PHOTOMETRICAL, SPECTRAL AND RADIO MONITORING FOR EV LAC IN 1986 AND 1987

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ABSTRACT. During 9 nights in 1986-1987 we have carried out the patrol observations of red dwarf EV Lac within the wavelength range from 3500 Å to 8 mm and registered more than 50 optical flares. Some features of stellar flares, spots and active regions for the periods of cooperative observations are discussed.

1. Introduction

In 1987 and 1987 during 9 September nights we carried out photometrical, spectral and radio monitoring for the red flaring dwarf EV Lac. The stellar photometry has been fulfilled at the 125cm telescope in the Crimea, at the 60cm telescope in Rozhen and at the 91cm telescope in Catania. Spectral and radio monitorings have been carried out in the Crimea at the Shajn 2.6m reflector in Nauchny and at the 22m radio telescope in Simeiz.

2. Flare photometry

The most complete photometrical data have been obtained at the 125cm telescope with Piirola's (1984) UBVRI photometer-polarimeter and Fig 1 presents the EV Lac light curves in the U band registered with this equipment; these curves yeild a rather certain image of a general level of flare activity in periods of our observations. The plot shows a significant variety of light curves of the star: there are single fast brightness flashes as well as prolonged - up to 2-3 hours - intervals of an enhanced brightness with a few overlapped flares. Differences in flare activity levels in consecutive nights are well noticeable. Let us remind that the axial rotation period of the star is near to 4 days, therefore in both seasons we observed EV Lac from the all sides, and differences noted mean an essential heterogeneity of different parts of the stellar surface.On the other hand, Fig 1 shows that in 1986 stellar

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flares were in general more frequent and shorter than in 1987.

3. Spot photometry

During observations at the 125cm telescope, we alternated 30-40 minute monitoring of the EV Lac brightness with 1-2 minute measurements of the brightness of the comparison star SAO 52337 (K2). Having omitted the EV Lac brightness estimations affected by close flares, we found gradual variations of the stellar brightness with small amplitudes that are caused by a spottedness of EV Lac. In Fig.2 brightness differences $\Delta V = V(EV\ Lac) - V(SAO)$ are confronted to the phase of the periods $Min = 2444435^d.447 + 4^d.379E$, that was obtained by Rojzman (1984) and coincides practically with one obtained earlier by Pettersen et al (1983). The plot shows that

i) in 1986 the periodic brightness variations with the amplitude $\Delta V = 0^m.15$ took place that is in agreement with the results by Kleinman et al.(1987), but in 1987 an amplitude of such oscillations decreased to $0^m.07$;

ii) in 1986 and 1987 phases of the EV Lac periodic brightness variations differed by about half a period and none of them coincided with the phase in 1980-81;

iii) in 1986 the EV Lac maximum brightness was at least by $0^m.055$ higher as compared with one in 1987, and the 1986 minimum brightness was about $0^m.025$ lower as compared with one in 1987; it means that the decrease of the brightness oscillation amplitude in 1987 is due mainly to more uniform distribution of spots over the stellar surface but not to a decrease of a total area of spots.

4. Spectral study

A spectral monitoring for EV Lac was carried out with the CCD matrix of the Helsinki University (Poutanen,1987): in the coude focus of the Shajn reflector we registered the stellar spectrum in the Hα region.During 9 nights we have obtained 143 spectrograms with expositions from 12 to 30 min. In Fig 3 the mean spectra of quiescent EV Lac for each night are given, they were obtained by summarizing all the spectra registered out of flares. The plot shows significant variations of mean Hα profiles from night to night, and given phases correspond to the stellar spottedness degree according to Fig 2. We have found no correlation between nightly mean equivalent widths of the Hα emission line and sums of equivalent durations of flares for each night. It means that measured values W(Hα) out of flares give a total intensity of the stellar active regions but are not due to an afterglow effect of strong flares in the line. However, it is seen in Fig 3, that 13 and 14.9.86 the Hα intensity was noticeably lower as compared to previous nights, and it is naturally to suggest that in noted two nights EV Lac faced the Earth with the least active side possessing a low brightness chromosphere. The stellar spottedness phases in Fig 3 are in agreement with such a suggestion. But in 1987 such simple correlation was not seen.

Spectral monitoring for EV Lac was carried out at the 2m reflector in Rozhen too.

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5. Radio data

Radio monitoring for EV Lac was carried out at 37 GHz. More than a hundred measurements with a 2.5min integration time were fulfilled, but no significant differences are found between the powerful flare on 11.9.86 19^h18^mUT and rather quiet states of the star.

