COMMISSION 27 OF THE I. A. U.
INFORMATION BULLETIN ON VARIABLE STARS
Number 1486

Konkoly Observatory
Budapest
1978 October 17

PHOTOELECTRIC OBSERVATIONS OF THE FLARE STAR AD Leo IN 1974

Continuous photoelectric monitoring of the flare star AD Leo has been carried out at the Stephanion Observatory (λ=-22°49'44", φ=+37°45'15") during the year 1974 using the 30-inch Cassegrain reflector of the Department of Geodetic Astronomy, University of Thessaloniki. Observations have been made with a Johnson dual channel photoelectric photometer in the B colour of the international UBV system. The telescope and photometer will be described elsewhere. Here we mention only that the transformation of our instrumental ubv system to the international UBV system is given by the following equations:

for the time interval from 16-1-1974 to 9-4-1974

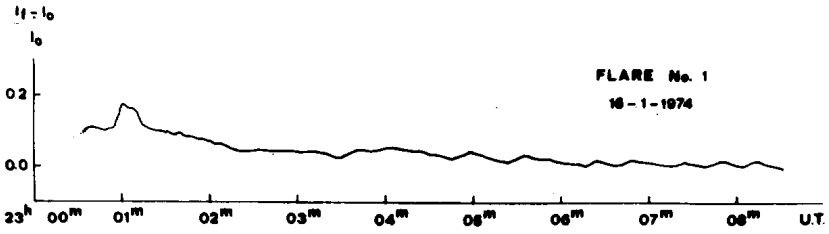
$$V = v_o + 0.030\ (b-v)o + 1.756,$$
$$B-V = 0.845 + 1.042\ (b-v)o,$$
$$U-B = -1.778 + 1.102\ (u-b)o,$$

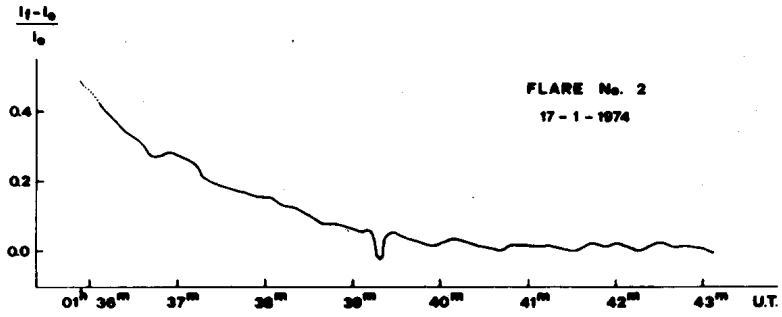
and from the time interval from 17-4-1974 to 26-5-1974

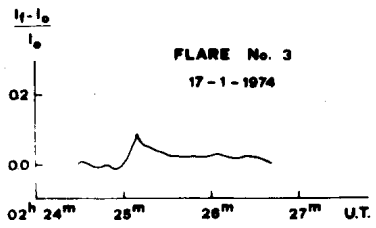
$$V = v_o - 0.011(b-v)o + 2.445,$$
$$B-V = 0.848 + 0.992(b-v)o,$$
$$U-B = -1.632 + 0.999(u-b)o.$$

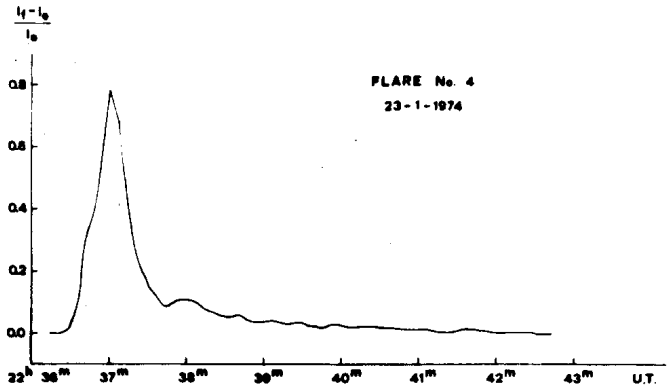
The monitoring intervals in UT as well as the total monitoring time for each night are given in the Table I. Any interruption of more than one minute has been noted. In the fourth column of Table I the standard deviation of random noise fluctuation σ(mag) = $= 2.5 \log(I_o+\sigma)/I_o$ for different times (UT) of the corresponding monitoring interval is given.

