

THE DEPENDENCE OF PHYSICAL PROPERTIES  
OF FLARE-UPS ON THE ABSOLUTE LUMINOSITY  
OF UV CET STARS

G. A. Gurzadyan\*

SUMARIO

Se analizaron más de 900 rafagazos de veinte estrellas ráfaga de la vecindad solar. De ahí se obtuvieron las siguientes conclusiones:

- i) La frecuencia de los rafagazos,  $f$ , es mayor para estrellas de menor luminosidad absoluta. La condición  $f_U > f_B > f_V$  siempre se cumple.
- ii) La amplitud media de los rafagazos es mayor para estrellas menos luminosas.
- iii) La función de distribución de la amplitud de los rafagazos,  $F(\Delta m)$ , es diferente para cada estrella; sin embargo el número relativo de rafagazos de gran amplitud es menor para estrellas de mayor luminosidad absoluta.
- iv) La energía radiada durante el rafagazo,  $E_r$ , es mayor en el caso de estrellas intrínsecamente más luminosas.
- v) El cociente de la energía radiada durante un rafagazo respecto a la energía total de la estrella,  $E_r/E^*$ , aumenta para estrellas de menor luminosidad absoluta.

ABSTRACT

As a result of the analysis of more than 900 recorded flare-ups of flare stars in the solar vicinity it is shown that:

- i) The frequency of flares,  $f$ , increases with decreasing absolute luminosity of the flare stars. For all stars the condition  $f_U > f_B > f_V$  is satisfied.
- ii) The mean flare amplitude is larger for lower absolute luminosities.
- iii) Although the distribution function of flare amplitudes,  $F(\Delta m)$ , varies for each flare star; in general, the relative amount of flare-ups of large amplitudes decreases with increasing absolute luminosity.
- iv) The energy radiated by the star during flare-up,  $E_r$ , is larger for intrinsically brighter stars.
- v) The relative amount of radiative energy released by the star during a flare-up,  $E_r/E^*$ , increases for lower absolute luminosity.

*I. Introduction*

It is important to analyze the dependence of the basic physical properties of the flare-ups (frequency, mean amplitude, equivalent duration and relative and absolute energy) on the absolute luminosity of flare stars.

The present paper is aimed at proving that such a dependence exists for objects of the UV Cet type. To this effect the data of more than 900 recorded flare-ups of about twenty flare stars in the vicinity of the Sun have been used.

*II. Dependence of Flare-Up Frequency on the Absolute Luminosity of the Stars*

A summary of flare-up observations of UV Cet stars is given in Table 1. It includes both photoelectric and photographic measurements; visual data have been excluded from this table. The extensive series of observations by Kunkel (1968 a, b) are rather homogeneous as well as those of Cristaldi and Rodono (1970). Therefore, those observations will have preference in our analysis.

Table 1 contains the star designation, color range, number of recorded flare-ups, total patrol time for each observer and the reference.

The frequency of flares,  $f$ , is obtained from the ratio of the number of flare-ups to the total patrol time for each color. Only four stars —UV Cet, YZ CMi, EV Lac and AD Leo— have data in all three colors and for these objects all three frequencies, namely  $f_U$ ,  $f_B$  and  $f_V$ , were derived; for the rest of the stars, we confined ourselves to the determination of frequency in one or two colors only. Table 2 contains the values of the flare-up frequency for each object and the absolute visual magnitudes of the stars under consideration.

From the data listed in Table 2 it is possible to establish the following two properties:

a) The frequency of flare-up increases with decreasing absolute luminosity. Figure 1 presents the dependence of  $f_U$  on  $M_V$ , based only on Kunkel's data (1968 a, b) for a group of flare stars. A similar curve, based on all the data contained in Table 2, does not differ qualitatively from Figure 1.

---

\* Burakan Astrophysical Observatory, Armenia, U. S. S. R.

