

COMMISSION 27 OF THE I. A. U.  
INFORMATION BULLETIN ON VARIABLE STARS  
NUMBER 851

Konkoly Observatory  
Budapest  
1973 December 4

PULSE-COUNTING OBSERVATIONS OF EV LAC  
DURING THE 1973 INTERNATIONAL PATROL

The flare star EV Lac was monitored on 5 nights at the 36-inch reflector of the Royal Greenwich Observatory during the period 22 August to 4 September 1973 proposed by the I.A.U. Working Group on UV Ceti-type stars (Ref.1). One major flare was observed in the ultraviolet and a number of other events suspected from a preliminary examination of the data. Details of coverage and some remarks on dual-channel pulse-counting techniques are presented.

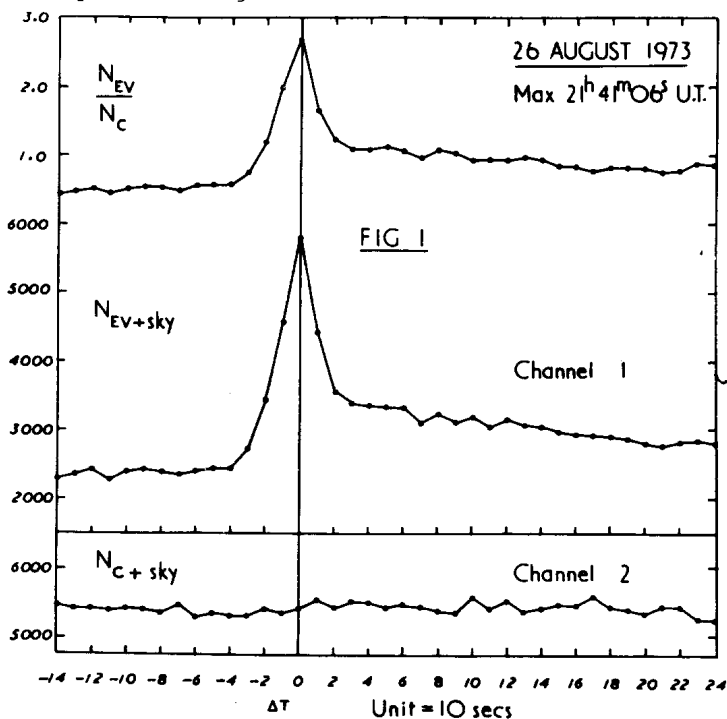
The Two-Star Photometer and Auxiliary Equipment. Instrumentation consisted of a two-star photometer developed by Dr. Bingham at the R.G.O. incorporating two uncooled E.M.I. 6256A photomultipliers in conjunction with a Brookdeal 5C1 photon-counting system capable of handling two 100 MHz pulse trains with integration times of one second. Output was in the form of a print-out of the simultaneous pulse-counts in the two channels through a data logger.

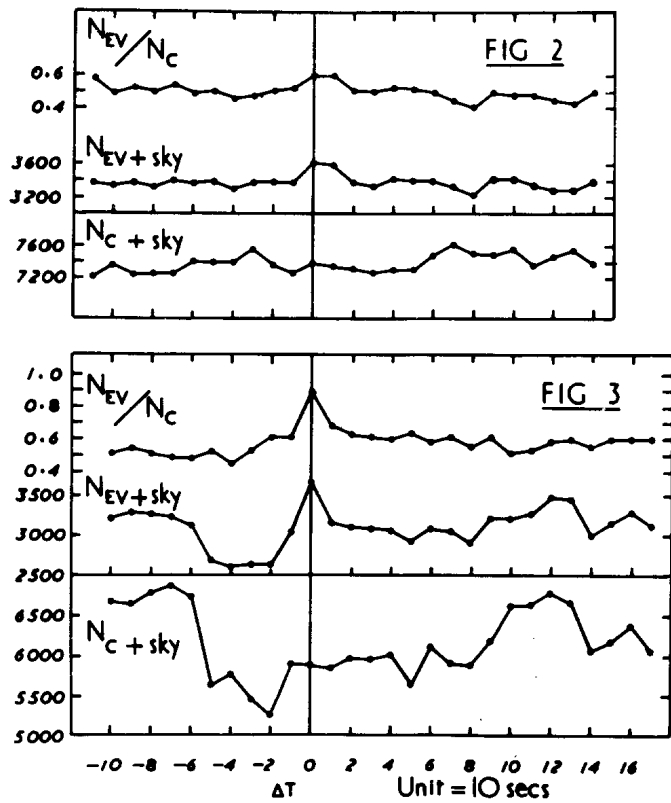
The single-photon peak was adjusted with the use of an oscilloscope following the manufacturer's instructions, with pulse discrimination set to reject the asymptotic contribution of small amplitude pulses (the dark current "grass") and the large amplitude pulses ("spikes"). The selected threshold voltages for the two tubes differed considerably, the comparison-star channel being somewhat noisier, and consequently the threshold of the latter was raised such that the noise count-rates were similar. The same pulse discriminator windows were used, however, and all settings maintained throughout the observations. A number of tests were performed on standard stars each night to assess the reliability of the equipment.

