

FLARE STAR OBSERVATIONS IN THE PRAESEPE REGION

I. Jankovics

Konkoly Observatory

H-1525 Budapest, XII

In a program of systematic search for flare stars in clusters and associations we have carried out a photographic survey in the region of Praesepe. The previously obtained interesting results in the Pleiades cluster and the Orion association stimulated us to continue the work of Haro (1968) and Rosino (1966) in Praesepe. The importance of observations in this cluster is obvious if we consider the following circumstances:

1. Praesepe and Pleiades have nearly the same distance from the Sun, 160 and 125 pc, respectively.
2. There exists a difference in age between the 2 clusters of at least one order of magnitude.
3. The use of Schmidt telescopes allows observations in large cluster regions.

A great number of observational data are desirable for comparison of flare activity in the regions of Pleiades and Praesepe.

The observational material of the present communication was obtained from December 1968 until March 1974 with the 40" and 21" Schmidt telescopes of Byurakan Observatory and the 24" Schmidt telescope of Konkoly Observatory. We used Kodak 103 a-0 or ORWO ZU 2 plates without filter for deriving photographic magnitudes and in connection with an UG 2 filter for U magnitudes. Flares were searched for with the multiple exposure method, typical exposure times were 5 minutes in the pg band and 10 minutes in U. The mean limiting magnitude of all survey plates is 17.^m5. In winter 1973/74 a photographic UVB photometry of all flare stars was carried out with the Byurakan 40" Schmidt using Kodak plates with the usual filters.

Within a total observing time of 285.5 hours 20 new flare stars have been discovered, (Jankovics, 1973) 2 of them showing one recurrent flare up. Furthermore the already known star Haro No.4 had 4 flare ups during the period of observation.

The new flare stars in Praesepe region are listed in Table I. The col-

umns show serial number, a special designation in the Byurakan (B) and Konkoly Observatory (K) system, the coordinates, the magnitudes at minimum, the amplitudes of flares, the data of observation and the telescope type.

Table I
New Flare Stars in the Praesepe Region

No	No	$\alpha(1950)$	$\delta(1950)$	m_{pg}	A	Date	Telescope
1	B 1	8^h33^m9	$19^o29'$	19.0	4.7	22.03.1971	21"
2	B 2	40.5	19 23	20.1	3.7	22.04.1971	40"
3	B 4	39.2	20 08	17.6	1.9	10.02.1972	21"
4	B 5	39.7	18 45	17.4	1.7	10.02.1972	21"
5	B 6	29.7	19 35	16.3	0.8	13.02.1972	21"
6	B 8	27.7	19 12	16.1	1.1	09.03.1972	21"
7	K 2	38.3	18 00	18.9	2.4	14.03.1972	24"
8	B 9	35.7	21 57	15.3	4.4u	17.03.1972	40", 21"
9	B 10	18.3	18 56	19.1	2.4	19.03.1972	40"
10	B 11	40.0	18 25	19.9	3.9	06.04.1972	21"
11	B 12	41.2	21 15	18.0	2.0u	05.01.1973	40"
	"	"	"	"	2.3u	18.02.1974	40"
12	B 13	44.9	18 32	18.2	3.9	07.01.1973	40"
13	K 3	35.7	19 26	19.9	6.2u	29.01.1973	24"
14	B 14	38.6	18 25	17.5	2.9u	27.02.1973	40"
	"	"	"	"	2.6u	19.02.1974	40"
15	B 15	38.7	18 56	19.9	4.1u	05.03.1973	40", 24"
16	K 5	39.7	20 53	15.3	2.6u	24.03.1973	24"
17	B 16	38.5	20 02	17.1	1.3	11.02.1972	21"
18	B 17	29.1	21 25	17.4	1.4u	18.02.1974	40"
19	B 18	33.3	20 12	21.0	3.1	15.03.1972	40"
20	B 19	36.2	20 13	15.7	2.9u	20.12.1973	40"

All information about UBV photometry of flare stars at minimum is tabulated in Table II: serial number, star numbers in the catalogue of Klein-Wassink, V magnitude and colour indices, total numbers of measured plates and standard deviations of magnitudes.

We compiled an HR-diagram of the flare stars at minimum, which is given in Figure 1. Despite the material is quite small it shows about the same picture known for example from the Pleiades cluster. This happens also when we have a look at the colour-colour diagram, presented in Figure 2.