TABLE 1  
*Summary of Observations of Flare Stars*

Star	Color	$N_f$	Total patrol time (hours)	Reference	Star	Color	$N_f$	Total patrol time (hours)	Reference
UV Cet	<i>U</i>	256	78	1	AD Leo	<i>V</i>	2	49	9
	<i>U</i>	11	16	2		<i>V</i>	3	34	30
	<i>B</i>	27	38	3		<i>U</i>	35	89	16
	<i>B</i>	3	28	4		<i>U</i>	1	54	3
	<i>B</i>	30	33	5		<i>U</i>	2	28	9
	<i>B</i>	7	20	6		<i>U</i>	21	28	31
	<i>B</i>	18	30	7		<i>B</i>	1	54	9
	<i>B</i>	66	52	8		<i>B</i>	2	28	9
	<i>V</i>	17	108	9		<i>B</i>	5	33	32
	<i>V</i>	17	70	10		<i>B</i>	1	51	9
YZ CMi	<i>V</i>	3	24	11	EV Lac	<i>B</i>	5	13	33
	<i>V</i>	3	87	12		<i>B</i>	9	33	34
	<i>V</i>	6	37	13		<i>B</i>	5	26	35
	<i>V</i>	6	26	14		<i>B</i>	1	19	36
	<i>V</i>	3	24	15		<i>B</i>	10	58	37
	<i>U</i>	28	63	16		<i>B</i>	0	9	38
	<i>U</i>	6	9	17		<i>V</i>	1	13	33
	<i>U</i>	21	39	18		<i>V</i>	2	28	39
	<i>B</i>	6	9	17		<i>V</i>	1	34	40
	<i>B</i>	10	67	19		<i>V</i>	2	37	8
V 1216 Sgr	<i>B</i>	11	48	20	EV Lac	<i>U</i>	9	20	16
	<i>B</i>	8	30	21		<i>U</i>	31	66	41
	<i>B</i>	4	17	22		<i>B</i>	4	113	42
	<i>B</i>	5	34	23		<i>B</i>	6	236	43
	<i>B</i>	7	34	24		<i>B</i>	4	159	44
	<i>B</i>	4	40	25		<i>B</i>	1	100	44
	<i>B</i>	4	23	26		<i>B</i>	2	97	9
	<i>B</i>	3	11	27		<i>B</i>	12	33	45
	<i>B</i>	9	73	28		<i>B</i>	15	48	46
	<i>V</i>	3	17	29		<i>B</i>	6	50	47
DO Cep	<i>V</i>	1	19	9	EV Lac	<i>V</i>	4	113	42
	<i>V</i>	0	17	9		<i>V</i>	4	159	43
	<i>V</i>	0	27	44		<i>BD+13°2618</i>	<i>B</i>	2	32
	<i>V</i>	1	100	44		<i>Wolf 630</i>	<i>U</i>	8	14
	<i>V</i>	3	104	8		<i>U</i>	3	10	16
	<i>U</i>	2	7	16		<i>Wolf 359</i>	<i>U</i>	31	29
	<i>B</i>	12	25	48		<i>Wolf 424</i>	<i>U</i>	12	13
	<i>B</i>	11	115	49		<i>WX UMa</i>	<i>U</i>	2	2.7
	<i>V</i>	0	20	9		<i>V 645 Cen</i>	<i>V</i>	4	15
	<i>U</i>	10	28	50		<i>BD+55°1823</i>	<i>V</i>	0	17
EQ Peg	<i>B</i>	0	5	9		<i>DY Dra</i>	<i>V</i>	1	99
	<i>B</i>	1	27	51		<i>Ross 614</i>	<i>U</i>	8	4
PZ Mon	<i>V</i>	1	54	52	<i>AC+18°1204</i>	<i>U</i>	2	6.8	16
BD+51°2402	<i>V</i>	1	76	52		<i>Ross 867</i>	<i>U</i>	2	3.9
					<i>G 24-16</i>	<i>U</i>	4	1.1	55

REFERENCES TO TABLE 1

- Kunkel W. E., 1968, *IAU Inf. Bull. Var. Stars* No. 315.
- Chugainov P. F., Harien R. J., Westerlund B. E., White R. E., 1969, *IAU Inf. Bull. Var. Stars* No. 343.
- Osawa K., Ichimura K., Noguchi T., Watanabe E., 1968, *IAU Inf. Bull. Var. Stars* No. 310.
- Bateson F. M., 1969, *IAU Inf. Bull. Var. Stars* No. 354.
- Osawa K., Noguchi T., Okada T., Ichimura K., Watanabe E., Okida K., 1969, *IAU Inf. Bull. Var. Stars* No. 405.
- Jarrett A. H., Eksteen J. P., 1969, *IAU Inf. Bull. Var. Stars* No. 406.

