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OBSERVATIONS OF FLARE STARS

a) YZ Canis Minoris, b) AD Leo, c) BD +13°2618 Virginis

A few unpublished results from 1966-67 of flare star monitoring and mean colour and magnitude photometry are presented. The material was obtained at the Boyden Observatory with the 16-inch Harvard Nishimura and 60-inch reflectors using equipment previously described (Refs. 1 and 2).

In February 1967 photoelectric monitoring of YZ CMi was undertaken by E. Schöffel (Bamberg) as part of the joint optical-radio programme. Results were communicated privately to the radio astronomers at that time. One major flare of more than 2 magnitudes (blue) was well observed at the 16-inch during 23 hours monitoring over 5 nights, and two suspected flares were recorded. The material has been re-examined for small flares occurring during stable sky conditions, and the 3-sigma rule applied together with an arbitrary 'minimum duration' test to aid in the weighting of the observations. Flares accepted on the basis of the 3-sigma rule were judged as possible or doubtful depending on whether the duration was greater or less than 2 minutes. Standard deviations were derived from several 2-minute samples near the flares, where the data points were averages over 12-second tracings. The time constant (half final-deflection) for the tracings was 0.9 second. For the 16-inch continuous-monitoring observations of YZ CMi ( $B = 12^m 88$ ), a typical detection threshold for blue flares is at apparent magnitude 15.4 (for flare alone). An excellent discussion of the detection problem applied to the statistics of flare activity is given by W. Kunkel (Ref. 3). Schöffel's hours of coverage and some details of flares are summarized in Tables 1 and 2, and light curves shown in the Figure.

Table 1  
Monitoring of YZ CMi  
Coverage U.T.

1967 Feb. 2	(2109-2258)
3	1859-2132, 2136-50, 2152-2255, 2257-2304, (2304-2400).
4	(0000-55), 0057-0158, 1849-0104.
6	1854-2009, 2014-21.
13	1814-2000, 2003-06, 2009-2400.
14	0000-35, 0045-0100.
Total Coverage 22 <sup>h</sup> 45 <sup>m</sup> (parenthesis indicate poor sky conditions)	

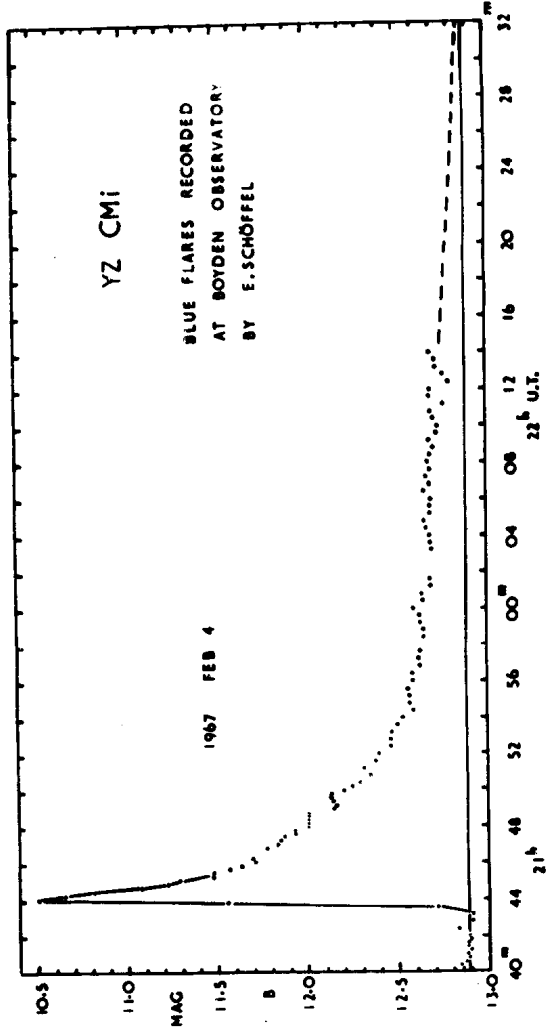
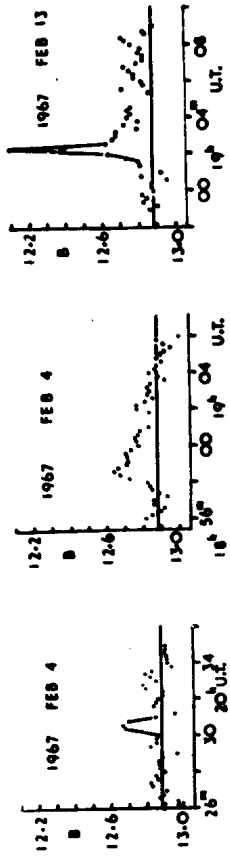


