diamond$), i.e. a little less than for the hot flares. The dynamical loops have greater ξ than the quiet ones have (symbols $\blacksquare$ and $\star$ correspondingly, Chae et al. (2000)). The nonthermal velocities in the coronal holes are greater than in the surrounding quiet coronal regions, and the ξ values in the nonflaring active regions are greater than in the quiet diffuse corona.

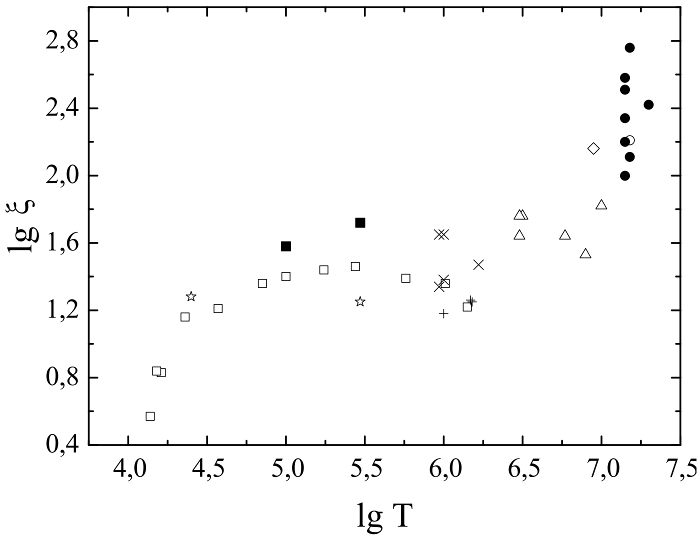

Figure 1. The nonthermal velocities ξ as a function of the electron temperature T.

2. Summary

In general the nonthermal velocity increases from several km s^{-1} to several hundreds km s^{-1} with temperature increase from 10^4 K to 3×10^7 K. But there is no one-to-one dependence between the nonthermal velocity and temperature. Different attentions are made to explane the excess nonthermal broadening of the line profiles. The most probable mechanism appears to be due to MHD turbulence although other expanations are possible.

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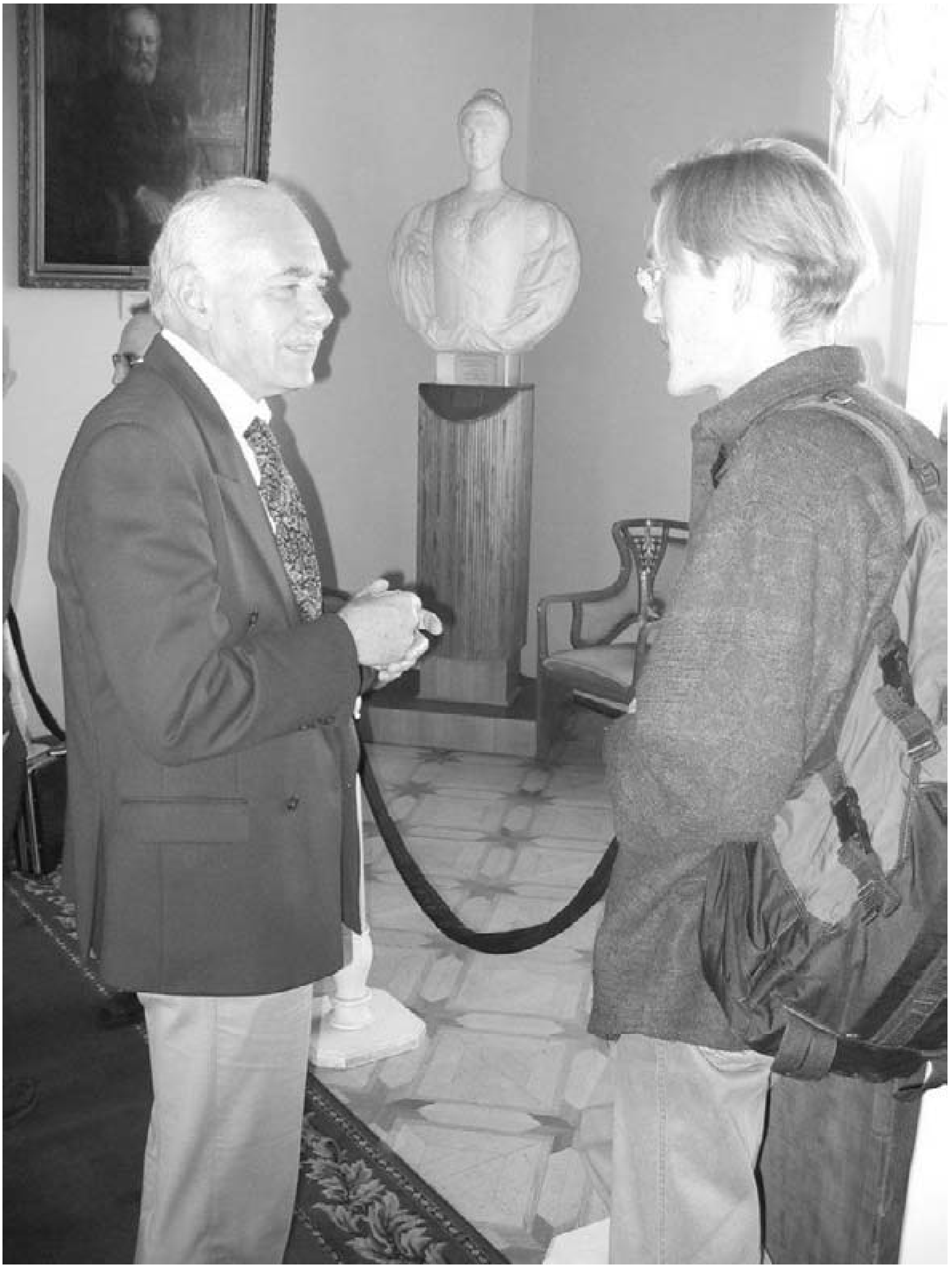

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