Observational Procedure. Continuous monitoring in the auto-repeat mode was performed with a 10-second time-cycle for EV Lac and a comparison star, BD +43°4310 (Sp.KO), which gave satisfactory count rates in the ultraviolet at about 12th magnitude. The signal-to-noise count-ratio was approximately 10. A 3mm diaphragm (45 arcsecs) was necessary for the permanent inclusion of the faint optical companion to EV Lac

(approx. 10 arcsecs west) over reasonable lengths of time ( $\frac{1}{2}$  to 1 hour). This entailed accepting rather low signal-to-sky count-ratios of 2 to 3. Utilization of +43°43'10 as a comparison star at an angular separation of 25 arcmins was dictated by the mechanical configuration of the two-star photometer and the matching of magnitude and colour.

The flare star and comparison star were set in Channels 1 and 2, respectively. The signal channel-controls of the photon counter then gave a rapid numeric display of Ch.1 and Ch.2 followed by a 10-second display of Ch.1 maintained until the next counting cycle was completed. This allowed large flares to be readily noticeable to the observer and the unintentional interruption, e.g. by sky measurements etc., to be avoided. Dome adjustment and hand-set, both causing interference in the pulse counts with the existing equipment, were generally made at the same time so little time was actually lost, and the print-out always marked accordingly. Universal time was recorded also at frequent intervals since the time is not directly indicated by the successive 10-second cycles. There is an apparent "loss" amounting to 0.86 seconds per count for the present integration times.





Observing procedure was planned such that ultraviolet monitoring was as complete as possible. The dual channels offered a fair assessment of the sky conditions and in general the U-sky was measured as the mean of three counts 4 or 5 times per night. The nature of long monitoring runs also allows the observer more than average visual assessment of sky conditions, haze and encroaching thin cloud, as well as extraneous lights. In addition to EV Lac, two other stars with photoelectric magnitudes, +43°4303 and +43°4304, in the immediate field were also measured in UBV each night in Channel 1. Assuming linearity of  $\log(N - N_{sky})$  against magnitude, these published magnitudes (Ref.2) appear good to at least  $\pm 0.03$ . This suggests not only that the equipment was functioning adequately but that these two stars might serve as suitable additional standards to those recommended by the I.A.U. Working Group for the investigation of slow, possibly secular variations of other UV Ceti-type stars (Ref.3).

Preliminary Results. About 3000 dual counts were accumulated over 20 hours' telescope time under fair to good sky conditions. A few percent were obtained in the B-band under fair conditions or during late evening twilight. The total coverage of EV Lac was  $9^{\text{h}}18^{\text{m}}$ , as given in Table 1. Times are given to the nearest minute and the parentheses indicate intervals of only fair sky. Only one major flare was detected on 26 August at  $21^{\text{h}}41^{\text{m}}06^{\text{s}}$  U.T. It showed an amplitude of  $1^{\text{m}}.8$  in U, and the decline was followed for 5 minutes after which a malfunction occurred in the data logger, but EV Lac had returned to its quiescent brightness 23 mins later when the fault was rectified. After subtraction of the close companion star's constant contribution ( $U=12.95$  from Ref.2) the flare amplitude is  $2^{\text{m}}.5$ . In Fig.1 the pulse counts are shown for each channel,  $N_{\text{C+sky}}$  and  $N_{\text{EV+sky}}$ , and the ratio,  $N_{\text{EV}}/N_{\text{C}}$  less sky, is plotted at 10-second intervals about maximum.

Table 1

Date 1973	Coverage (U.T.)	Filter
Aug.24	2053-2149	B
	2149-57,2159-2203,2206-09,2210-31,2236-2301,2307-37	U
25	2125-27,2141-56,2158-2209,2210-13,2217-19,2253-55,2303-05, 2309-31,2332-51,2352-2400	U
26	0000-07,0008-27,0028-30,0038-0104,0108-17,0120-22,2102-25, 2129-46,2210-19,2238-40,2300-02,2311-29,2332-2400	U
27	0000-07	U
30	2034-40,2041-43,2044-2107, (2110-22), 2134-37,2153-2203, 2204-13, (2214-27) (2230-35)	U
31	(2217-19,2229-32,2237-39,2241-49),2314-20,2351-2400	B
Sept.1	0000-01	B
	0001-34,0058-59,0100-05,0110-11,0115-20,0122-27,0131-56, 0157-0222	U
	Total Coverage $9^{\text{h}}18^{\text{m}}$ over 5 nights	

Further Discussion. From a plot of all the dual-count data a number of minor flares were suspected at the 3-sigma level but it is necessary to exercise caution in the acceptance of these events. A prime consideration was that under stable sky conditions an event is detectable in the EV Lac channel only. A few such "events" are illustrated in Figs. 2,4,5 and 6. The two-star photometer does not compensate for changes in sky brightness which is important in the present instance where the sky contributes a sizable fraction of the total signal. However, an event not immediately credible from the raw data is shown in Fig.3, an event of amplitude  $0^{\text{m}}.6$  in U, which appears to be at least as acceptable as the best of the other suspected events in the  $N_{\text{EV}}/N_{\text{C}}$  plot. The details relating to the Figures are given in Table 2.

