FLARE STARS IN STELLAR AGGREGATES

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After the report on flare stars presented by Ambartsumian and the author (1971) at the last Bamberg Colloquium, some success has been achieved in the study of these interesting objects.

Optical observations of stellar flares with high time-resolution undoubtedly proved the explosive character of this phenomenon and the non-thermal nature of the radiation that appears at least at the beginning of the flare. Parallel optical and radio observations of flares in stellar aggregates complicated the interpretation and showed how far we are from an understanding of the physical nature of this phenomenon. Finally, new optical observations of stellar flares in aggregates of different age confirmed the evolutionary significance of this stage in the life of a star and led to the study of certain regularities in the evolution of flare stars.

Although new results in the investigation of flare stars did not reveal the physical nature of the flare phenomenon, they did lead to a further study of problems which are directly connected with the evolution and the physical properties of flare stars. The problems related to flare stars in stellar aggregates were discussed in recent years by Haro (1976), as well as by Ambartsumian and the author (1975, 1977). In this paper we shall deal with certain questions concerning mainly the evolution of these stars.

The fact that the flare star phenomenon presents a regular phase in the evolution of a star was revealed by the detection and study of flare stars in stellar aggregates, i.e., in associations and comparatively young star clusters. Let us first briefly review the history of this problem. After Ambartsumian (1954) had interpreted the observational data and shown that there exists a close connection between flare stars and young T Tauri-type stars, Haro and his collaborators (1957) were the first to discover flare stars in the Orion association. This discovery together with Johnson and Mitchell's (1958) detection of the first flare star (HII 1306) in a considerably older system, the Pleiades cluster, revealed the evolutionary significance of these stars.

In 1968, Haro and Chavira studied already existing observational data on flare stars present in stellar aggregates of different ages which had been obtained at the Tonantzintla and Asiago observatories and noticed several important regularities in the time-depending changes such as an advancing spectral class of the brightest flare star; a decrease in the dispersion of flare stars around the main sequence in the Hertzsprung-Russell diagram; a weakening of the connection with diffuse matter, etc. These observations were later confirmed by Rosino (1969).

When V.A. Ambartsumian (1969) estimated the total number of flare stars in the Pleiades aggregate, he found that they were exceptionally numerous. His study indicated that the flare star stage is one of the regular early phases in the life of a star which is common for all dwarf stars. The principal importance of this conclusion stimulated systematic observations of flare stars in stellar aggregates; they all confirmed the high abundance of these stars in all studied systems: in the Pleiades (i.e., Ambartsumian and Mirzoyan, 1977), Orion (Haro, 1976), Praesepe (Jankovics, 1975), Cygnus (around V 1057 Cyg)(Tsvetkov, 1976), etc.

One of the important questions connected with the evolutionary significance of flare stars is whether all stars in a certain aggregate that have a low luminosity show flare activity at the same time. In other words, do all stars of a given mass that have all entered the flare star stage, stop their flare activity almost simultaneously. This question was studied by Ambartsumian (1969) for the stars of the Pleiades aggregate. The unexpected high number of flare stars in this system led him to the conclusion that all its stars which are fainter than visual magnitude 13.3^m must be flare stars. But soon it was found (Ambartsumian et al., 1970) that among 78 probable members of the Pleiades cluster (according to Hertzsprung et al., 1947) with photographic magnitudes between 14.50^m and 16.05^m only half of them showed noticeable flare activity during the period when the observations were carried out.

This result is confirmed by all flare observations made up to now. 144 probable members of the Pleiades aggregate (Ambartsumian et al., 1977) with photographic magnitudes between 12.8^m and 16.8^m, were observed until 1 May 1976 (Mirzoyan et al. 1977); of these, only 54 objects showed flare activity.

The total number (n_o) of unknown flare stars in a system can be estimated from the relation

$$n_o = \frac{n_1^2}{2n_2} , \qquad (1)$$

where n_k is the number of flare stars already observed with k (k=1 or 2) flares (see e.g., Ambartsumian and Mirzoyan, 1975). Employing this relation, it is found that additional 13 potential flare stars are present, among mentioned 144 probable members of this system.

A change of the luminosity interval limits, changes this portion of flare stars among the probable members of the system only slightly. If we take e.g., photographic magnitudes 14.50^m and 16.05^m, it appears that only a few more than one half of the probable members of the system (41 among 78) possessed flare activity during the time of observations. We see that in both cases only about half of the probable members of the Pleiades aggregate showed (or could show) flares during the past 15 years.

