THE FINE TEMPORAL STRUCTURE OF THE EV LACERTAE FLARE ON FEBRUARY 6, 1986 AT THE C IV (λ 1550 Å) RESONANCE LINE
I. OBSERVATIONS

B.A.Burnasheva, R.E.Gershberg, A.M.Zvereva,
I.V.Ilyin, N.I.Shakhovskaya, A.I.Sheikhet

Crimean Astrophysical Observatory
Crimea, Nauchny, 334413 USSR

ABSTRACT. While monitoring the flare star EV Lac with high time resolution using the Space Astrophysical Station ASTRON, a rather strong flare was recorded. During this event, flare emissions were detected in the C IV (λ 1550 Å) UV line, in the narrow band continuum at λ 2434 Å (28 Å bandwidth) and in the wide wavelength range from 1700 Å to 6500 Å, all emission enhancements taking place within 10 s. About 50 s after the flare start, a fast and very powerful burst of the C IV line took place.

On February 6, 1986, a flare was detected while monitoring the flare star EV Lac with the Space Astrophysical Station ASTRON (Boyarchuk et al., 1984). The observations were carried out in the offset guiding mode with an entrance diaphragm of 1 arcmin and the integration time of 0.61 s. The photomultipliers in the scanning spectrometer were positioned in such a way that the second channel was centered at the C IV (λ 1550 Å) line, the first channel on the continuum radiation at λ 2434 Å (both channels with 28 Å bandwidth), and the fourth channel was recording the "white light" flux from 1700 Å to 6500 Å, which was reflected in the zero order from the concave grating.

Ultraviolet patrol observations were carried out from 16h 11m to 18h 40m UT. We simultaneously monitored EV Lac with the 1.25-m reflector AZT-11 of the Crimean Astrophysical Observatory using a 5-channel photometer-polarimeter (Piirola 1984). In Figure 1 we show the EV Lac light curves from 17h 05m to 18h 15m for the 3 channels of the ASTRON spectrometer and for the U band from the ground-based observations. Before the flare, from 16h 11m to 17h 37m UT, the mean square errors of single measurements were 7, 8 and 44 counts for the first, second and fourth channel, respectively. The original ASTRON data (0.61 s time resolution) are averaged in Figure 1a over 50 measurements with a resulting time resolution of 30.5 s. In Figure 1b the time resolution is 5.5 s from running means over 9 measurements. The time resolution of the ground based observations was about 6 s. Unfortunately, just at the flare maximum the ground-based observations were interrupted to change a perforator band. In spite of this circumstance, Figure 1 clearly shows that at about 17h 42m UT a rather powerful flare started on EV Lac. By extrapolating the ground-based data to the time of maximum and using an UBV calibration of the fourth channel measurements of the ASTRON

https://doi.org/10.1017/S0252921100153825 Published online by Cambridge University Press

spectrometer, we obtained two independent and consistent estimates: in the U band the flare amplitude was about 3 magnitudes.

As apparent in Figure 1a, the flare maximum occurred first in the ultraviolet continuum radiation (first channel). A brightness maximum occurred 30 s later in the fourth channel, which is sensitive to optical and ultraviolet radiation. The strongest luminosity in the C IV (λ 1550 Å) line was observed 30s later. At first glance, there seems to be a close analogy with optical observations, where a maximum in the continuum precedes the maximum in line emissions (Bopp and Moffett, 1973). However, from Figure 1b and especially from the analysis of telemetric readings, a more intricate picture appears.

At about 17h 42m 00s UT, two consecutive readings in the second channel exceeded the mean level during the preceding 1.5 hours of monitoring by 3.1 σ and 4.2 σ, respectively, where σ is the mean