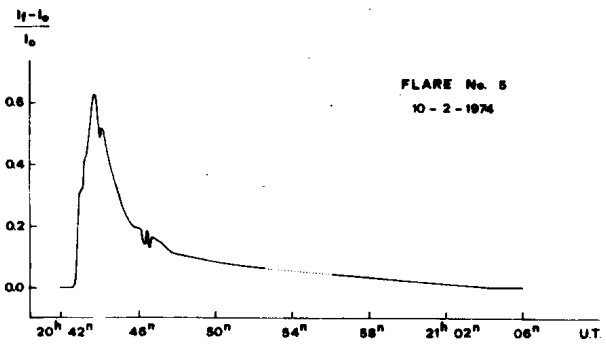
During the 40.85 hours of monitoring time 8 flares were observed the characteristics of which are given in Table II. For each flare following characteristics (Andrews et al., 1969) are given: a) the date and universal time of flare maximum, b) the duration before and after the maximum (t_b and t_a, respectively), as well as the total duration of the flare, c) the value of the ratio $(I_f-I_o)/I_o$ corresponding to flare maximum, where I_o is the intensity deflection

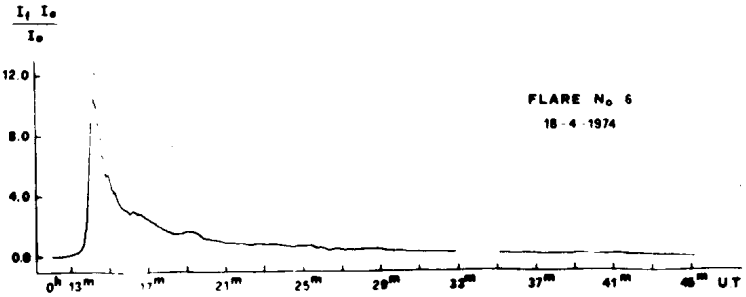

$\frac{I_f - I_o}{I_o}$
FLARE No. 1
16 - 1 - 1974
0.2
0.0
23h 00m 01m 02m 03m 04m 05m 06m 07m 08m U.T.

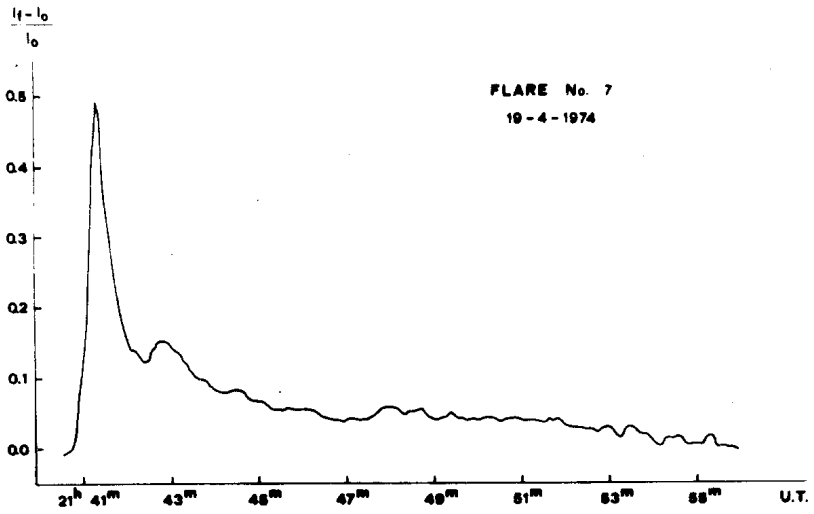

$\frac{I_f - I_o}{I_o}$
FLARE No. 2
17 - 1 - 1974
0.4
0.2
0.0
01h 36m 37m 38m 39m 40m 41m 42m 43m U.T.

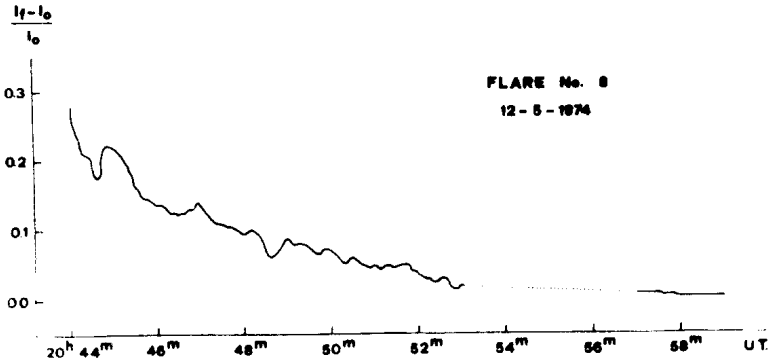

$\frac{I_f - I_o}{I_o}$
FLARE No. 3
17 - 1 - 1974
0.2
0.0
02h 24m 25m 26m 27m U.T.