6. Conclusion

Thus, our photometric and spectral observations suggest that in two consecutive seasons the general picture of the EV Lac surface activity was noticeably different. Such qualitative difference may be due to different characteristic distances between stellar spots, since according to Gershberg et al.(1987), with respect to such distances one may expect the appearance in a star the MHD disturbances of different kinds which correspond to stellar flares of different energy deposits and durations.

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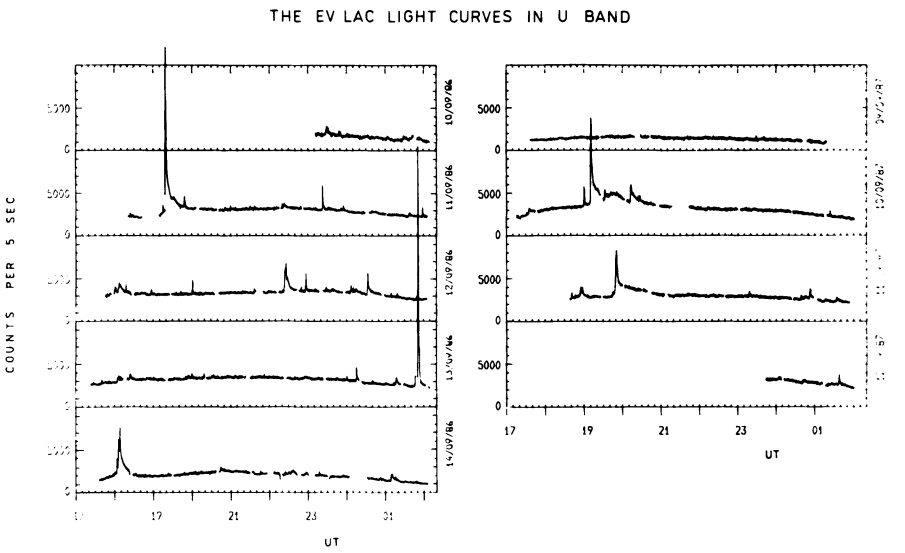

Fig. 1. The EV Lac light curves in the U band.

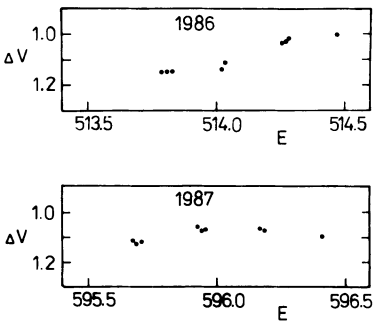

Fig. 2. Small amplitude variations of the EV Lac brightness due to stellar spots.

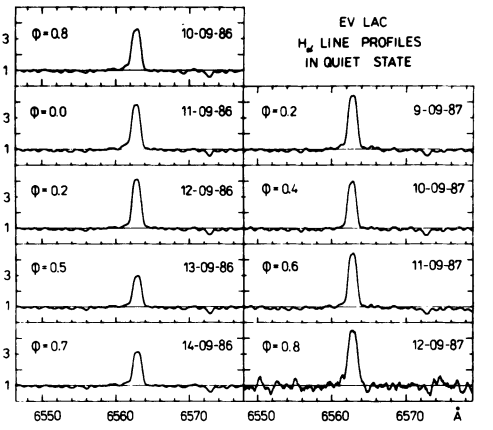

Fig.3. The nigthly averaged Hα line profiles in a quiet state of the star.

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PETTERSEN: The flare time scale of the H-alpha emission line is much longer than e.g. in the U-filter (continuum). Identifying quiet intervals in the H-alpha studies from U-filter monitoring may therefore be risky. Sometimes H-alpha never reaches "quiet level" during nights of active flaring.

GERSHBERG: We had long duration exposures - up to 30 minutes, therefore this effect was weakened on the selected CCD-spectra.

MIRZOYAN: What was the correlation between the behavior of EV Lac in optical and radio wavelengths during your synchronuous observations?

GERSHBERG: We have no detection of radio flares during very strong optical flare.

BENZ: Have you observed a radio flare at 8 mm? How long was your observing time and what was the sensitivity? I have observed UV Ceti for 6 hours with the Very Large Array at 1.3 cm but not seen a flare.

GERSHBERG: We did not detect radio flares during the powerful optical one. The radio coverage was about 1 hour and the noise was several tens of milliJansky.

LANG: The radiation mechanism at radio and optical wavelengths may be very different, so you might not expect to see flares simultaneously at these two regions of the electromagnetic spectrum.

GERSHBERG: I completely agree.

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