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Some new results on the Pleiades flare stars

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With the aid of photographic photometry in the U band, more than 300 multiexposure, survey plates were reexamined. 101 flare outbursts of 86 flare stars were found on the plates. The light curves of flare-ups, determined by chain exposures, can be divided into two subgroups: fast events, shorter than 30 min and slow events, lasting more than 30 min. The examination of flare energies showed that a newly introduced quantity "average flare intensity" is the same for the two subgroups, in spite of their different appearance. There was a relation between the flare amplitude and the average flare intensity. This relation shows that the different graphs of slow and fast flares intersect each other or combine on greater amplitudes.

I suppose that physically the two types of flares are not different; it is possible that only the conditions of the energy release vary.

Key words: flare stars, Pleiades.

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During the 1976-1983 period more than 300 multiexposure survey plates were made at the mountain station of the Konkoly Observatory with the aid of a 60/90 cm Schmidt telescope. The exposures made on Kodak 103a0 type plates through UG2 filter, represent the photographic U band. Then the plates were checked by visual method with the aid of a Zeiss Blinckcomparator (K e l e m e n, 1986).

86 flare stars were found on the plate collection and 101 flare-ups occurred on these stars. About the half of the flare-ups occurred on faint stars which were fainter than 18 magnitude at their quest state. The other half of the flare stars were brighter than 18 mag. The latest flare catalogue (H a r o et al., 1982) shows the same ratio. The distribution of observed flare amplitudes are quite similar to the same distribution of the Haro catalogue. The maximum of the distribution curve of flare-up amplitudes lies between 2-3 mag. in U band.

The distribution of the previously published quiet U magnitudes shows a valley between 16-17,5 mag. but the same kind of distribution for my flare stars do not show that effect. It is quite similar to the distribution of the published B magnitudes. The reason of similarity would be that the previously published B quiet brightnesses and the U brightnesses measured by me should be more accurate than the previously estimated U magnitudes. In Fig. 1 the dotted line shows the previous U estimations, the continuous line shows the newly measured U magnitudes and the broken line respresents the earlier B brightnesses.

The time resolution of the chain exposure method is rather poor because one exposure represents 10 min observation time. Due to that fact the true lengths of flare-ups are not measurable, but the numbers of the flare-up points in the chain could give an upper limit.

If one plots the distribution of the number of images which show some brightening, the result is a two peaked curve. Reexamining the flare-ups' light curves

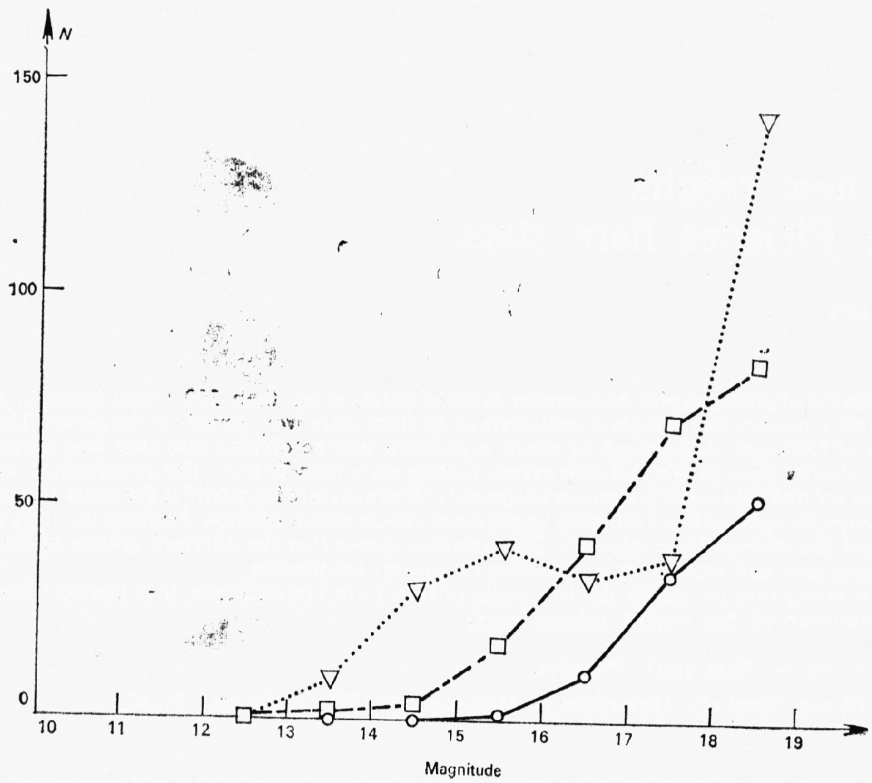


Fig. 1

the following turned out. An average short (fast) event shows a sharp peaked curve with relative quick decrease. An average long lasting (slow) event shows a steeply rise and slow decrease in their light curves. So with the aid of the chain exposure method one could distinguish between the so called slow and fast flares (O s k a n y a n, 1969).