$\frac{I_f - I_o}{I_o}$
0.8
0.6
0.4
0.2
0.0
FLARE No. 4
23-1-1974
22h 36m 37m 38m 39m 40m 41m 42m 43m U.T.


$\frac{I_f - I_o}{I_o}$
0.6
0.4
0.2
0.0
FLARE No. 5
10-2-1974
20h 42m 46m 50m 54m 58m 21h 02m 06m U.T.


$\frac{I_f\ I_o}{I_o}$
12.0
8.0
4.0
0.0
FLARE No 6
18-4-1974
0h 13m 17m 21m 25m 29m 33m 37m 41m 45m U.T.


$\frac{I_f - I_o}{I_o}$
FLARE No. 7
19 - 4 - 1974
0.5
0.4
0.3
0.2
0.1
0.0
21h 41m
43m
45m
47m
49m
51m
53m
55m
U.T.


$\frac{I_f - I_o}{I_o}$
FLARE No. 8
12 - 5 - 1974
0.3
0.2
0.1
00
20h 44m
46m
48m
50m
52m
54m
56m
58m
U.T.

F l a r e S t a r AD Leo,

T a b l e I

Date	Monitoring intervals (U.T.)	Total Monitoring Time	$\mathcal{E}$(U.T.)
1974			
January			
16	$23^h00^m.64$ -23^h09^m, 23^h14^m-23^h23^m,		0.01(23^h33^m)
	23 25 -23 36 , 23 39 -24 00 ,	$00^h49^m.36$	
17	00 00 -00 09.40, 00 12.05 -00 17 ,		0.01(00^h07^m), 0.01(00^h38^m),
	00 24 -00 41 , 01 36 -02 01 ,		0.01(01^h58^m), 0.02(02^h17^m),
	02 03 -02 15 , 02 17 -02 30 ,		0.01(02^h47^m), 0.02(03^h21^m),
	02 34 -03 06 , 03 08 -03 14 ,		0.02(03^h58^m), 0.02(23^h16^m),
	03 21 -04 01 , 22 53 -23 18 ,		0.02(23^h47^m).
	23 22 -23 33 , 23 37 -24 00 .	$3^h37^m.9$	
18	00 00 -00 08 , 00 13 -00 19 ,		0.01(00^h31^m), 0.01(01^h29^m),
	00 22 -00 38 , 01 25 -01 45 ,		0.02(02^h00^m), 0.01(02^h40^m).
	01 49 -02 15 , 02 18 -02 47 .	1^h45^m	
20	22 14 -22 47 , 22 51 -23 11 .	53^m	0.02(22^h16^m), 0.02(22^h53^m).
23	22 29 -22 51 , 22 54 -22 58 ,		0.01(22^h34^m), 0.02(23^h07^m),
	23 04 -23 26 , 23 33 -23 50 .	1^h05^m	0.01(23^h45^m).
February			
10	20 25 -20 53 , 20 56 -21 22 ,		0.01(20^h39^m), 0.01(21^h09^m),
	21 27 -21 50 , 22 00 -22 34 ,		0.02(21^h41^m), 0.01(22^h15^m),
	22 41 -23 11 , 23 15 -23 38 .	2^h44^m	0.01(23^h01^m), 0.01(23^h29^m).
11	00 38 -01 05 , 01 10 -01 37 ,		0.01(00^h58^m), 0.02(01^h28^m),
	01 41 -02 18 .	1^h31^m	0.02(02^h00^m).
April			
3	22 05 -22 33 , 22 39 -23 03 ,		0.11(22^h28^m), 0.12(22^h43^m),
	23 07 -23 37 .	1^h22^m	0.15(23^h13^m).
7	19 30 -19 59 , 20 03 -20 30 ,		0.03(19^h38^m), 0.04(20^h12^m),
	20 33 -21 02 , 21 22 -21 47 ,		0.04(20^h58^m), 0.04(21^h44^m),
	21 51 -22 23 , 22 28 -22 59 .	2^h53^m	0.05(22^h17^m), 0.05(22^h56^m).
9	20 15 -20 43 , 20 48 -20 58 ,		0.02(20^h36^m), 0.03(21^h48^m),
	21 29 -22 00 , 22 14 -22 43 ,		0.02(22^h34^m), 0.03(23^h09^m).
	22 46 -22 50 , 22 57 -23 14 .	1^h59^m	
17	22 20 -22 51 , 23 22 -23 51 ,		0.01(22^h35^m), 0.01(23^h27^m).
	23 54 -24 00 .	$1^h 6^m$	

