SLOW FLARES IN STELLAR AGGREGATES AND SOLAR VICINITY

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ABSTRACT. The study of slow flares in star clusters, associations and Solar Vicinity is carried out. The dependances of flare amplitude from the inverse velocity of flare increasing time in U,B,V bands are obtained. It is shown, that strong flares frequently take place in deep layers of stellar photosphere.

The first attempt to find the reason of the difference between slow and fast flares was made by Ambartsumian [1]. According to Ambartsumian, slow flares take place under photospheric layers. First slow flares was found by Haro [2].

1. In work [3], based on existing observational data, attempt was made to classify slow flares by the form of brightness curve :

1. Slow increase and slow decrease.
2. Slow increase, continuous maximum and decrease.
3. Combination of two flares:slow and fast and vice versa.

At present, distribution of slow flares in stellar clusters by types is the following:

TABLE 1. A distribution of slow flares in stellar clusters

Aggr\Type	I	II	III
Orion	15	7	1
Pleiades	28	2	5
Preasepe	2	–	–

Comparison with similar table from work [3] shows, that insrease in the quantity of flares took place due to flares of type I and flares of type II are again rare. The flat maximum of brightness curve of slow flares of type II can be

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considered as a result of superposition of several slow flares, which took place in the same layer at small time interval, perhaps having the same source.

As for flares type III, they take place both, under photosphere and over it, being divided by small time interval.

2. Based on new observational data, an attempt was made to find the relationship between amplitude in brightness maximum and inverse velocity of the brightness increase $t_m=t_B/\Delta m$, where t_B – the time of increase till to maximum, Δm – amplitude, for Orion association and Pleiades cluster.

1. Orion:

$$\ln\Delta m_U = -0.05\ t_m + 2.3 \qquad (1)$$

$$\ln\Delta m_B = -0.02\ t_m + 1.5 \qquad (2)$$

2. Pleiades:

$$\ln\Delta m_U = -0.04\ t_m + 1.9 \qquad (3)$$

$$\ln\Delta m_B = -0.05\ t_m + 1.6 \qquad (4)$$

The obtained relationships confirm the results received before, that flare amplitude depends on depth of layer where the flare occured, as t_B depends on depth [3].

Slow flares occure not only in stellar aggregates, but also on flare stars of Solar Vicinity. However only two stars AD Leo and EV Lac show flare with t_B about 20 min [4,5]. In other cases t_B<10 min. For that case, when t_B varies in the range of 5–10 min we get:

$$\ln\Delta m_U = -0.17\ t_m + 1.27 \qquad (5)$$

Let us note, that slow flares of Solar Vicinity can also be classified by types I,II,III. If photoelectric observations of flare stars in stellar aggregates were made, it is doubtless , that slow flares with small t_B, similar to those in Solar Vicinity can be found.On the other hand, we can surely say, that probability to find slow flares with t_B>20 min in Solar Vicinity is small and depends on evolution stage of these stars.

3. Observational data do not let us to get immediate connection between maximal amplitude and t_B, as flares of different energy can take place on the same depth. That is why, having an idea of flare energies distribution with depth only, we can consider the known slow flares in order of increasing of t_B, i.e.with depth, where slow flares occur.

Fig.1 shows dependance of $\ln\Delta m_B$ on t_m for Pleiades cluster of different intervals of t_B:

$$\ln\Delta m_B = -0.07\ t_m + 1.58, \qquad t_B = 16 - 25\ \text{min}, \qquad (6)$$

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$$\ln\Delta m_B = -0.06\, t_m + 1.86, \qquad t_B = 27 - 36 \text{ min.} \qquad (7)$$

the angle coefficients show that the diffusion of radiation takes place by the same law. The increase of constant in (6),(7) shows that the deeper the flare, the stronger it in average. The same is true for Orion association.

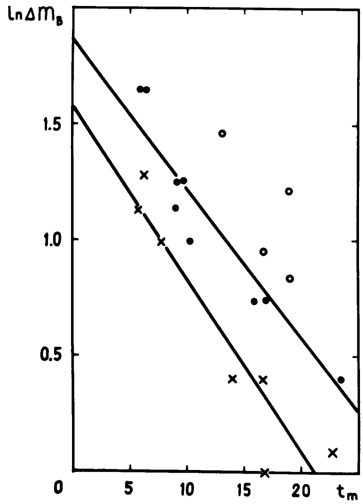

Figure 1. Dependance of $\ln\Delta m_B$ on t_B for Pleiades cluster of different intervals of t_B:

crosses	16 – 25 min,
dark circles	27 – 36 min,
light circles	>36 min.

4. According to Ambartsumian [6] the probability of fast and slow flare appearances must depend on width of corresponding layer. The photosphere width is of the order of 10^2 km. The small dispersion values of t_B confirms, that the layers, where slow flares take place are relatively narrow. The width of the layers where fast flares occure is about 10^4–10^5 km. The ratio of the numbers of fast and slow flares must be proportional to the width of the layer where the flares occur and is about 10^2–10^3 . Let us compare this value with the results of observations in Orion and Pleiades. From the observed data it is seen that the ratio of fast and slow flares is in order of 10^2 . In this case fast flares ($\Delta m<1$) which can not be observed as slow, if

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they occured under photospheric layers, because of small amplitude is taken into account. Consequently, the ratio of the numbers of slow and fast flares must be more than 10^{-2}. Thus, in the photosphere the flares with great energy happen more frequently than they are thought to be, on the base of ratio of numbers of slow and fast flares.

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