7. Jarrett A. H., Eksteen J. P., 1969, *IAU Inf. Bull. Var. Stars* No. 349.  
 8. Cristaldi S., Rodono M., 1970, *Astron. and Astrophys. Suppl.*, **2**, 223.  
 9. Gershberg R. E., Chugainov P. F., 1969, *Izvest. Krymskoy Astr. Obser.*, **40**, 7.  
 10. Gershberg R. E., Chugainov P. F., 1967, *Izvest. Krymskoy Astr. Obser.*, **44**, 260.  
 11. Eksteen J. P., Andrews A. D., 1966, *M. N. R. A. S.*, **25**, 167.  
 12. Solomon L. H., David M. A., 1968, *IAU Inf. Bull. Var. Stars*, No. 297.  
 13. Solomon L. H., 1968, *IAU Inf. Bull. Var. Stars*, No. 296.  
 14. Chuaze, A. D., Barblishvili T. I., 1967, *Astron. Zirkular*, No. 451.  
 15. Chuaze A. D., *Astron. Zirkular*, No. 345.  
 16. Kunkel W. E., 1967, unpublished, Ph. D. Thesis, Univ. of Texas.  
 17. Andrews A. D., 1968, *IAU Inf. Bull. Var. Stars* No. 265.  
 18. Kunkel W. E., 1969, *Nature*, **222**, 1129.  
 19. Eksteen J. P., Schmidt Th., 1968, *IAU Inf. Bull. Var. Stars*, No. 264.  
 20. Osawa K., Ichimura K., Noguchi T., Watanabe T., 1968, *IAU Inf. Bull. Var. Stars*, No. 267.  
 21. Oskanian V. S., 1968, *IAU Inf. Bull. Var. Stars*, No. 268.  
 22. Cristaldi S., Rodono M., 1968, *IAU Inf. Bull. Var. Stars*, No. 274.  
 23. Chugainov P. F., 1969, *IAU Inf. Bull. Var. Stars* No. 338.  
 24. Shakhovskaya N. I., 1969, *IAU Inf. Bull. Var. Stars* No. 339.  
 25. Osawa K., Ichimura K., Noguchi T., Watanabe T., 1969, *IAU Inf. Bull. Var. Stars* No. 331.  
 26. Andrews A. D., 1968, *IAU Inf. Bull. Var. Stars* No. 307.  
 27. Stepien K., 1968, *IAU Inf. Bull. Var. Stars* No. 305.  
 28. Andrews A. D., 1966, *Pub. A. S. P.*, **78**, 324.  
 29. Chugainov P. F., 1968, *IAU Inf. Bull. Var. Stars* No. 266.  
 30. Chuaze A. D., Barblishvili T. I., Kuljanashvili G. S., 1967, *Astron. Zirkular* No. 408.  
 31. Mac Donell D. J., 1968, *Ap. J.*, **153**, No. 1, 313.  
 32. Gershberg R. E., Chugainov P. F., 1966, *Astron. Jour.*, **43**, 1168.  
 33. Szveidl B., 1969, *IAU Inf. Bull. Var. Stars* No. 345.  
 34. Chugainov P. F., Shakhovskaya N. I., 1969, *IAU Inf. Bull. Var. Stars* No. 340.  
 35. Cristaldi S., Narbone, M., Rodono M., 1969, *IAU Inf. Bull. Var. Stars* No. 333.  
 36. Ichimura K., Noguchi T., Watanabe E., 1969, *IAU Inf. Bull. Var. Stars* No. 334.  
 37. Cristaldi S., Narbone M., Rodono M., 1969, *IAU Inf. Bull. Var. Stars* No. 367.  
 38. Oskanian V. S., 1969, *IAU Inf. Bull. Var. Stars* No. 345.  
 39. Andrews A. D., Perrott J., 1969, *IAU Inf. Bull. Var. Stars* No. 336.  
 40. Kumsishvili J. P., Abulazc O. N., 1966, *Astron. Zirkular* No. 370.  
 41. Chugainov P. F., 1969, *Izvest. Krymskoy Astr. Obser.*, **40**, 33.  
 42. Chugainov P. F., 1961, *Izvest. Krymskoy Astr. Obser.*, **26**, 171.  
 43. Chugainov P. F., 1962, *Izvest. Krymskoy Astr. Obser.*, **28**, 150.  
 44. Chugainov P. F., 1965, *Izvest. Krymskoy Astr. Obser.*, **33**, 215.  
 45. Osawa K., Noguchi T., Okada K., Ichimura K., Watanabe E., Okida K., 1969, *IAU Inf. Bull. Var. Stars* No. 399.  
 46. Maslenikov K. L., Shakhovskaya N. I., 1969, *IAU Inf. Bull. Var. Stars* No. 401.  
 47. Cristaldi S., Rodono M., 1969, *IAU Inf. Bull. Var. Stars* No. 403.  
 48. Jarrett A. H., Eksteen J. P., 1969, *IAU Inf. Bull. Var. Stars* No. 379.  
 49. Andrews A. D., 1966, *Pub. A. S. P.*, **78**, 542.  
 50. Herr R. B., Breich J. A., 1969, *IAU Inf. Bull. Var. Stars* No. 329.  
 51. Roques P., 1954, *Pub. A. S. P.*, **66**, 256.  
 52. Godoli G., Narbone M., Rodono M., 1969, *Non Periodic Phenomena in Variable Stars* Ed. L. Detre, p. 149.  
 53. Shakhovskaya N. I., 1969, *IAU Inf. Bull. Var. Stars* No. 361.  
 54. Bateson F. M., 1969, *IAU Inf. Bull. Var. Stars* No. 353.  
 55. Kunkel W. E., 1968, *IAU Inf. Bull. Var. Stars* No. 294.