Table I (Continued)

I8	00^h00^m-00^h46^m.	46^m	0.02(00^h11^m).
I9	20 30 -20 59 ,2I 03 -2I 30 ,		0.0I(20^h47^m),0.0I($2I^h14^m$),
	2I 34 -2I 59 ,22 I3 -22 45 ,		0.0I($2I^h39^m$),0.0I(22^h28^m),
	22 49 -23 25 ,23 28 -24 00 ,	3^h0I^m	0.0I(23^h02^m),0.02(23^h44^m).
20	00 00 -00 02 .	2^m	
23	20 30 -20 58 ,2I 0I -2I 3I ,		0.0I(20^h34^m),0.0I($2I^h18^m$),
	2I 34 -22 03 ,22 I8 -22 50 ,		0.0I($2I^h48^m$),0.0I(22^h38^m),
	22 53 -23 I9 .	2^h25^m	0.0I(23^h04^m).
May			
7	2I 22 -2I 3I ,2I 32 -2I 45 ,		0.02($2I^h35^m$),0.02(22^h05^m),
	2I 5I -22 00 ,22 0I -22 I4 ,		0.03(22^h36^m).
	22 30 -22 39 ,22 42 -22 5I ,		
	23 07 -23 I6 ,23 I9 -23 26 .	$0I^hI8^m$	
9	I9 47 -I9 54 ,I9 56 -20 02 ,		0.0I(20^h00^m),0.0I(20^h24^m),
	20 05 -20 I3 ,20 I8 -20 30 ,		0.02($2I^h4I^m$),0.02(22^hI6^m).
	2I 39 -2I 49 ,2I 53 -22 02 ,		
	22 II -22 20 .	$0I^h0I^m$	
I0	20 09 -20 I8 ,20 20 -20 27 ,		0.0I(20^h25^m).
	20 29 -20 36 ,	23^m	
II	I9 I9 -I9 25 ,I9 27 -I9 33 ,		0.0I($I9^h30^m$),0.0I(20^h02^m),
	I9 35 -I9 47 ,I9 5I -I9 58 ,		0.0I(20^h56^m),0.0I($2I^h40^m$),
	I9 59 -20 06 ,20 08 -20 I8 ,		0.02(22^hI0^m),0.03(22^h40^m).
	20 22 -20 34 ,20 40 -20 48 ,		
	20 53 -2I 04 ,2I 2I -2I 3I ,		
	2I 34 -2I 43 ,2I 46 -2I 55 ,		
	22 00 -22 05 ,22 07 -22 I5 ,		
	22 20 -22 26 ,22 35 -22 43 ,		
	22 46 -22 53 .	02^h2I^m	
I2	20 06 -20 I6 ,20 I9 -20 28 ,		0.0I(20^h22^m),0.02($2I^h06^m$).
	20 29 -20 40 ,20 44 -20 53 ,		
	20 57 -20 59 ,2I 03 -2I I3 ,		
	2I I5 -2I 23 ,2I 26 -2I 37 ,	$0I^hI0^m$	
I3	I9 42 -I9 55 ,I9 56 -20 03 ,		0.0I($I9^h57^m$),0.0I(20^h26^m),
	20 07 -20 I9 ,20 22 -20 34 ,		0.0I(20^h43^m).
	20 39 -20 49 ,20 52 -2I 02 ,		
	2I 03 -2I I4 .	$0I^hI5^m$	

Table I (Continued)