The first peak is at 20 min, but here the influence of the observational selection effect is very strong because of the time resolution which is 10 min (one point in the chain) and at the rather high error level of the U observations the so called "one point flare-up" is very uncertain. The second peak near to 40 min seems more certain. By means of visual classification of flare light curves the subgroups of the fast and slow flares could have been distinguishable. The Fig. 2 shows the common distribution curve of the flare lifetimes (continuous line) the distribution for the fast (broken line), and the slow (dotted line) events, respectively.

A flare-integral like characteristic was also determined for the flares. Fig. 3 shows the statistics of flare-integrals of the whole sample. The two-peaked structure is clearly visible (continuous line). The first maximum at small values represents the contribution of fast events (broken line). The second maximum at greater integral values represents slow flares (dotted line). This result shows that the slow events emit more energy than the fast ones.

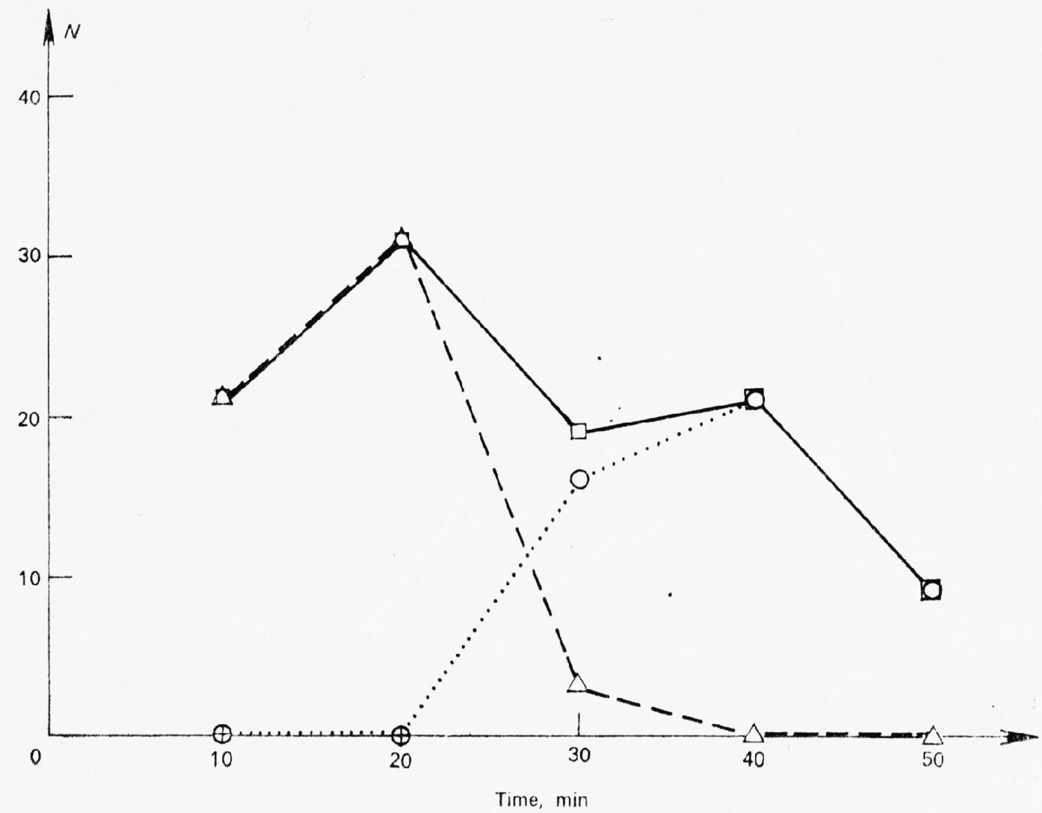

N
40
30
20
10
0
10
20
30
40
50
Time, min

Fig. 2

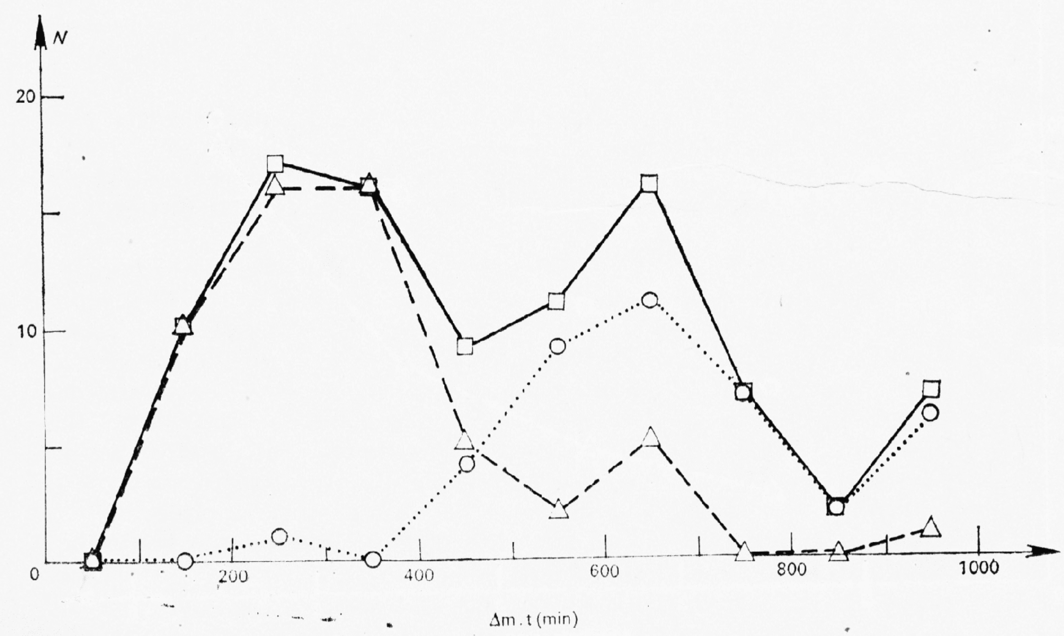
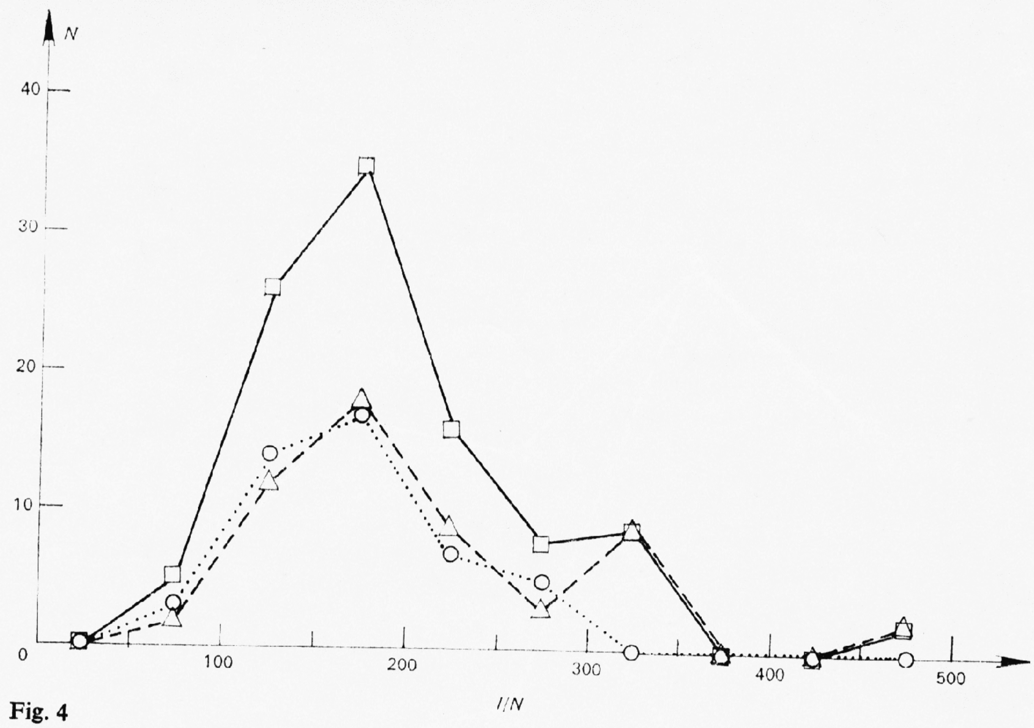
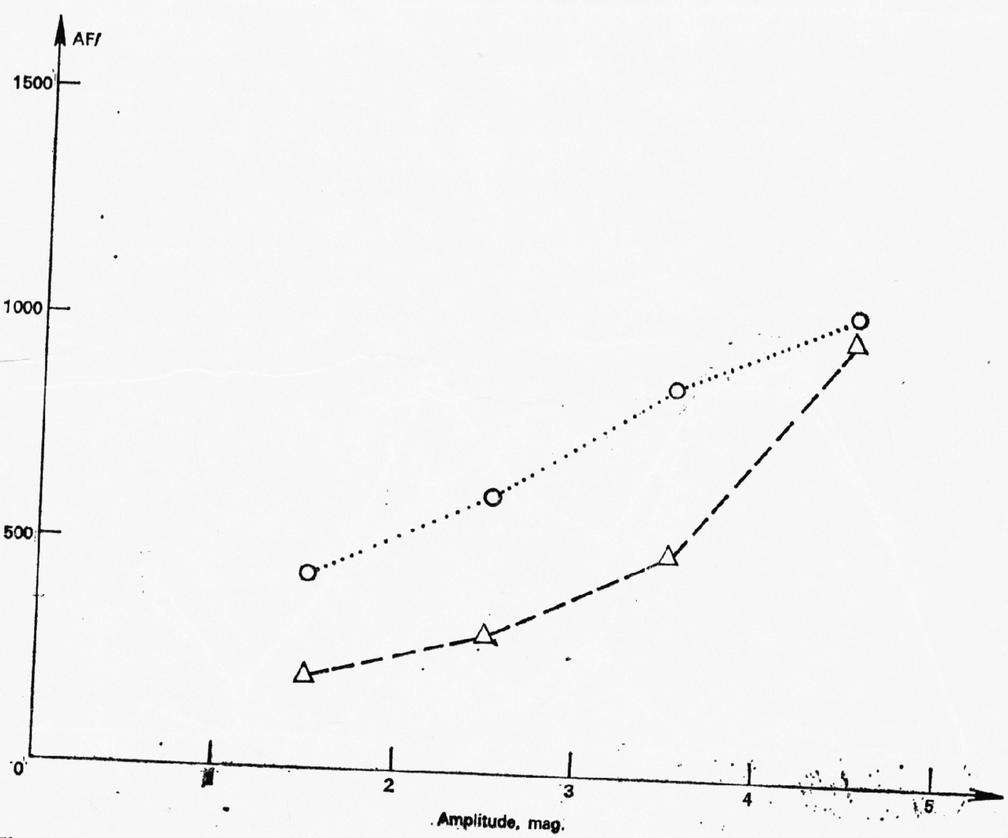

