ON THE FORMATIONS CONNECTED WITH THE LIMB FLARE OF NOVEMBER 6, 1979

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We analyzed the observation data obtained at Abastumani astrophysical observatory in the form of spectrograms and filtergrams of formations associated with the November 6, 1979 limb flare. We studied the system of flare loops, the late stage of the bright flare loop development, and post-flare coronal loops obtained in $H_{\alpha}$ and coronal lines. The physical parameters of the structures observed as well as their dimensions and mutual locations are determined. The Doppler velocities at different altitudes are measured and the prevailing upward direction of the matter motion in the flare loops is revealed.

The phenomena related to the intense flare at the east limb of the sun of November 6, 1979 were observed simultaneously on the photospheric-chromospheric telescope and the small Lyot type extraeclipse coronograph at Abastumani observatory [1]. An active region HR No. 16419 (according to the designations in [2]), in which the above events occurred, was formed as a result of joining of the old (HR No. 16357) and new regions. A group of spots had a complex structure: small spots of the S polarity, which varied at a relatively high rate, were located between the well-developed spots of the N polarity. One of the S polarity spots, which was initially rather close to the leading part of the N polarity group, was found to be far from the latter on subsequent days.

The following formations were observed above the active region under consideration from the beginning of observations (05h50' UT): the withdrawing and luminous-in-$H_{\alpha}$ matter at a distance of 300,000 km from the edge of the sun disc, the slightly twisted weak prominence, the bright loop and the knots in the corona lines accompanied by a continuous radiation, and a developing system of loop prominences that appeared in a short period of time. These formations are usually observed in connection with an intense flare on the limb. One can assume that, as previously, they are related to the flare, which, most probably, occurred beyond the limb (the corresponding group of spots appeared on the disc only on November 7), or, perhaps, on the limb, but it was not recorded, probably because of the fact that the period before our observations (from 02 to 06 UT) was not properly covered by $H_{\alpha}$ patrol. At about 05h20' UT the solar radio bursts were recorded at the fixed frequencies of 950, 2950, and 9100 MHz according to the data obtained at the Radiophysical Research Institute [3], 2695 and 8800 MHz according to the data of the Manila station [4], and radio bursts of types II and IV were recorded in the meter range according to the spectral observations of the radio-frequency solar radiation conducted at Kulgor station [3].

From the very beginning of observations one could single out the loop system (I) with intensity higher than the unperturbed chromosphere whose south foot was on the disc (near the limb) in a floccule with varying brightness, and the other was setting beyond the limb. Initially, the system involved two almost parallel branches of the same brightness; however, later the south side of the south branch turned weaker more rapidly. The actual length of the loop was about 80,000 km, and the loop cross-section diameter was about 5".

At the initial stage of observations we saw no formation between the loop system I and the prominence. At 06h28' UT a weak limb flare starts to appear at this place (1f with maximum at 06h31' UT), and the...
related formation (II) appears in the form of a smooth loop. The flare near its south foot goes out at about 06h38 m UT, while the north foot becomes brighter. The visible distance between the loop bases is about 24600 km and the loop length is about 70,000 km. At 06h45 m UT the second flare (1f with maximum at 06h53 m UT) starts to appear slightly to the south of the first flare and the related bright loop appears against the background of the previous one that goes out, which also disappears at 07h15 m UT. Therefore, both loops existed for several dozens of minutes. A typical post-flare loop appears at 07h28 m UT in place of system II and two loops with bright knots at the apices appear at 07h52 m UT. Unfortunately, we were unable to perform a more detailed study of the flare and post flare loops, in particular, the process of disappearance of the former and formation of the latter, because of the insufficient time resolution of our filtergrams.

Above the studied active region we observed coronal loops in the red, yellow, and green lines [5]. This bright system of coronal loops is considered to be activated, due mainly, to the primary intense flare, since the knots and the accompanying continuum were the brightest before we started to observe the weak limb flares and went out only after the disappearance of the post-flare loops. The observation of this activation is reported in [6, 7] for the higher-temperature coronal structures, which are called post-flare coronal loops or arcs.

The electron density and the temperature of formations observed were calculated in terms of the brightness of continuous radiation from the knots and in terms of the spectral line contours. As a result of analysis of the obtained physical and geometric properties of the structures observed we developed a diagram of the relative location of formations related to the limb flare of November 6, 1979 (Fig. 1). The loops of helium lines join the loop \( H_\alpha \) mutually penetrating and propagating slightly higher than \( H_\alpha \) loops. The hydrogen-helium loop is followed by the loop in the red coronal line 6374 Å and then by a system of green loops (5303 Å) among which one can distinguish two brightest loops extending to an altitude of about 40000 km. The yellow loop (5694 Å) is located between the two green loops partially penetrating into them and propagating to the greater altitude of 50000 km. The system of coronal loops is located closer to the center of the active region near the neutral line. The flare loops are formed in the northern part of the active region behind the coronal lines; after the disappearance of the flare loops a system of post-flare loops appeared.

To study the dynamics of the observed formations, we examined the field of their Doppler velocities (this method is rather informative if the limb structures are located outside the sky plane) and its variation in time. The Doppler velocities of the loops are measured for several spectrogram series at altitudes 10", 20", 30", and 50" in the interval from 06 to 08 UT; Doppler velocities of order of +10 km/sec were observed in the brightest knots of the green and yellow coronal lines.

The loop system (II), which consists of the structures that start burning one after another, was formed during our observations. A series of spectra that coincide with the onset of the second limb flare indicates