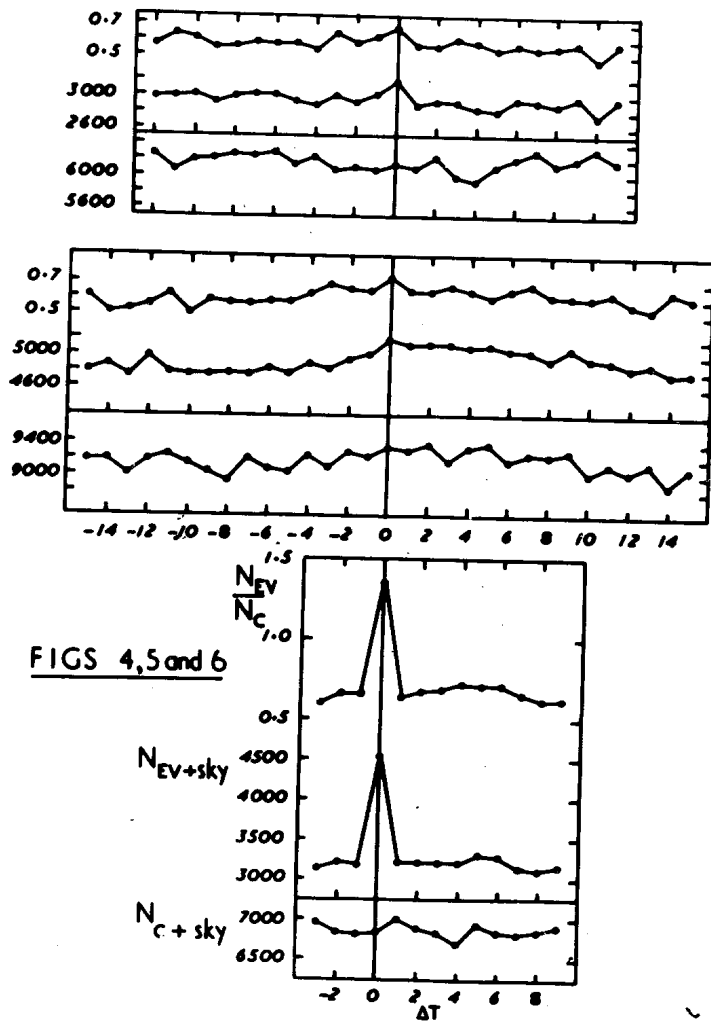


Table 2

Date	U.T.	Max.	Remarks	Fig.
1973				
Aug. 25	22 <sup>h</sup> 03 <sup>m</sup> 00 <sup>s</sup>		Doubtful	5
25	23 38 20		Doubtful	4
26	21 41 00		Amp. 1. <sup>m</sup> 8	1
30	20 36 30		Amp. 0. <sup>m</sup> 2	2
30	22 23 30		Amp. 0. <sup>m</sup> 6	3
Sept. 1	01 31 30		Amp. 0. <sup>m</sup> 75	6

Another aspect of the two-star photometer to consider is the effect of cloud structure which introduces phase from one channel to the

other, but this does not appear to be a major effect when using 10-second counting cycles at the angular separation employed here. The present preliminary results from the total data does not indicate that night-to-night intensity variations occur in EV Lac in the ultraviolet. For example, from 16 compounded means from four nights, we find:

$$\Delta U (EV - BD +43^{\circ}4310) = 0^m.71 + \text{const } \pm 0^m.06$$

which is the magnitude difference between the two channels derived with nightly interpolated values for the sky pulse-counts. Furthermore, from Channel 1 alone, we find:

$$\Delta (B - V) (BD +43^{\circ}4303 - EV) = 0^m.029 + \text{const } \pm 0^m.033$$

$$\Delta (U - B) (\text{ditto}) = 0^m.712 + \text{const } \pm 0^m.021$$

from four nights' observations. No significant variations in colour were found.

Acknowledgements. It is a pleasure to acknowledge the generous cooperation and invaluable assistance of Dr.R.G.Bingham and Dr.D.H.P. Jones in the setting up of the equipment. I should especially like to express my thanks to the Director, Prof.E.M.Burbidge, and the staff of the Royal Greenwich Observatory for the enthusiastic hospitality which I received. Not least, my thanks extend to the Science Research Council for financial support of this project.

A.D. ANDREWS  
 Armagh Observatory,  
 Armagh.  
 N.Ireland.

References:

- 1) Chugainov, P.F., 1972. I.B.V.S. No.744.
- 2) Andrews, A.D., and Chugainov, P.F., 1969. I.B.V.S. No.370.
- 3) Andrews, A.D., Chugainov, P.F., Gershberg, R.E. and Oskanian, V.S., 1969, I.B.V.S. No.326.