Monitoring of Flare Stars at Nainital Observatory

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1 Observations and Reductions

Five UV Cet-type flare stars were photoelectrically monitored during the period 1970 to 1981 using either the Carl Zeiss Jena 1.04 m reflector or the 0.56 m reflector of the Uttar Pradesh State Observatory Nainital. Thermoelectrically cooled EMI 6094S and 1P21 photomultipliers were used with the 1.04 m and 0.56 m telescopes, respectively. The sky brightness was also recorded frequently for short intervals during continuous monitoring of the stars.

The light curves of the recorded flare events were represented by a graph showing the dependence on time of the quantity $i = I_f/I_0$, which represents the flow of excess radiation I_f, expressed in units of the flow I_0 from the star in the normal non-excited state. The fraction of the flow of the outburst is given in stellar magnitudes: $\Delta m = 2.5 \log{(I_f + I_0)/I_0}$. The energy released during a flare event was computed using the relation given by Cristaldi & Rodonò (1973):

$$E_c = 4\pi\, d^2 \times 10^{-0.4 m_c}\, \Pi i_c \times 60 \times P_c \text{ erg} \tag{1}$$

where d is the distance of the star, m_c is the apparent magnitude of the star in colour c, Π_c is the energy flux produced by a zero magnitude star outside the terrestrial atmosphere which is taken from Cristaldi & Rodonò (1973) and

$$P_c = \int \left(\frac{I_{f+o}}{I_0} - 1 \right)\, dt \tag{2}$$

$$\Pi_B = 6.3 \times 10^{-6} \text{ erg cm}^{-2} \text{ sec}^{-1}, \quad \Pi_U = 2.4 \times 10^{-6} \text{ erg cm}^{-2} \text{ sec}^{-1}$$

We estimated Δm, E_c, P_c, rise and decay times and energy released by the flare outbursts for most of the recorded events. Some of the statistics of the recorded events are given in Table 1. The results of the observed events have been published in the Information Bulletin on Variable Stars Nos. 557, 750, 758, 810, 848, 901, 932, 998, 1180, 1210, 1572, 2143 and IAU Coll. No. 15.

Name of star	UV Cet	YZ CMi	AD Leo	Gliese 867B
Visual magnitude	12.95	11.24	9.43	11.8
Spectral type	dM5.5e	dM4.5e	dM3.5e	dM4e
Total nights	5	36	46	1
Filter used	B	B	B	U
Total monitoring duration(hours)	11.6	103.8	107.6	3.1
Total flares recorded	17	20	20	2
Quiescent energy (10^{28} erg sec^{-1})	0.73	20.6	80.0	2.2
Energy range of flare events (10^{30} ergs)	1.2–0.07	22–0.8	70.6–1.0	1.17–1.08
Mean energy per flare (10^{30} ergs)	.26	8.2	14.0	1.12
Mean flare duration (min)	5.6	9.5	10.6	2.6
Mean rise time (min)	.5	.8	1.9	.38

2 Conclusions

The following conclusions support those drawn from statistical studies done by other authors:

1. The mean energy per flare increases with increasing intrinsic quiescent luminosity of the parent star.
2. Brighter flare stars have more energetic but less frequent flares.
3. The rise times become more rapid as the quiescent energy of the parent star decreases.
4. Most of the flare light curves are either combinations of spike and slow flares or successive overlapping flares, supporting the view that energy can be added at various times during the development and decay of a flare event.
5. Flares with greater energy release occasionally last longer.

References

Bhatt T.R., Sinvhal S.D., 1971, IBVS 557
Bhatt T.R., Sinvhal S.D., 1971, IAU Coll. 15, 124
Cristaldi S., Rodono M., 1973, A&A Suppl. 10, 47
Kapoor R.C., Sinvhal S.D., 1972, IBVS 750
Kapoor R.C., 1973, IBVS 758
Kapoor R.C., Sanwal B.B., Sinvhal S.D., 1973, IBVS 810
Kapoor R.C., 1973, IBVS 848
Kapoor R.C., Sinvhal S.D., 1974, IBVS 901
Sanwal B.B., 1974, IBVS 932
Sanwal B.B., 1975, IBVS 998
Sanwal B.B., 1976, IBVS 1180
Sanwal B.B., 1976, IBVS 1210
Sanwal B.B., 1979, IBVS 1572
Sanwal B.B., 1982, IBVS 2143