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FLARE ACTIVITY OF DO CEPHEI

DO Cep (Krüger 60 B, BD +56°2783 B) was monitored photoelectrically in the ultraviolet for a total of 27.8 actual observing hours, as shown in Fig.1. Ten short-duration increases in brightness were recorded; however, this activity was not uniformly distributed since five of these brightenings occurred within a four-hour period on September 15,1968. Light curves of the ten events exhibited shapes characteristic of the photoelectrically observed variability of the better-studied UV Ceti-type stars.

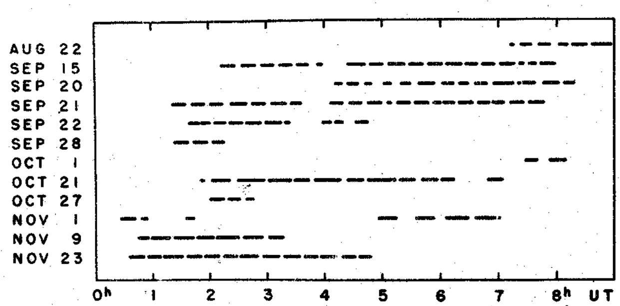

Fig.1. Photoelectric coverage of DO Cep during 1968.

The observations were made with the 24-inch Cassegrain at Mt. Cuba Observatory using an EMI 6256S photomultiplier,a Corning 7-54 (standard U) filter, and a quartz Fabry lens. In the photometer diaphragm it is impossible to separate DO Cep from the more luminous Krüger 60 A. Thus, the photoelectrically recorded flares represent increases over the combined brightness of both components of this binary system. Presumably,it is the fainter star exhibiting these latest flares since it was unambiguously the fainter star which brightened on the 1939 flare-discovery plate (1).

Table I summarizes the observed events. The change in the system's brightness from its quiescent level is expressed in magnitudes by

$$\Delta m_{systen} = 2.5 \log \frac{S}{Q},$$

where S = measured deflection on the chart record

Q = interpolated quiescent deflection.

If Kruger 60 A is 1.81 magnitudes brighter in U than DO Cep, then the magnitude change in DO Cep alone is

$$\Delta m_{DO\ Cep} = 2.5 \log \left(\frac{S}{Q} - 0.841\right) + 2.00.$$

Because of the background noise, an increase in the system's brightness averaging 0.10 magnitude over a 0.3-minute interval would not usually be tabulated as real. No.1 in Table 1 is such a borderline case. No.8 is so short as to raise the question of its being spurious, although this spike stood three times higher than the largest peaks considered to be noise. On the other hand, the elevated signal around Nos.2 and 5 seems real enough but changes to slowly to meet some definitions of a flare. Activity around No.5 may have a total duration of twice that tabulated and may include more than one event. Outside of the identified brightenings, slower variations having an amplitude less than 0.2 magnitude were observed with respect to the comparison star (BD +56°2777). However, neither Krüger 60 A nor the comparison star were established as nonvariable.

Statistics regarding flare frequency should take into consideration the fact that an event as short as No.8 would only have been detected within the actual monitoring time of 27.8 hours; whereas, the effective observing time during which a flare such as No.10 would have been detected is better estimated as 36 hours, because its duration was long compared with the interruptions to measure sky and the comparison star.

Table 1

No.	U.T. of Max. Date 1968	Time	Δm_{system} Ultra-Violet	Rise Time (min.)	Total duration (min.)
1	Sep 15	$2^h17^m.8$	0.17:	0.21	0.7*
2	Sep 15	3 35.6:	0.13	1.2-2.4*	4.0-5.2
3	Sep 15	4 34.2	0.26	0.52	2.0
4	Sep 15	5 15.2	0.33	0.40	3.1
5	Sep 15	6 15.2	0.21	1.3*	3.5
6	Sep 20	5 25.7	0.20	0.3	0.6
7	Sep 20	5 26.1	0.73	0.22	3.5
8	Oct 21	2 31.5	0.45	0.05	0.16*
9	Oct 21	5 52.2	1.28	0.29	10-16
10	Oct 27	2 21.1	2.11	0.67	18 ?
	"	2 21.6	1.20		
	"	2 22.1	0.76		
	"	2 23.1	0.46	Decay curve of flare No.10.	
	"	2 24.1	0.37		
	"	2 25.1	0.28		
	"	2 26.1	0.22		
	"	2 27.1	0.21		

* Reality of flare less certain.

