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The evolution of Hα and CaII K emission before and during the solar M-class flare on 25th July 2004

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Abstract. The last decade observations revealed the essential variations of energy balance take place in the pre-flare active regions at all atmospheric levels and they are caused by both evolution of AR and processes associated with flare activity. We present the multi-wavelength study of the solar flare jointly with the preceding event. The combined investigation is perspective for the mechanism understanding of the energy storage, trigger and release during the solar flares. A special attention was given to signatures of energetic particle beam effect on chromosphere according to Hα and CaII K intensity changes. Combination of data from ground based instruments and space observatories (TRACE, MDI, RHESSI) will allow us to track processes taking place in a wide range of solar atmosphere layers - from the temperature minimum region to the corona. The obtained results are discussed.

Keywords. HXR, energy release, accelerated particle beams, solar flare, RHESSI, Hα

1. Introduction

Fast temporal fluctuations of both hard X-ray and optical emissions are usually attributed to the propagation of beams of accelerated particles and to the dissipation of the energy in lower layers of solar atmosphere (Heinzel, 2003). It is rather difficult to prove a temporal correlation between HXR and optical emission variations, nevertheless, we've seen series of interesting results. The first one is an investigation of rapid variations of the Hα line intensity and its correlation with HXR flux during the impulsive phase of chromospheric flares which have been reported by many authors, e.g. Trottet *et al.* (2000). The other one is comparison of the spatial distribution of hard X-ray sources and Hα flare kernels. For example, such study was done by Asai *et al.* (2002). They found that many Hα kernels brighten successively during the evolution of the flare ribbons.

2. Observations and first results

We carried out the multi-wavelength study using optical, RHESSI, TRACE, and MDI observations. The Hα and CaII K line slit-jaw images with the temporal cadence of five seconds were obtained at the Vacuum Tower Telescope (VTT), Obsevatorio del Teide. The duration of the series was usually about 1–2 minutes. We used the data obtained in AR 0652 (N08W35) from 13:34 UT to 13:42 UT on July 25, 2004. In order to fix the heliographic coordinate system of the studying region, we use SOHO/MDI intensitygrams and 1600 Å TRACE observations. The accuracy of the heliographic coordinate

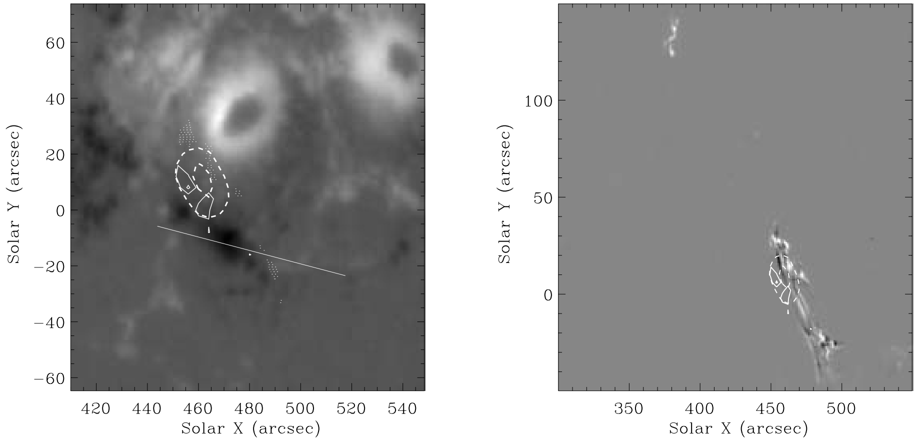

Figure 1. Left: A superposition of HXR sources and Hα emission (shaded areas) with the magnetogram of investigated region obtained by MDI (SOHO) at 13:39:30 UT. Right: A superposition of HXR sources with the difference intensity image in 1600 Å(13:40:19-13:39:34 UT). RHESSI HXR image at 12–25 keV and 25–50 keV are plotted as dashed and solid contours at 50 and 90% of the image maximum, correspondingly.

determination is about 2 arcseconds. For comparison Hα intensity changes with HXR flux, we used RHESSI data with temporal resolution 2 seconds. The HXR source images for 12–25 keV and 25–50 keV bands were reconstructed by PIXON algorithm known as suppressing of spurious sources and high photometric accuracy (Metcalf *et al.*, 1996). We used 1600 Å images obtained by TRACE for detecting the changes in lower layers (the temperature minimum region). SOHO/MDI magnetograms and 195 Å images by TRACE were used for magnetic field structure analyzing.

We revealed correlation of the fast increasing in the Hα and CaII K line intensity of flare beginning with HXR-data (Fig. 1, left panel). At the same time the considered events were seen not only in chromospheric lines but in UV 1600 Å band where the several kernels of intensity rising were detected (see Fig. 1, right panel). But the only one of the kernels were conceded with HXR sources. Possibly, it connected with complex structure of AR magnetic field and its fast evolution on the threshold of forthcoming dramatic changes. The should be noted that HXR sources in 12–25 keV and 25–50 keV energy range located at the same place where the HXR sources of pre-flare event were revealed (Chornogor *et al.*, 2005).

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