For the explanation of this fact two contradicting assumptions may be proposed (Mirzoyan and Ohanian, 1977):

1. The stage of flare activity has a certain cyclic recurrence, like the solar activity, and periods of comparative calmness are followed by periods of high activity.
2. The duration of the flare activity of flare stars of the same mass (and probably luminosity) is different for different individual stars and the values of this parameter show a very large dispersion.

In order to be able to choose between these two alternatives, we have studied the statistics of all registered flares in the Pleiades region, dividing the known flares into two independent samples according to the time they were observed: flares observed during the period 1957-1970 (Sample I) and flares observed between 1970 and 1975 (Sample II). The effective observing time (t) is approximately the same for both samples. Corresponding data are listed in Table 1 where n is the number of all known flare stars in the system. Data given in sample I are independent on the data of sample II.

With these data the number of known flare stars among the probable members of the Pleiades aggregate (Hertzsprung et al. 1947) has been calculated for samples I and II (Table 2). The numbers are approximately the same for both samples. When formula (1) is used, the portion of flare stars turns out to be about half as large before and after 1970.

Table 1.

Distribution of Flare Stars in the Pleiades Aggregate Before and After 1970

k	n_k	
	I (t = 1374^h)	II(t = 1238^h)
1	151	240
2	64	42
3	21	26
4	16	10
5	6	11
$\geq$ 6	12	5
n	270	334

Table 2.

Number of Known Flare Stars Among Probable (According to Hertzsprung et al. 1947) Members of the Pleiades Aggregate Before and After 1970

	Probable Members	Observed Flare Stars	
		I	II
12.80-16.80	144	42	38
14.50-16.05	78	28	27

The fact that we find for our samples I and II the same number of flare stars among the probable members of the Pleiades aggregate agrees with both assumptions mentioned above, since the total number of flare stars in the system must be approximately constant in both cases. But if the assumption of a cyclic recurrence of flare activity is correct, the samples must have a different composition, and the time-dependent distribution of flares of individual stars must be different for the two assumptions. This fact can be used to

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choose between the assumptions (Mirzoyan and Ohanian, 1977). The number of flare stars which could accidentally be observed in k flares during each of the periods I and II is given through Poisson's approximation (Ambartsumian et al. 1970).

$$\tilde{n}_k = N\, e^{-2\nu t} \frac{(\nu t)^{2k}}{k!k!} \tag{2}$$

where N is the total number of flare stars in the system, assumed to be the same for both samples, and ν the mean frequency of the flares; the effective time t of the photographic observations of the system is roughly the same for both samples.

On the other hand, the number n_{2k} of stars which are observed in 2k flares during all photographic observations of the Pleiades region, is determined by

$$n_{2k} = N\, e^{-2\nu t} \frac{(2\nu t)^{2k}}{(2k)!} \tag{3}$$

The duration of all observations is assumed to be 2t.

From expressions (2) and (3) we obtain the ratio

$$\frac{\tilde{n}_k}{n_{2k}} = \frac{(2k)!}{2^{2k}k!k!} \tag{4}$$

This ratio can be calculated for different values of k and can then be compared to the observations. In the case of the cyclic recurrance of flare activity, the observed values of this ratio must be smaller than the calculated ones. Table 3 lists the different values found.

It is apparent that for all values of k the theoretical ratio is larger than the observed one. It means that the distribution of flares in time is not the same for the samples I and II, and that our assumption about a cyclic recurrance of flare activity is more probable (Mirzoyan and Ohanian, 1977).

This conclusion is supported by the data listed in Table 4 for 16 flare stars.

In 4 of these stars (Nos. 62, 108, 149, and 201), four to five flares were observed in period I and no flares in period II. Just the opposite is true for the four stars Nos. 244, 257, 326 and 467; they showed no activity during period I, whereas 4, 5, 7 and 5 flares respectively, were registered during period II. For each of the remaining 8 stars only one single flare was observed during one period and from 5 to 8 flares in the other.

Table 3.