I4	I9 57 -20 05 ,20 I0 -20 I6 ,		0.0I(20^hI3^m),0.02(20^h44^m).
	20 I9 -20 26 ,20 3I -20 40 ,		
	20 43 -20 52 ,20 56 -2I 02 ,	45^m	
I7	I9 53 -20 00 ,20 03 -20 09 ,		0.0I(20^h2I^m),0.0I(20^h38^m),
	20 II -20 I7 ,20 I8 -20 3I ,		0.02($2I^h$I9^m).
	20 35 -20 43 ,20 45 -20 54 ,		
	20 55 -2I 0I ,2I 05 -2I I3 ,		
	2I I5 -2I 22 ,2I 24 -2I 3I .	$0I^h$I7^m	
22	I9 32 -I9 40 ,I9 44 -I9 52 ,		0.0I($I9^h$56^m).
	I9 54 -20 02 ,20 04 -20 I3 .	33^m	
23	I9 37 -I9 44 ,I9 46 -I9 5I ,		0.02($I9^h$49^m),0.02(20^h24^m),
	I9 53 -I9 58 ,20 0I -20 07 ,		0.02(20^h59^m).
	20 I2 -20 I9 ,20 2I -20 29 ,		
	20 3I -20 37 ,20 46 -20 53 ,		
	20 56 -2I 0I ,2I 04 -2I I0 ,		
	2I I4 -2I 22 .	$0I^h$I0^m	
24	I9 43 -I9 5I ,I9 53 -I9 59 ,		0.0I($I9^h$56^m),0.0I(20^h38^m),
	20 02 -20 I2 ,20 I4 -20 22 ,		0.0I($2I^h$08^m).
	20 25 -20 33 ,20 35 -20 43 ,		
	20 45 -20 52 ,20 58 -2I 04 ,		
	2I 06 -2I I5 ,2I I7 -2I 25 ,		
	2I 28 -2I 32 .	$0I^h$22^m	
25	I9 49 -I9 59 ,20 03 -20 I4 ,		0.0I(20^h06^m),0.02(20^h46^m),
	20 I7 -20 25 ,20 3I -20 36 ,		0.02($2I^h$22^m).
	20 38 -20 42 ,20 44 -20 49 ,		
	20 5I -20 57 ,2I 02 -2I 06 ,		
	2I I0 -2I I7 ,2I 20 -2I 25 ,		
	2I 3I -2I 36 ,2I 40 -2I 46 .	$0I^h$I6^m	
26	I9 54 -20 05 ,20 07 -20 I5 ,		0.0I(20^h2I^m),0.02(20^h35^m).
	20 I7 -20 27 ,20 30 -20 40 ,		
	20 43 -20 52 ,20 55 -2I 03 ,		
	2I 06 -2I II .	$0I^h$0I^m	
	Total	40^h5I^m	

Flare Star AD Leo, 1974

T a b l e II

Characteristics of the Flares Observed

Flare No.	Date 1974 January	U.T. max.	t_b min.	t_a min.	Duration Min	$(I_f-I_o)/I_o$ max.	P min	Δm mag.	σ mag.	Air mass
1	16	23^h01^m04 ?	0.44 ?	7.52 ?	7.96 ?	0.175 ?	0.352 ?	0.175 ?	0.01	1.373
2	17	01 36.00 ?	-	>7.0	-	>0.4	>0.682	-	0.01	1.058
3	17	2 25.20	0.68	1.52	2.20	0.088	0.072	0.092	0.02	1.104
4	23	22 37.01	0.64	5.52	6.16	0.784	0.619	0.628	0.01	1.168
	February									
5	10	20 43.70	1.20	20.50	21.70	0.630	2.240	0.530	0.01	1.290
	April									
6	18	00 14.14 ?	1.76	30.88	32.64	10.890 ?	29.574	2.688 ?	0.02	2.689
7.	19	21 41.30	0.60	14.56	15.56	0.492	1.025	0.435	0.01	1.300
	May									
8	12	20 44.00 ?	-	-	-	>0.280	>0.915	>0.265	0.01	1.444

less sky background of the quiet star and I_f is the total intensity deflection less sky background of the star plus flare, d) the integrated intensity of the flare over its total duration, including pre-flares, if present, $p = \int(I_f-I_o)/I_o dt$, e) the increase of the apparent magnitude of the star at flare maximum $\Delta m(b)=2.5\log(I_f/I_o)$, where b is the blue magnitude of the star in the instrumental system, f) the standard deviation of random noise fluctuation $\sigma(mag)= 2.5\log(I_o+\sigma)/I_o$ during the quiet - state phase immediately preceding the beginning of the flare and g) the air mass at flare maximum. The light curves of the observed flares in the b colour are shown in Figs. 1-8.

M.E. CONTADAKIS, G. KAREKLIDIS
L.N. MAVRIDIS, D. STAVRIDIS, H. ZERVAKI-ZOEROU
Department of Geodetic Astronomy
University of Thessaloniki

Reference:

Andrews, A.D., Chugainov, P.F., Gershberg, R.E. and Oskanian, V.S.: 1969, I.B.V.S. No. 326