TABLE 2  
*Flare Frequency in U, B and V*  
*(Flares/day)*

Star	$M_V$	$f_U$	$f_B$	$f_V$
Wolf 359	16.8	26	—	—
UV Cet	16.1	68	18	3.5
V 645 Cen	15.4	—	—	6.4
Wolf 424	15.1	22	—	—
DO Cep	13.4	8.6	—	—
V 1216 Sgr	13.3	7.0	4.0	—
YZ CMi	12.4	12	4.8	1.6
EQ Peg	12.0	—	0.9	—
EV Lac	11.8	11.2	1.5	0.7
AD Leo	10.9	7.1	2.8	1.3
Wolf 630	10.6	11	—	—
BD+55°1823	8.5	—	—	1.0
BD+51°1402	8.0	—	—	0.3
PZ Mon	7.1	—	—	0.4
BD+13°2618	—	—	1.5	—
DY Dra	—	—	—	0.2

b) For all stars, the condition  $f_U > f_B > f_V$  is satisfied, independently of absolute luminosity, spectral class and flare-up amplitude. No exception to this trend exists in the available data. For three stars —UV Cet, YZ CMi and AD Leo— the dependence of flare-up frequency on color range is presented graphically on Figure 2. The slope of the frequency decreases for increasing absolute luminosity. However, for EV Lac this relation does not hold since its slope is greater, but we believe it results from the inhomogeneity of the material available.

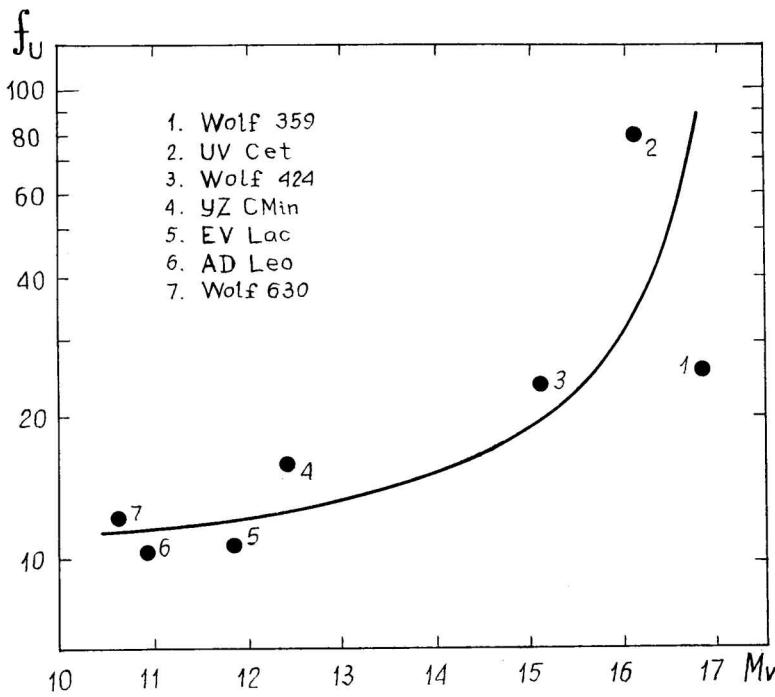


Figure 1.