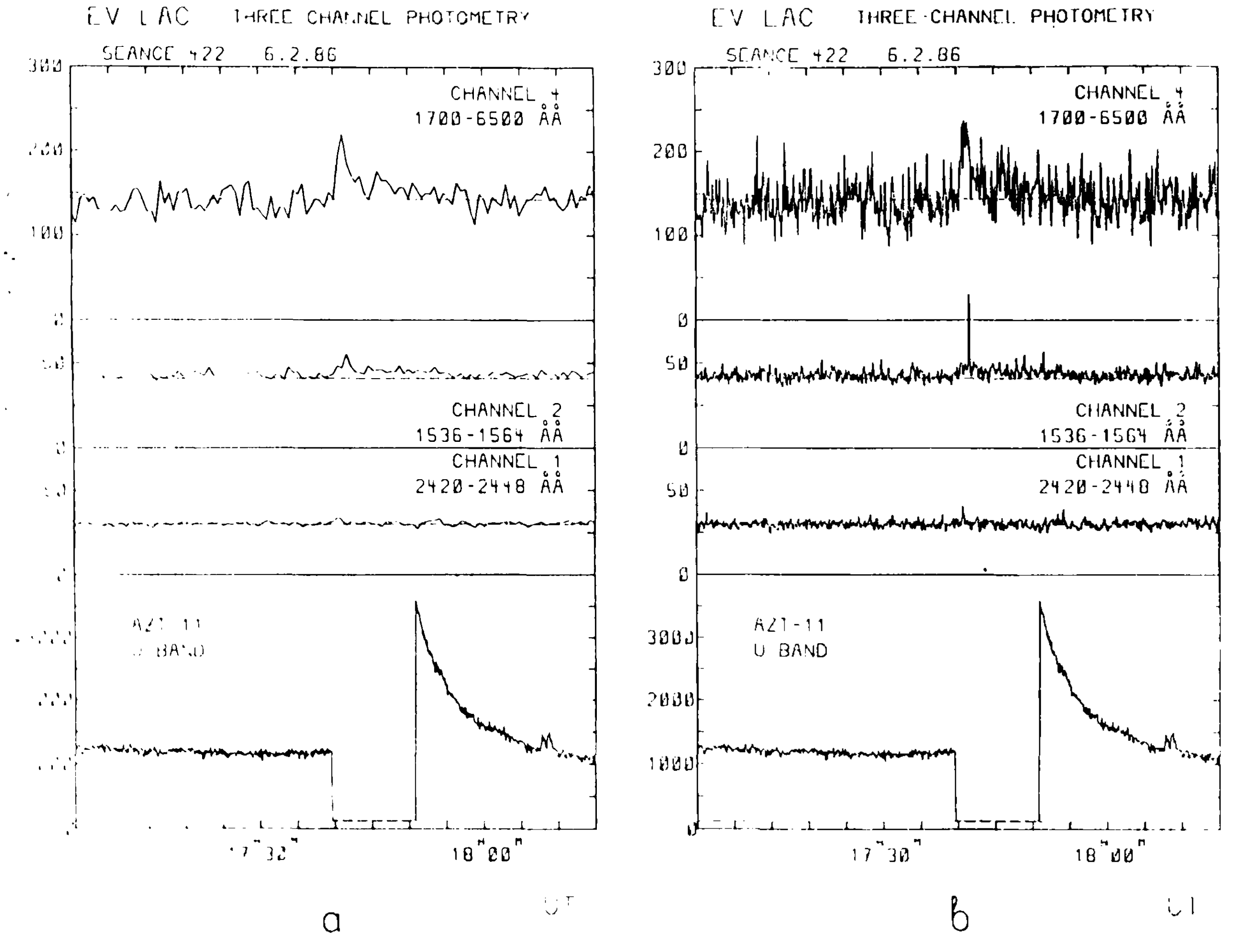

Figure 1. Light curves of the EV Lac flare on February 6, 1986 recorded on 3 channels of the ASTRON spectrometer and in the U band. The ASTRON data are 30 s (a) and 5.5 s (b) averages. Dashed lines indicate the levels of dark current and sky.

square deviation for one measurement. In the fourth channel, the second corresponding reading exceeded the mean level by 3 σ. At 17h 40m 07s UT the flare started in the first channel as an isolated "spike" with 8σ amplitude. Another spike with 4.4 σ amplitude was detected in the second channel 3 s later and, beginning from the following reading, an unusually long-duration maximum of about 45 s was recorded in the fourth channel. At 17h 42m 58s another isolated spike occurred in the second channel, but 11 times more intense than the preceding 8σ one in the same channel; this spike was the cause of the apparently delayed maximum in the second channel (see Figure 1a).

In all channels of the ASTRON spectrometer the flare was still detectable, more or less confidently, about 15 minutes after the maximum. Then, the bursts were detected only in the first and second channels and their amplitudes were comparable with those detected at the beginning of the flare. These bursts, however, were not correlated. At 18h 08min in the optical and second channel light curves appreciable brightenings were seen; similar bursts had been detected earlier in the second channel.

Since the strongest burst at 17h 42m 58s was detected in only one reading in the second channel, one might suspect that this reading is spurious. Unfortunately, statistics cannot give a definite answer on the reality of this unique measurement. However, since a) the probability of so large a spurious signal (55 σ) is very small, b) the burst under discussion took place at the beginning of a powerful flare, and c) the burst had the largest intensity among the 14000 measurements carried out during the 2.5 monitoring hours, we believe that this burst is due to stellar activity. Quantitative estimates show that such a burst would have occupied on the stellar surface an area that is 100 times larger than the areas of similar fast C IV line bursts on the Sun, which are observed in active regions and their vicinities (Athay et al., 1980; Lites, 1981). However, the energy release associated with the stellar burst we observed exceeded by several orders of magnitude its solar analogue and was an order of magnitude faster

The complete version of this study is published in Astron. J. (USSR) 65, N. 6, 1988.

REFERENCES

Athay R.G., White O.R., Lites B.W., Bruner E.C.: 1980, Solar Phys. 66, 357.

Bopp B.W., Moffett T.J.: 1973, Astrophys. J. 185, 239.

Boyarchuk A.A., Gershberg R.E., Granitskij L.V., Kovtunenko V.M., Krmoyan M.N., Cruvellier P., Courtes G., Pronik V.I., Severnyj A.B., Tovmassyan G.M., Khodzhayants Yu.M., Hua C.T.: 1984, Letters to Astron. J. (USSR) 10, 163.

Lites B.W.: 1981, Solar Phys. 71, 329.

Piirola V.: 1984, Observatory and Astrophys. Lab., Univ. Helsinki, Report No. 6, p. 151.