The Ratio of the Number of Flare Stars $\tilde{n}_k$ that Showed k Flares in the Pleiades Aggregate Before and After 1970 to the Number of Flare Stars n_{2k} that Showed 2k Flares During the Whole Period of Observation.

k	$\tilde{n}_k/n_{2k}$	
	Expected	Observed
1	0.50	0.41
2	0.38	0.29
3	0.31	0.17
4	0.27	0.20
5	0.25	0.17
6	0.23	0

Of course, such cases could also be expected if the flare activity remained constant so that the distribution of flares in time was uniform. But a systematically larger number of such cases as compared to the expected number, is decisive evidence in favour of our assumption of cyclic recurrence of flare activity. For instance, the mathematical expectation of the case that we observed eight flares in one period and only one single flare in other - case (8.1)- is 1/15, whereas one such case is observed; the mathematical expectation for a case (7.0) is 1/10, and for a case (5.0) it is 1, but observed are 1 and 3 cases, respectively.

Table 4.

Number of Registered Flares (n) Before and After 1970 for Some Flare Stars of the Pleiades Aggregate

No.	HII	m_{pg}	n I	n II
8	357	14.9	8	1
15		17.9	5	1
40		18.0	6	1
62		17.0	4	0
105		16.4	1	6
108		14.8	4	0
143		17.5	1	5
149	146	15.6	4	0
180		17.1	5	1
201		18.5	5	0
244	1128	15.4	0	4
245		18.4	1	5
257		18.6	0	5
326		18.4	0	7
335	1321	16.2	1	5
467		16.6	0	5

It is interesting to note, that the number of registered flares in these stars of samples I and II is practically the same (45 and 46) respectively. This would be quite unprobable if the hypothesis were correct that the occurrance of flares is independent on time (uniform random distribution). We must therefore assume that from the probable (according to Hertzsprung et al.,1947) members of the Pleiades aggregate with low luminosities, about half of them did not show or were not able to show flares-not because they have already stopped their flare activity but only because the observations embrace the calm periods of their activity. It may be added that the number of unknown flare stars in a system given by formula (1) which is based on the assumption that all flare stars have the same frequency of flares, gives only a lower limit of that number; the actual number can be twice as large (Ambartsumian et al., 1970).

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From the same data it can also be concluded that for stars of the same luminosity the flare activity stops practically at the same time. The observations indicate that there is a reduced activity until it finally stops (Ambartsumian and Mirzoyan, 1977). If the amplitude of a flare is introduced as a parameter characterizing the degree of relative flare activity, all known flare stars in the Pleiades aggregate can be divided into two groups: flare stars showing flares with a maximal photographic amplitude of at least $2^{m}_{.}0$, and those with flares of smaller amplitude. If a statistical treatment of these data is carried out separately for each of these groups, it appears that only about half of all flare stars of the system have already shown or are able to show flares with amplitudes $\geq 2^{m}_{.}0$, while the mean brightness of the known flare stars which have exhibited such flares is lower than the mean brightness of flare stars which are unable to show such flares. The relative flare activity of flare stars decreases clearly with increasing luminosity, i.e., the stop in flare activity of a star is preceded by a gradual decrease of this activity. Since the maximum relative flare activity of a star in a given system is determined by its age, the correlation between maximal possible amplitude and flare star luminosity was used by Parsamian (1976) in order to derive an estimate for the age of stellar aggregates.

The flare observations in the Pleiades aggregate showed finally that the mean flare frequency for different flare stars in this system differs by more than one order of magnitude. Whereas the first flare observations in the Pleiades region could be represented quite exactly by two Poisson distributions with different mean frequencies (Ambartsumian et al., 1970), it was later necessary after more observations had accumulated, to introduce three and more Poisson distributions (Mirzoyan et al., 1977).

The study of flare stars leads also to a better understanding of the physical nature of the flare phenomenon. Here the most important results were achieved analyzing observations of the UV Ceti type flare stars in the vicinity of the Sun. However, there are various evidences pointed out to a similarity of UV Ceti type stars and flare stars in stellar aggregates: one finds a great similarity in their energetic spectra (Krasnobabtsev and Gershberg 1975), light curves (Rodono,1975), colours,(Mirzoyan et al. 1977), the distribution of flares with the star's luminosity (Kunkel 1975) etc. Due to this similarity, we want to review below mainly observations of UV Ceti-type flare stars.