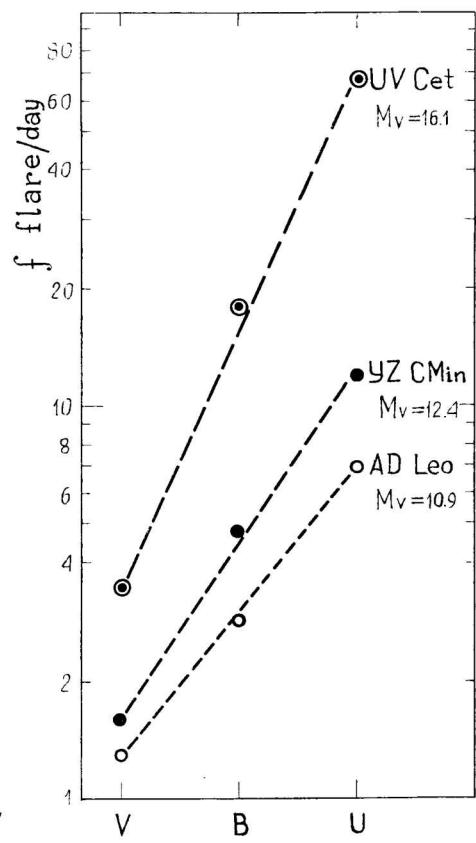


Figure 2.

Fig. 1.—The dependence of ultraviolet flare frequency,  $f_U$ , on the absolute visual magnitude.

Fig. 2.—The dependence of flare frequency on spectral range for UV Cet, YZ CMi and AD Leo.

### III. Dependence of Mean Flare-Up Amplitude on Absolute Luminosity

Table 3 presents mean values of flare-up amplitudes in  $U$ ,  $B$  and  $V$  for several flare stars. The data are presented in order of increasing absolute luminosities. It should be pointed out that the mean values  $\Delta U$ ,  $\Delta B$  and  $\Delta V$  are affected by the inhomogeneity of the observational material as the time

TABLE 3

Mean Amplitude of Flares

Star	$M_V$	$\Delta U$	$\Delta B$	$\Delta V$
Wolf 359	16.8	1.84	—	—
UV Cet	16.1	1.40	1.03	0.85
DO Cep	13.4	0.59	—	—
YZ CMi	12.4	1.23	0.73	0.69
EV Lac	11.8	—	0.71	0.58
AD Leo	10.9	0.62	0.45	0.52
Wolf 630	10.6	0.35	—	—

of integration of photoreceivers is different for each observer. Nevertheless, the data of Table 3 enable us to draw the following qualitative conclusions:

- a) The mean amplitude of  $U$ ,  $B$  and  $V$  flare-ups increases for decreasing absolute luminosity.
- b) For all stars, the condition

$$\overline{\Delta U} > \overline{\Delta B} > \overline{\Delta V}$$

is satisfied, independently of absolute luminosity and spectral type. This property is present also in the simultaneous observations of the same flare-ups in  $U$ ,  $B$  and  $V$ . Formulated otherwise: the dispersion in flare-up amplitudes increases for shorter wavelengths.

#### IV. The Flare-Up Amplitude Distribution Function

Let  $n(\Delta m)$  be the number of registered flare events for a given star in a given color with amplitudes within  $\Delta m$  and  $\Delta m + 1$ . The distribution function of flare-up amplitudes,  $F(\Delta m)$ , can be defined by the formula

$$F(\Delta m) = \frac{n(\Delta m)}{\Sigma n} ,$$

where  $\Sigma n$  is the total number of recorded flare-ups for the same color.

Numerical values of  $F(\Delta m)$  for  $U$ ,  $B$  and  $V$  are given in Table 4 for several flare stars. Data on H II 2411 were also included (Haro and Parsamian 1969). In the case of UV Cet the relative number of recorded flares by photographic means is much larger than for other objects.