Some examples of light curves are given in Figure 3. It also shows the result of a simultaneous observation at Byurakan and at the Konkoly Observatory (No. 15).

Together with the former observations of Haro (1968) and Rosino (1966) we at present know 33 flare stars in the region of Praesepe. The distribution of all those stars in an area of 16 square degrees is given in Figure 4. We projected the flare stars against a net which was ob-

tained by Artjukina (1962) from star counts in Praesepe of all stars with magnitudes between 11.6 and 16.4. Within the inner part which covers 25% of the whole observed area 52% of all flare stars that is 17 stars have been found. The area covered by the outer rectangular countains 43% of the whole region, here we find 73% of the flare stars this means 24 stars. This picture suggests a concentration to the centre of the region.

Table II
Tricolour Photometry of Flare Stars

No	NoK-W	V	B-V	U-B	n_V	n_B	n_U	σ_V	σ_B	σ_U
1		16.64	2.17		6	4	-	0.19	0.15	-
2		18.21	2.0:	-	4	4	-	0.14	0-	-
3		17.33	0.42	-0.16	5	4	4	0.17	0.21	0.14
4		16.73	0.66	0.2	5	4	3	0.17	0.27	0.28
5		15.86	0.55	0.27	6	4	4	0.14	0.20	0.26
7		17.25	1.35	-	4	2	-	0.24	-	-
8		14.51	1.33	1.38	5	5	4	0.11	0.19	0.24
9		18.70	0.55	-	3	3	-	0.13	0.13	-
10		17.26	1.84	-	4	2	-	0.10	-	-
11		17.17	0.79	0.97	5	4	2	0.35	0.24	-
12		1.85	1.77	-	5	4	-	0.13	0.27	-
13		17.78	1.71	-	5	3	-	0.20	0.35	-
14		15.63	1.67	0.71	4	4	4	0.25	0.21	0.17
15		17.57	2.0:	-	5	2	-	0.17	-	-
16		14.21	1.18	1.24	4	4	3	0.13	0.14	0.26
17		15.99	1.12	0.78	6	5	4	0.19	0.19	0.24
18		16.02	1.12	0.45	5	4	3	0.13	0.13	0.29
20	561	14.35	1.43	1.11	5	4	3	0.12	0.15	0.23
T-3	563	16.18	1.79	1.39	5	4	2	0.15	0.13	-
T-4		18.0	2.0:	-	5	2	-	0.26	-	-
T-5		19.3	2.0	-	4	2	-	0.23	-	-
A-1		15.86	1.59	1.57	6	4	2	0.18	0.27	-
A-2		16.14	1.05	1.16	6	4	4	0.14	0.18	0.28

Until spring 1974 the Praesepe cluster has been kept under control for a total time of 425 hours, in which 33 flare stars were discovered: $n_1 = 27$ of them had just one flare, $n_2 = 5$ showed 2 flares. Ambartsumian (1969) gave a formula for the estimation of the number of all possible flare stars which up to now could not be detected:

$$n_0 = \frac{n_1^2}{2n_2}$$

from which we can calculate the total number N of flare stars in the region.

$$N = \sum n_k \quad (k=0,1,2,\dots).$$

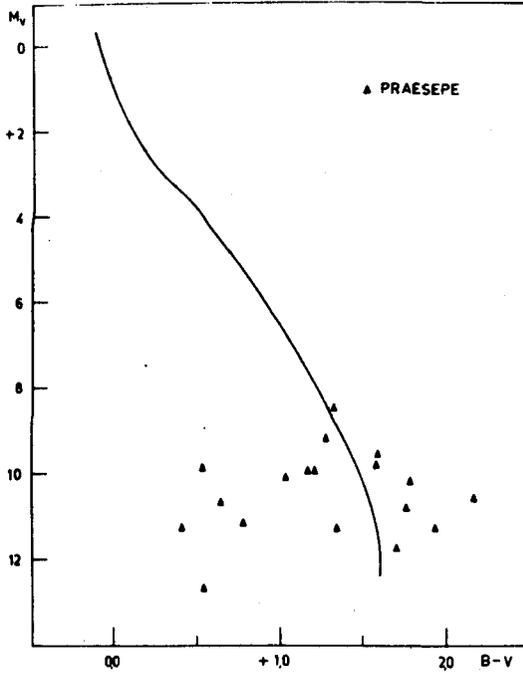


Fig.1. The Praesepe flare stars in the HR-diagram.