Table 2

## Flares of YZ CMi

1967	U.T. of max.	Blue Ampl.	Duration ≥3 (mins)	$\sigma$	Rise Rate mag/sec	Remarks
Feb.4	18 <sup>h</sup> 58 <sup>m</sup> .6	0 <sup>m</sup> .24	3	+0 <sup>m</sup> .035	0.005	Possible
4	20 30.6	0.21	1	+0.048	0.006	Doubtful
4	22 44.0	2.38	40	+0.017	0.092	Definite
13	19 02.3	0.76	2 ?	+0.044	0.022	Definite

The flare star, AD Leo, and the suspected flare star, BD +13°2618 (Ref.4), were fragmentarily monitored in 1966 by W.Pretorius (Boyden) and myself. No flares were detected. Coverage is given in Tables 3 and 4, but this material is heterogeneous in that several filters (standard U, B and V) were used for monitoring. Detection thresholds in blue were at 14<sup>m</sup>8 and 14<sup>m</sup>6, for the two stars, respectively.

Table 3  
Monitoring of AD Leo  
Coverage U.T.

1966	Jan.24	1954-2027.
	Feb.16	2144-53, 2155-56, 2202-32, 2236-2400.
	17	0000-15
	May 8	1933-38, 1941-43, 1958-2000, 2002-13, 2037-42, 2045-52.
Total Coverage		3 <sup>h</sup> 24 <sup>m</sup>

Table 4  
Monitoring of BD +13°2618  
Coverage U.T.

1966	Feb.17	0118-24, 0129-0235.
Total Coverage		1 <sup>h</sup> 12 <sup>m</sup>

The photometric data for the three stars in Table 5 is in the standard UBV system of Johnson et al. (Ref.5). The 60-inch observations were made during the programme mentioned in Ref.2, and the standard errors for AD Leo and its companion at 1:7 NE, in V, V-R, B-V and U-B are +0<sup>m</sup>01, +0<sup>m</sup>2, +0<sup>m</sup>3 and +0<sup>m</sup>4, respectively. The 16-inch observations of BD +13°2618 are less accurate, being made by comparison with AD Leo. Mean extinction coefficients were used at air masses of 1.35 and 1.55 for the two stars, respectively, and the small differential colour terms neglected. Except for the red band, results for AD Leo have been published pre-

viously by Johnson and Morgan (Ref. 6) and Engelkemeir (Ref.7). Agreement is satisfactory save in the V magnitude. We note that AD Leo is an unresolved astrometric binary (Ref.7), and that small variations in magnitude have been suspected by several workers.

Table 5,  
Photometric Results

Star	J.D. -2439000	V	V-R	B-V	U-B	Instrument
AD Leo	486. <sup>d</sup> 551	9. <sup>m</sup> 38	1. <sup>m</sup> 63	1.52	1.03	60-inch
Comp.to AD	486.558	10.71	0.98	1.05	0.98	60-inch
BD+13°2618	173.429	9.56		1.54	1.20	16-inch

Armagh Observatory  
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A.D.ANDREWS

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