The following conclusions can be made from the data presented in Table 4:

- a) The slope of the flare-up amplitude distribution function  $F(\Delta m)$  is steeper in  $B$  than in  $U$ .
- b)  $F(\Delta m)$  varies more rapidly for increasing absolute luminosity. This property of the amplitude distribution function is presented in Figure 3, where the dependence of  $F(\Delta U)$  on  $M_V$  is plotted for  $\Delta U < 1$  mag. Most of the flare-ups in bright stars, —AD Leo and Wolf 630— correspond to amplitudes less than 1 mag, while in the case of faint stars —UV Cet and Wolf 359— flares with  $\Delta U < 1$  mag constitute less than half of the total number.

TABLE 4  
Distribution Function of Flare Amplitudes  $F(\Delta m)$

Star	Spectral region	Number of recorded flares	$\Delta m$					
			0-1	1-2	2-3	3-4	4-5	5-6
UV Cet	$U$	253	0.43	0.28	0.16	0.08	0.03	0.02
	$B$	99	0.72	0.18	0.06	0.04	—	—
	$V$	52	0.62	0.34	0.04	—	—	—
YZ CMi	$U$	16	0.53	0.28	0.12	—	0.04	0.03
	$B$	74	0.78	0.19	0.02	0.01	—	—
AD Leo	$U$	50	0.86	0.07	0.07	—	—	—
	$B$	37	0.90	0.08	0.02	—	—	—
EV Lac	$B$	45	0.73	0.19	0.07	0.01	—	—
Wolf 359	$U$	31	0.23	0.38	0.23	0.16	—	—
V 1216 Sgr	$B$	23	0.91	0.09	—	—	—	—
DO Cep	$U$	10	0.80	0.10	0.10	—	—	—
HII 2411	$U$	48	0.78	0.16	0.02	0.04	—	—
Wolf 630	$U$	11	0.92	0.08	—	—	—	—

#### V. Equivalent Duration of the Flare

The equivalent duration of flare-up,  $\Delta T$ , is defined as the integrated energy throughout the total time of the flare-up divided by the maximum flare-up intensity. In other words the total energy radiated during a given flare-up is

$$E_f = (10^{4.0 \Delta m} - 1) E^* \Delta T .$$

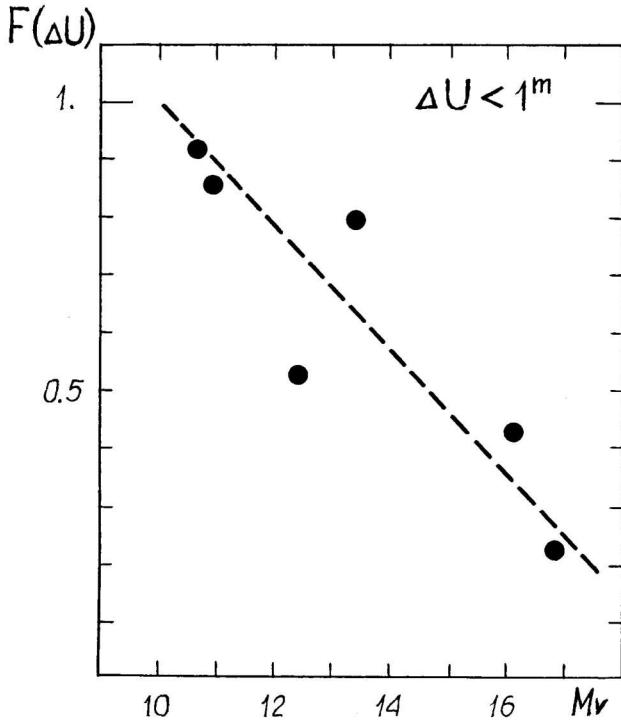


Figure 3.

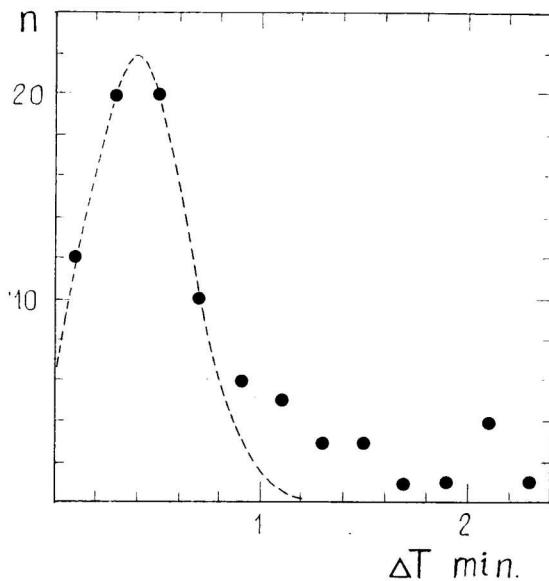


Figure 4.