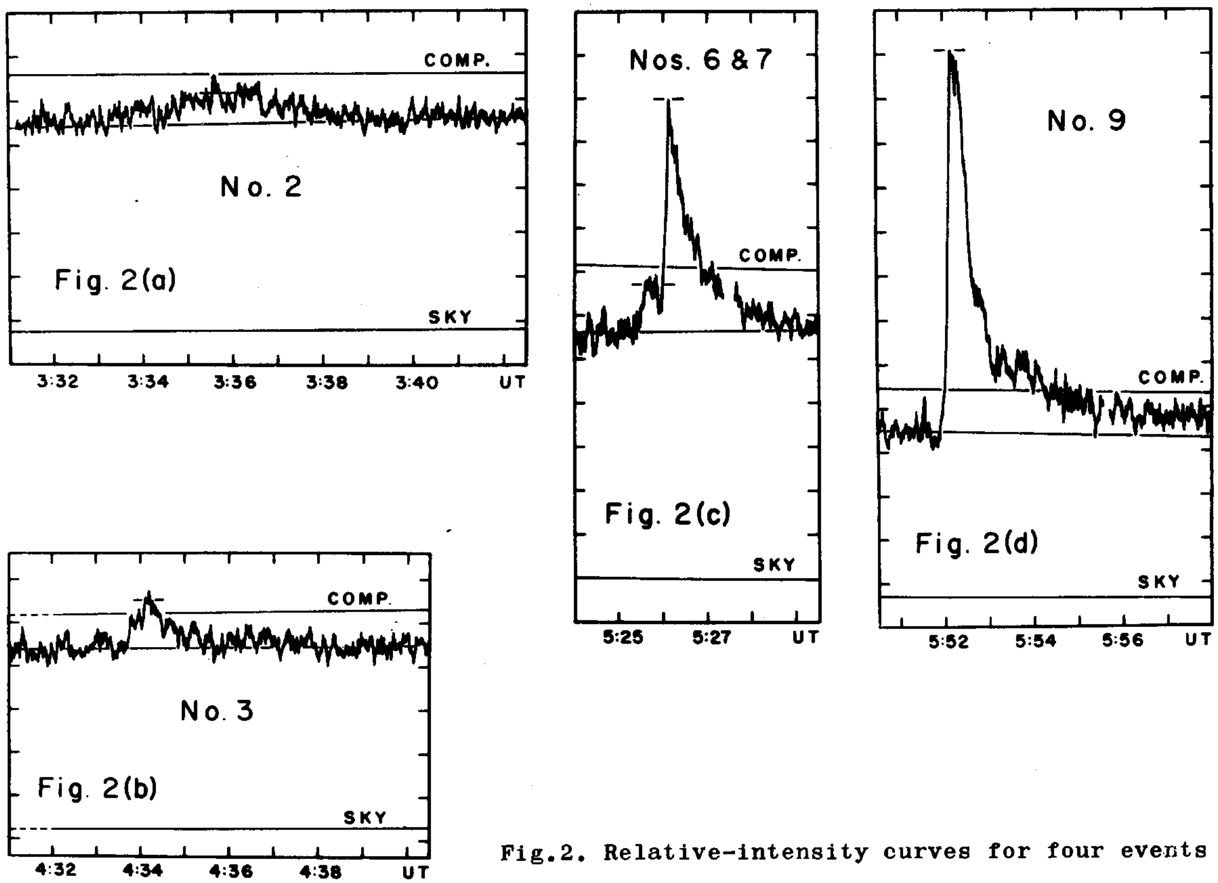

Fig.2. Relative-intensity curves for four events

Tracings from the chart recorder are reproduced in Fig.2 to illustrate in detail some of the light curves. Interpolation lines represent levels for Krüger 60 AB at quiescence, for the comparison star, and for the background sky. The minor flare in Fig.2(b) rises more rapidly than it falls but has no sharply peaked maximum. The more gradual and symmetric rise and fall in Fig.2(a) has even less suggestion of a fast flare component. Fig.2(d) shows a rapid rise and a return that bears some similarity to the stepwise decay of the December 13, 1958 flare of YZ CMi observed by Roques (2). A seeming drop of 0.11 magnitude at 6:08 UT from a final elevated plateau to the quiescence level would be convincing were it not for the definite interference of clouds 15 minutes later. In Fig.2(c) the peak is sharper and immediately followed by a more continuous decline. A notable brightening is seen just preceding this event and has been tabulated as a separate flare. The largest flare (No. 10) required amplifier gain changes and is not reproduced here. Values in Table 1 illustrate its sudden increase and relatively smooth decline. Clouds which appeared 11 minutes after the peak prevented following this flare back to quiescence.

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1) P.van de Kamp and S.L.Lippincott, P.A.S.P.Vol.63, p.141, 1951.

2) P.E.Roques, Ap.J. Vol.133, p.914, 1961.