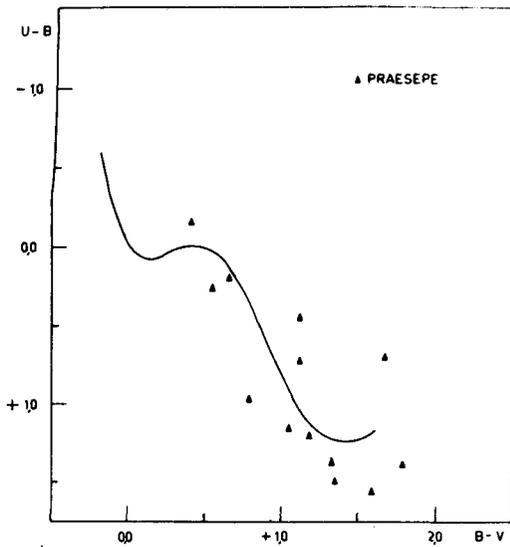


Fig.2. The Praesepe flare stars in the colour-colour diagram.

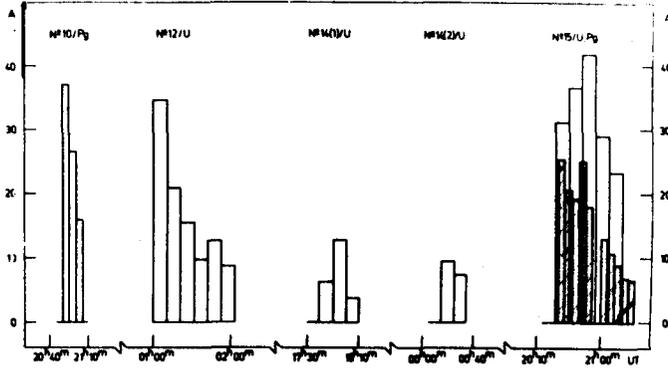


Fig. 3. Some examples of light curves of Praesepe flare stars. The figure shows at right a simultaneous observation of the flare star No. 15 at Byurakan (in U band) and at the Konkoly Observatory (in pg region).

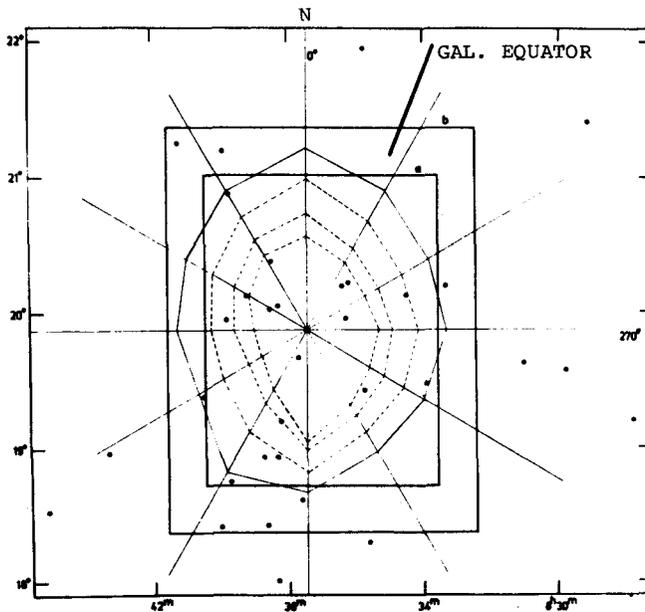


Fig. 4. The distribution of 33 flare stars in the Praesepe region.

From the available observational data we can estimate a total number of approximately 100 flare stars in the field of Praesepe. These results indicate that there should be less flare activity in the Praesepe region than in the Pleiades, a fact which was emphasized by Haro already in 1968.

References:

- Ambartsumian, V., 1969, *Zvezdy, Tumannosty, Galaktiky*, Jerevan, Izd. Akademii Nauk ASSR
- Artjukhina, N., 1962, *Astronomicheskij Zhurnal*, 39, 1050
- Haro, G., 1968, *Stars and Stellar Systems*, Vol. VII. page 141
The University Press of Chicago
- Jankovics, I., 1973, *Information Bulletin on Variable Stars*, No. 839
- Rosino, L., 1966, *Contr. Asiago Obs.* No. 189