Fig. 3.—The distribution function of flare amplitudes,  $F(\Delta U)$ , for the case  $\Delta U < 1$  mag.

Fig. 4.—The equivalent duration of the flare,  $\Delta T$ , based on the observations by Cristaldi and Rodono (1970).

About 70 light curves of  $U$  flare-ups of UV Cet were published by Cristaldi and Rodono (1970). This constitutes a very homogeneous material. They also give ten light curves of flare-ups of other stars. By adding ten more light curves obtained by Andrews (1970) for V 1216 Sgr we can construct the time distribution function. This function, presented in Figure 4, has a clear-cut maximum at  $\Delta T = 0.4$  minutes, with a mean value of  $\Delta T$  equal to 0.6 minutes. For comparison a Gaussian curve is also drawn.

As to the dependence of  $\Delta T$  on the absolute luminosity of the star, nothing definite can be stated since there are no light curves available for most flare stars (see Kunkel 1969).

#### VI. Energy Radiated during Flare-ups

The  $U$  energy released by the star during one flare-up of amplitude  $\Delta U$  is equal to  $\Delta T (10^{0.4 \Delta U} - 1) E_U^*$ , where  $E_U^*$  is the stellar luminosity (erg/sec) in normal conditions. The number of flares per day with an amplitude between  $\Delta U$  and  $\Delta U + d(\Delta U)$  is equal to  $f_U F(\Delta U) d(\Delta U)$ . Therefore the total amount of  $U$  energy,  $E_f$ , released by the star per day from all flare-ups with different amplitudes (above 0.1 mag) is

$$E_f = E^* \Delta T \frac{f_U}{8.64 \times 10^3} \int (10^{0.4 \Delta U} - 1) F(\Delta U) d(\Delta U) \text{ erg/sec.} \quad (1)$$

where  $f_U$  is in flares/day, and  $\Delta T$  in seconds. A similar relation holds for  $B$  and  $V$ . The total energy during flare-ups in units of the stellar luminosity was calculated for six objects and is presented in Table 5. The data on the functions  $f$  and  $F(\Delta m)$  were obtained from Tables 2 and 4, respectively.

Only flare stars for which there are twenty flare-ups or more in a given spectral range were used. In the calculations  $\Delta T = 40$  sec was adopted for all stars.

A comparison of the data listed in columns 5, 6 and 7 of Table 5 with the absolute luminosities of the flare stars leads to the following conclusions:

a) The relative amount of radiative energy released by the star during the flares-ups,  $E_f/E^*$ , increases for fainter stars; the relative  $U$  energy amounts to about 30% in the case of UV Cet and 5% in case of AD Leo while the relative  $B$  energy is equal to 2% and 0.1%, respectively. For greater clarity those data are graphically presented in Figures 5 and 6. The dependence of the relative energy,  $E_f/E^*$ , on absolute luminosity may be represented by the following relationship:

$$\log (E_f/E^*) = a + b M_v \quad (2)$$

where, for  $B$ :  $a = -6.18$  and  $b = +0.28$  and for  $U$ :  $a = -3.08$  and  $b = +0.16$ .

TABLE 5

*Relative ( $E_f/E^*$ ) and Absolute ( $E_f(U)$ ) Energy Emitted by the Star during Flare-up*

Star	$M_V$	$M_B$	$M_U$	$E_f/E^*$		$E_f(U)/E_\odot$
				$U$	$B$	
Wolf 359	16.8	18.5	19.7†	0.088	—	$0.16 \times 10^{-6}$
UV Cet	16.1	17.7	18.9†	0.306	0.021	$1.1 \times 10^{-6}$
V 1216 Sgr	13.3	15.1†	16.3	—	0.0027	—
YZ CMi	12.3	14.0	14.9	0.054	0.0034	$25 \times 10^{-6}$
EV Lac	11.8	13.1	14.6	—	0.00133	—
AD Leo	10.9	12.4	13.5	0.045	0.00128	$73 \times 10^{-6}$

† Assuming  $U-B = 1.20$  mag and  $B-V = 1.80$  mag.

