

Nonthermal broadening of the Fe X $\lambda 6374\text{\AA}$ and Fe XIV $\lambda 5303\text{\AA}$ coronal lines and its correlation with the intensity

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Abstract. The results of research of halfwidths ($\Delta\lambda$) and intensities (W) of Fe X $\lambda 6374\text{\AA}$ and Fe XIV $\lambda 5303\text{\AA}$ spectral lines using observations obtained with the Large coronagraph of the Sayan observatory in 1968-1983 show the inverse correlation between $\Delta\lambda$ and W always exists for Fe X $\lambda 6374\text{\AA}$; it takes place at all latitudes at the same height as well as with height irrespectively of activity level. For Fe XIV $\lambda 5303\text{\AA}$ this correlation varies from direct to inverse depending on activity level. It is shown that relation type between $\Delta\lambda$ and W for different spectral lines is determined by different coronal *structurednesses* in these lines.

For the first time the inverse correlation between $\Delta\lambda$ and W was found for $\lambda 6374$ using numerous observations of spectra of this line (~ 5500 profiles) obtained with Large coronagraph of the Sayan observatory in 1968-1972. The inverse correlation takes place at all latitudes as illustrated in Fig. 1 [Tyagun, Stepanov, 1976]. As was shown later by the observations of $\lambda 6374$ in some active regions as well as with height in corona the inverse correlation between $\Delta\lambda$ and W always takes place irrespectively of activity and height in corona [Tyagun, 1988, 2004] (Fig. 2). One could say that for red line it is always true. The observations of $\lambda 5303$ (as well as Ca XV $\lambda 5694\text{\AA}$) in some active regions along the latitude and with height show that the relation between $\Delta\lambda$ and W is unambiguous for this line. For active region in which yellow line is emitted this correlation is direct and it is retained up to height of about $2'$ in inner corona (for yellow line the correlation is not evident but probably it is closer to direct one). In old active region there is no any correlation. In degradable active region the the correlation can be inverse for spectral line $\lambda 5303$ [Tyagun, 1994, 1998]. It is interesting to note that on average the halfwidths of $\lambda 6374$ are greater when compared with $\lambda 5303$ ones, and their dynamics is similar to dynamics of line-of-sight velocities. At present nonthermal broadening and inverse correlation between $\Delta\lambda$ and W are observed from space in UV and EUV ranges. In most cases a wave origin is used to interpret these phenomena. But then it is difficult to explain such facts as different correlations between $\Delta\lambda$ and W for $\lambda 6374$ and $\lambda 5303$ spectral lines, as well as larger width of red line. These phenomena can be explained using the concept of structuredness in corona along the light-of-sight. The well-known monochromatic observations of the corona show that "red" corona with its finer and homogeneous structuredness differs from "green" one. If we characterize this structuredness by the factor of homogeneity Q (first of all, on the basis of electronic density n_e : $Q = \overline{(n_e^2)} / (\overline{n_e})^2$) then $Q_{red} \ll Q_{green}$. Theoretically, Q should be the efficient in the expression for intensity but because it is practically unknown it is usually ignored and some line-of-sight-averaged value is used for n_e . If we take Q into account then we can conclude the following. Q_{green} can increase significantly even due to some very dense element on the line-of-sight (for example, an

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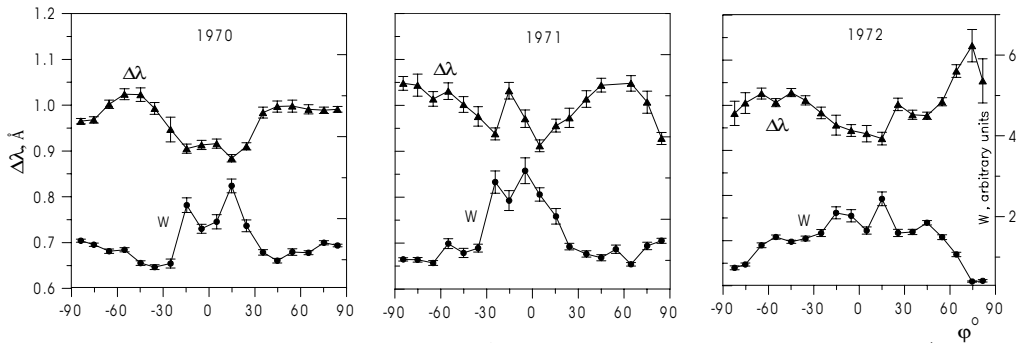


Figure 1. Time variations with latitude of $\Delta\lambda$ and W for red line during 1970-1972 (~ 5500 profiles).

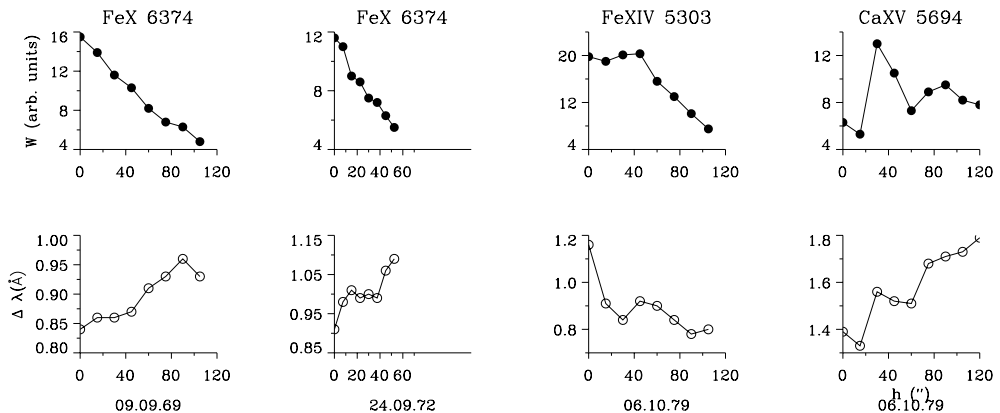


Figure 2. Variations of $\Delta\lambda$ and W with height above active regions for red, green and yellow lines.

active region). As a result of this the intensity increases many times (due to n_e^2 and Q) and the line width is determined mainly by the line width from the same element on the line-of-sight. So, we have large W and nonebroadened $\Delta\lambda$. More homogeneous and finely structured red corona is characterized by small value of Q and greater freedom of motion of elements along the line-of-sight that results in increase of $\Delta\lambda$. Then the line is weak and wide. Conclusions: The character of corona structuredness can have determinative influence on the kind of dependence of $\Delta\lambda$ and W . The results of research of spectra of $\lambda 6374$ depending on latitude and height in corona demonstrate that red corona is more homogeneous and finely structured as compared with green one *everywhere* on Sun, and the inverse dependence between $\Delta\lambda$ and W is its fundamental characteristic.

References

- Tyagun, N. F. and Stepanov V. E. 1976 *In Contributions of the Astronomical Observatory Skalnaté Pleso, Proc. 7 Regional Consultation Solar Activity and Solar-Terrestrial relations* (ed. Sykora J. P.), 323-332.
- Tyagun, N. F. 2004 *Solnechno-zemnaya fizika 6, in press.*
- Tyagun, N. F. 1998 *Izvestiya Akademii nauk, ser. fiz. 62, No 6, 1244-1245.*
- Tyagun, N. F. 1994 *In IAU Colloquium 144. Solar Coronal structures* (eds. V. Rusin, P. Heinsel and J.C. Vial), 421-426.