N
20
10
0
200
400
600
800
1000
Δm . t (min)

Fig. 3


N
40
30
20
10
0
100
200
300
400
500
I/N
Fig. 4


AFI
1500
1000
500
0
2
3
4
5
Amplitude, mag.
Fig. 5

Although the lifetime of fast flares is shorter than the lifetime of slow flares, a slow flare emits in average more energy than the others so it would be useful to make a comparison for their energetics. I tried to introduce a new flare characteristic: the average flare intensity.

During the strongly varying flare-up the outburst makes a definite intensity increase on the photoplate. But the same amount of density variation could be produced by a certain amount of constant brightening during the total lifetime of the flare. I have called the measure of the mentioned constant brightening "average flare intensity". Fig. 4 shows the distribution of the average flare intensities (continuous line) for the whole sample. The graph has only one sharp peak. The distribution of fast flares (broken line) and the distribution of slow flares (dotted line) reach their maxima at the same value. It could show that the two observable kind of flare-ups should have common origin and the difference between their apparent light curves should be caused by local environmental effects in the stellar atmosphere. May be the various depths of the place of the energy release during flare-ups could play such a role.

There is a relation between the amplitude of the flareup and the average flare intensity of the particular event. By increasing amplitude the average flare intensity increases, too. The relation for the two kinds of flare-ups could be represented by nearly linear graphs. The actual graphs show a possible intersection at the region of great amplitudes. Fig. 5 shows the relations. The dotted line represents the graph of slow flares, the broken line — of the fast ones.

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