The conclusion that the relative flare-up energy increases with decreasing absolute luminosity of the star is qualitatively in accordance with what has already been established for flare stars in stellar associations (Gurzadyan 1970).

b) The absolute energy,  $E_f$ , radiated by the star during flare-up is larger for brighter stars as can be seen from Figure 7. The absolute energy of U flare-ups of AD Leo is about two orders of

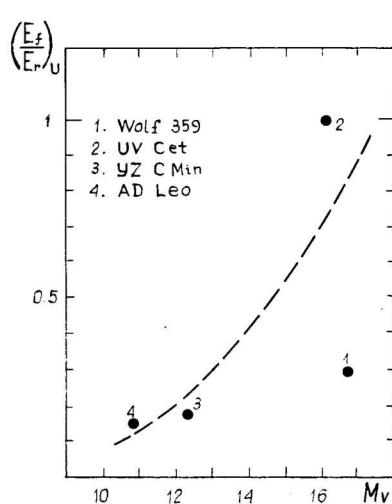


Figure 5.

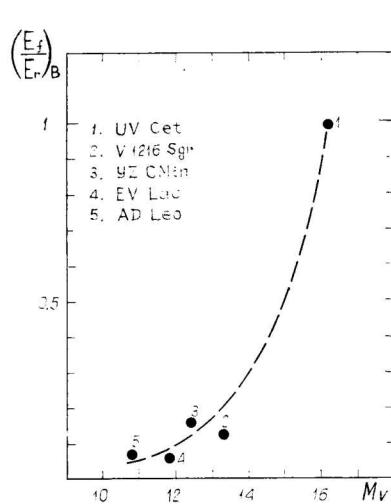


Figure 6.

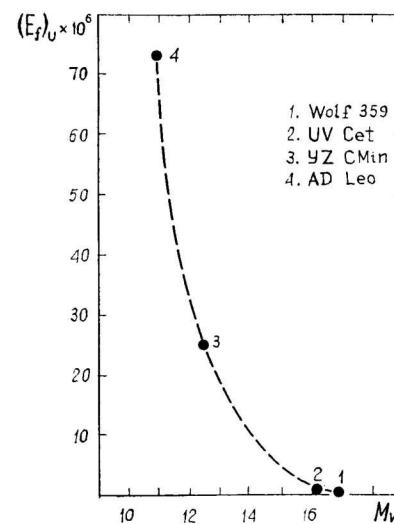


Figure 7.

Fig. 5.—The dependence of the relative amount of  $U$  energy radiated during flare-up on absolute luminosity.

Fig. 6.—The dependence of the relative amount of energy radiated during flare-up on absolute luminosity.

Fig. 7.—The absolute  $U$  energy, in solar units, radiated during flare-up.

magnitude larger than that of UV Cet. The dependence of the flare energy,  $E_f$  on  $M_v$  is well represented by the following formula:

$$\log E_f = c + d M_v \quad (3)$$

where for  $U$ :  $c = -0.31$  and  $d = -0.35$  and  $E_f$  is in solar units.

However, the fundamental and determining factor is the *relative* amount of energy released during flare-ups as expressed by equation (1), since only this parameter specifies the degree of non-stability of a given star. In this sense UV Cet, for instance, is a nonstationary object to a much greater extent than AD Leo.

#### REFERENCES

- Andrews, A. D. 1970, unpublished.  
Cristaldi, S., Rodono, M. 1970, *Astron. Astrophys. Suppl.*, **2**, 223.  
Gurzadyan, G. A., 1970, *Bol. Obs. Tonantzintla y Tacubaya*, **5**, 263.  
Kunkel, W. E., 1968a, unpublished, Ph. D. Thesis, Univ. of Texas.  
———, 1968b, *IAU Inf. Bull. Var. Stars*, No. 315.  
———, 1969, *Low Luminosity Stars*, ed. Kumar, p. 195.  
Haro, G., and Parsamian, E. 1969, *Bol. Obs. Tonantzintla y Tacubaya*, **5**, 45.