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Line-of-sight velocity variations in the low-temperature layers of the H_α flare loops

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Abstract. We studied the line-of-sight (LOS) velocity field at the photospheric and chromospheric levels in the H_α-loops in the course of the development of the bright flare. The spectra and filtergrams were acquired with the solar telescope ATsU-26 at the Terskol Peak Observatory. Time variations of the LOS velocities at loop tops and bases were compared to the H_α and hard X-ray fluctuations. The intensity variations and H_α-filtergrams are evidence that elementary X-ray spikes are associated with consecutive disturbances of H_α-loops in the arcade. The H_α intensities and velocities at the loop bases are much higher than at the tops. Different mechanisms can be efficient at the early stages of elementary X-ray spikes and at their maxima: ascent of photospheric matter at loop bases was recorded only when the H_α and hard X-ray intensities were minimum, and the intensity maxima were accompanied by descending motions of the photospheric plasma.

The line-of-sight velocity field at the photospheric and chromospheric levels in flaring loops in the course of the development of a bright flare (1b/M2.2) of 3 September 1990 ($\cos\theta = 0.545$) was examined. The spectra and TV H_α-images were acquired with the horizontal solar telescope ATsU-26 of the Terskol High-Altitude Station ($h = 3200$ m). In addition, GOES X-ray emission data (http://spidr.ngdc.noaa.gov/) and photospheric magnetic field map of the active region (NSO Digital Library) were used.

The flare evolution scenario was as follows: the brightest sites of the H_α- loops moved along the loop arcade above the neutral line, rounding separate supergranulation cells and earlier flare sites gradually decayed. The set of H_α-filtergrams shows that this flare can be regarded as a sequence of elementary flares along an arcade of loops. The spectrograph slit crossed two brightest loops (A and B) at the initial flare site, they were observed throughout the flare.

Some features of H_α-loops revealed in this study are similar to the characteristics of soft X-ray loops (Inda-Koide et al. (1995); Kurokawa et al. (1988); Priest (2000)): the localization of the H_α-loop system along supergranule boundaries, successive excitation of loops in the arcade, virtually simultaneous radiation intensity increase in the X-ray range and at the tops and bases of H_α-loops, and higher brightness of H_α-loop bases as compared to the tops (see figure 1).

The first flare H_α and hard X-ray maxima (09:44 UT) coincide with the first brightness maximum of loop A, and the second flare maximum (09:47 UT) coincides with the brightness maximum in loop B. This allows us to suppose that the H_α bursts in the loops were associated with two consecutive reconnections above these loops. In both loops the H_α intensity varied in step at the top and at the base, but the line intensity was greater at the base.

The velocity field in this flare had the following peculiarities in the chromosphere and

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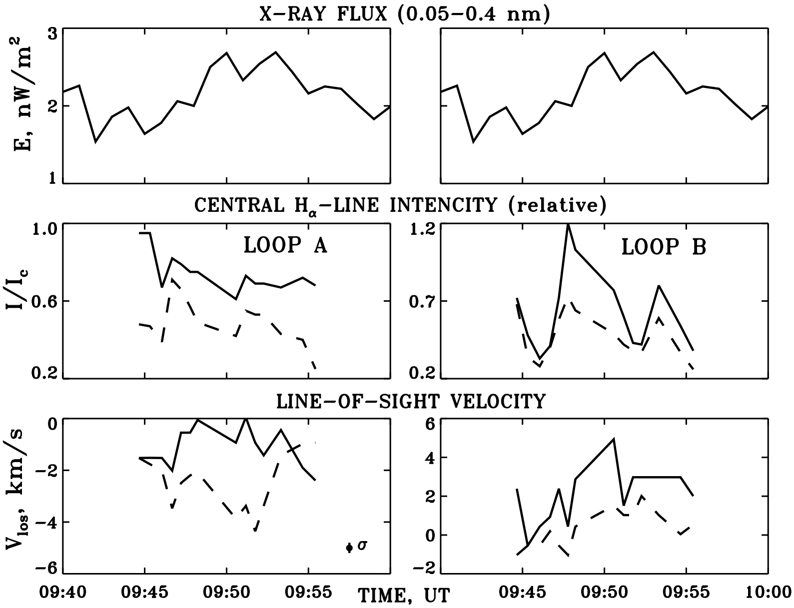

Figure 1. Time variation of some parameters of flaring loop A (left panel) and B (right panel); dashed line - loop top, solid line - loop base.

photosphere. At the beginning of the X-ray spike phase ascent motions were observed in the both loops in the chromosphere. At the photospheric levels upflows dominate at the bases of both loops. The exception is the layer 230–270 km, where the velocities are close to zero. The observed photospheric velocity pattern is in satisfactory agreement with the height profile of the vertical velocity component of longitudinal-transverse waves in the photosphere (Osin et al. (1999)). At the X-ray spike maxima, descent motions dominate at all levels. In both loops the velocity magnitudes were greater before the soft X-ray and H_α-intensity maxima.

In the course of the flare the velocity fluctuated in both loops with a period of about 3 min in the chromosphere and 1–2 min in the photosphere.

Thus, the mechanisms which are responsible for the observed motion pattern at the photospheric and chromospheric levels at the impulsive phase of X-ray spikes can be different from the mechanisms which act at the flare maximum. At the beginning stage of the burst testify to the initial propagation of the excitation from the photosphere base. But the downflows observed at cycle maxima can be explained by a condensation which was formed in the reconnection in the upper atmosphere and was moving deep into the photosphere.

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