THE RELATIVE NUMBER OF FLARE STARS IN SYSTEMS OF DIFFERENT AGES

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ABSTRACT. The problem of flare activity frequency among red dwarf stars is discussed.The observational data on stars in Orion, Pleiades and solar vicinity are used. It is shown, that relative number of flare stars among all red dwarf stars in the considered samples is increasing towards the lower luminosity stars. The flare stars are found in the considered samples begining with a definite luminosity, this limiting luminosity being decreased with the aging of the system which includes flare stars. A possible explanation of the observed phenomenon is given.

1. INTRODUCTION

An observational approach to the evolution of flare stars has shown that the flare activity stages is one of the early stages in stellar evolution [1-3].

On the other hand flare stars of different ages belong to the same class of non-stable stars possessing flare activity and the observed differences between them are due to their different ages [4].

Conseqently, one can expect that there is certain dependence of the flare activity upon the star age. In this report the frequency of flare activity phenomenon among red dwarf stars of different ages is estimated.

2. RELATIVE NUMBER OF FLARE STARS AMONG RED DWARF STARS

The relative number of flare stars is estimated for three samples of different ages:in the Orion association,Pleiades cluster and solar vicinity.

As criteria of star membership to these samples besides proper motion some physical parameters, in particular the flare activity are used, according to catalogues by

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Hertzsprung et al [5], Parenago [6] and Gliese [7,8]. For each sample the number of flare stars for corresponding magnitude range is determined as a sum of the numbers of known and potential ones. The latter number is estimated by Ambartsumian's formulae [1].

The results of these estimates are presented in Table 1, including M_{Pg} range of absolute photographic magnitudes, N – number of red dwarf stars in a given sample, N_F – number of flare stars among them and N_F/N – relative number of flare stars among all red dwarf stars in the sample.

Table 1 shows, that the relative number of flare stars– N_F/N, is increasing while the luminosities are decreasing for all three samples.

However, there is one significant difference between the considered samples, namely the magnitude ranges of flare star luminosities.

Both these regularities can be explained by different ages of these samples. Indeed, according to generally accepted proposition the rates of stellar evolution depend on star mass (luminosity). As a result the flare stars of higher luminosities lose their flare activity earlier than the lower luminosity flare stars.

Table 1 testifies in favour of this conclusion. In each of the samples the relative number of flare stars is increasing to lower luminosities. At the same time the older the sample the lower luminosities of flare stars meet in it.

TABLE 1. Relative number of flare stars among red dwarf stars [9].

M_{Pg}	N			N_F			N_F/N		
	I	II	III	I	II	III	I	II	III
4.4–5.5	73	–	–	2	–	–	0.03	–	–
5.5–6.5	115	–	–	10	–	–	0.09	–	–
6.5–7.5	143	–	–	26	–	–	0.18	–	–
7.5–8.5	104	34	50	79	14	1	0.76	0.41	0.02
8.5–9.5	*	55	100	*	37	3	*	0.67	0.03
9.5–10.5	*	64	131	*	40	7	*	0.63	0.05
10.5–11.5	*	73	67	*	58	10	*	0.79	0.15
>11.5	*	*	113	*	*	47	*	*	0.42

I – Orion, II – Pleiades, III – Solar vicinity

Another important result following from Table 1 is the decreasing of the relative number of flare stars with the

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age of the sample.

This result can also be interpreted by the dependence of stellar evolution rates from star mass.

It should be added that the data presented in Table 1 are only qualitative. Besides, they are not complete for Orion sample: in some intervals of absolute photografic magnitude (M_{Pg}) the data on the numbers of not flaring red dwarf stars are absent.

However, even these qualitative data, which are trustworthy enough seem to be important for further study of the flare activity phenomenon in evolution of red dwarf stars.

3. CONCLUSION

The analysis of the observational data for three samples of flare stars in Orion, Pleiades and solar vicinity having different ages shows that relative number of flare stars among red dwarf stars is increasing to lower luminosities. It is the direct consequence of the fact that the duration of flare activity phenomenon depends on the masses (luminosities) of corresponding stars. Due to this dependence the older is the flare star system the lower are luminosities of corresponding flare stars.

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LADA: In your comparative study of Orion, Pleiades, and the solar vicinity, did you take into account differing observing times for each group?

Of the stars listed in your Table 1, how many were actually observed to flare and how many were included as a result of correction or normalization due to different amounts of observing time? In other words how many stars did you add to account for the fact that each group of stars was monitored for different amounts of time?

HAMBARIAN: Of course you are right. The observational times for the three samples listed in Table 1 are quite different. But the relative number of flare stars among all red dwarf stars (N_F/N) do not depend on the observational time because N_F includes not only the known flare stars, but also the potential ones which we have estimated from the formula by Ambartsumian, $n_o = (n_1^2/2n_2)$, where n_1 is the number of stars seen to flare once and n_2 are those seen to flare twice.

RODONO: Did you take into account the different detection thresholds that favour the detection of faint flare stars or do your data refer to original uncorrected observations?

HAMBARIAN: No. But this circumstance cannot explain the observed regularity.

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