The emission of stellar flares is registered in a broad range of electromagnetic waves, from metre radiowaves (Lovell 1971) to X-ray waves (Heise et al. 1975). However, until now no correlation could be found between those characteristics in different spectral regions and such a correlation might not even exist (Bopp and Moffett 1973, Spangler and Moffett 1974, Moffett and Bopp 1976). This conclusion is strengthened by simultaneous optical and radio observations of flares in stellar aggregates (Tovmassian 1977). During the flare the spectrum of the star changes drastically and the more or less normal spectrum of a red dwarf star is transformed into the spectrum of a T Tauri-type star, showing strong short wave continuous emissions as well as line emissions.

For the physical interpretation of stellar flares the observational fact has great significance that flares can be divided into two phases: the fast phase of flaring-up (spike-phase), lasting usually up to several seconds, and the immediately following slow-phase, which lasts from minutes to several dozen minutes (Evans 1977). This division was first introduced by Kunkel (1967) and was recently supported strongly by optical observations made in particular at McDonald (Evans 1977, Moffett 1974), and Katania (see, e.g., Rodono 1975, Cristadly, and Rodono 1971) Observatories.

The first phase, when the flare intensity increases from minimum up to maximum is very short, but the light curve in this period is exceptionally interesting. It possibly corresponds to a very simple process of energy liberation, since energy conversion has probably not yet started. In order to determine the exact path of the light curve in this phase, observations with a time-resolution that gives at least 10-15 separate points during this period are necessary. Continuous registration of the star's brightness with a fountain-pen may not be sufficient and the use of a photon counter with a time constant of not more than 0.5 sec is advocated.

Spectral flare observations (Bopp and Moffett 1973, Moffett and Bopp 1976) show that the sharp brightness increase is due to continuous emission, whereas the slow increase, when the conversion of the liberated energy has already begun, is caused by emission lines.

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Some years ago it seemed that the optical flares could be explained with the nebular model proposed by Gershberg (1970) and Kunkel (1967). But it became soon apparent that it was very difficult to interpret the (U-B, B-V) diagram in the frame of this model (Mirzoyan 1966) and also an extended nebular model that used additional assumptions about the physical parameters of the hydrogen gas did not give satisfactory results. Kunkel (1970) therefore assumed that a third component contributed to the optical flare emission in the form of a hot spot that appeared on the surface of the star during the flare. Grinin and Sobolev (1977) studied the effect of the emission of negative hydrogen ions, when the flare appears at the limit of photosphere and chromosphere, but Ambartsumian (1977) showed that these ions might perhaps play a noticeable role in the slow phase of the flares but that they cannot explain the spike-phase phenomenon. The discussion of other, less popular theoretical interpretations of the flare phenomenon is beyond the scope of our report.

One can probable assume that the flares in the optical and radio regions of the spectrum are secondary processes; the energy is released by an explosive process and is initially transmitted by particles radiating in the X-ray range of the spectrum. This idea corresponds to Ambartsumian's (1954) original hypothesis about the liberation of the energy of discrete amounts of protostellar matter in the atmosphere of non-stable stars. If this assumption is correct, the physical parameters of the flare emission must noticeably change during the flare development. The colours of the flare emission change in fact in broad enough limits during different periods of the flare (see, e.g., Kunkel 1967) and also the spectral index of the radio emission changes (Tovmassian 1977, Spangler et al. 1974).

It should be added that in all proposed explanations of the continuous emission of flares, Ambartsumian's (1954) radical assumptions remain unchanged, namely that the energy sources are located in or transferred into the upper layers of the stars, and that they are responsible for all manifestations of this additional emission.

In conclusion, we thank Prof. V.A. Ambartsumian for the valuable discussion of this paper.

References:

Ambartsumian, V.A., 1954, Comm. Byurakan Obs., 13, in Russian.
Ambartsumian, V.A., 1969, Stars, Nebulae, Galaxies, Ac. Sci. Armenian SSR, Erevan, p. 283, in Russian.
Ambartsumian, V.A., 1977, Flare Stars, Ac. Sci., Armenian SSR, Erevan, p. 173, in Russian.
Ambartsumian, V.A., Mirzoyan, L.V., 1971, New Directions and New Frontiers in Variable Star Research, IAU Colloquium No. 15, Veröff. Bamberg, 2, No. 100, 98.
Ambartsumian, V.A., Mirzoyan, L.V., 1975, Variable Stars and Stellar Evolution, IAU Symposium No. 67, eds. V. Sherwood and L. Plaut, Reidel Publ. Co., Dordrecht, p. 3.
Ambartsumian, V.A., Mirzoyan, L.V., 1977, Flare Stars, Ac. Sci. Armenian SSR, Erevan, p.63, in Russian.
Ambartsumian, V.A., Mirzoyan, L.V., Parsamian, E.S., Chavushian, H.S. Erastova, L.K., 1970, Astrofizika, 6, 3, in Russian.
Bopp, B.W., Moffett, T.J., 1973, Ap. J., 185, 239.
Cristadly, S., Rodono, M., 1971, Inf. Bull. Var. Stars No. 525, No. 526.
Evans, D.S., 1977, Flare Stars, Ac. Sci. Armenian SSR, Erevan, p. 40 in Russian.
Gershberg, R.E., 1970, Flares of Red Dwarf Stars, Nauka, Moscow, in Russian.
Grinin, V.P., Sobolev, V.V., 1977, Flare Stars, Ac. Sci. Armenian SSR, Erevan, p. 169, in Russian.
Haro, G., 1957, Non-Stable Stars, IAU Symposium No. 3, ed. G.H. Herbig, University Press, Cambridge, p. 26.
Haro, G., 1976, Bol. Inst. Tonantzintla, 2, 3.
Haro, G., Chavira, E., 1968, Vistas in Astronomy, Vol. 8, eds. A. Beer and K.Aa.Strand, Pergamon Press, London, p. 89.
Heise, J., Brinkman, A.C., Schrijver, J., Mewe, R., Gronenschild, E., den Boggende, A., Grindlay, J., 1975, Ap. J., 202, L73.
Hertzsprung, E. , Sanders, G., Kooreman, C.J. et al., 1947, Ann. Leiden Obs. 19, No. 1a.
Jankovics, I., 1975, Flare Activity of Red Dwarf Stars in the Open Star Cluster Preasepe Region, University of Erevan, Erevan, in Russian.
Johnson, H.L., Mitchell, R.I., 1958, Ap. J., 128, 31.
Krasnobabtsev, V.I., Gershberg, R.E., 1975, Izv. Crim. Astrophys. Obs., 53, 154, in Russian.

Kunkel, W.E., 1967, An Optical Study of Stellar Flares, the University of Texas, Austin.

Kunkel, W.E., 1970, Ap. J., 161, 503.

Kunkel, W.E., 1975, Variable Stars and Stellar Evolution, IAU Symposium No. 67, eds. V. Sherwood, and L. Plaut, Reidel Publ. Co., Dordrecht, p. 15.

Lovell, B., 1971, Quart. Journal R.A.S., 12, 98.

Mirzoyan, L.V., 1966, Astrofizika, 2, 121, in Russian.

Mirzoyan, L.V., Chavushian, H.S., Erastova, L.K, Ohanian, G.B., Melikian, N.D., Natsvlishvili, R.Sh., Tsvetkov, M.K, 1977, Astrofizika, 13, 203, in Russian.

Mirzoyan, L.V., Ohanian, G.B., 1977, Astrofizika, in press.

Moffett, T.J., 1974, Ap. J., Suppl., 29, 273.

Moffett, T.J., Bopp, B.W., 1976, Ap. J. Suppl., 31, 61.

Parsamian, E.S., 1976, Astrofizika, 12, 235, in Russian.

Rodono, M., 1975, Variable Stars and Stellar Evolution, IAU Symp. No. 67, eds. V. Sherwood and L. Plaut, Reidel Publ. Co., Dordrecht, p. 69.

Rosino, L., 1969, Low-Luminosity Stars, ed. Sh.S.Kumar, Gordon and Breach Science Publishers, N.Y., London, Paris, p. 181.

Spangler, S.R., Moffett, T.J., 1974, Ap. J., 203, 479.

Spangler, S.R., Shawhan, S.D., Rankin, J.M., 1974, Ap. J., 190, L129.

Tovmassian, H.M., 1977, Flare Stars, Ac. Sci. Armenian SSR, Erevan, p. 23, in Russian.

Tsvetkov, M.K., 1976, A Study of Non-Stable Stars in the Region of NGC 7000 and IC 5068-70 Nebulae in the Cygnus, University of Erevan, Erevan, in Russian.

D I S C U S S I O N of paper by MIRZOYAN:

RUCINSKI : I would like to point out that there is evidence that rotation is the main factor (or reason) for the flare activity: the recently studied eclipsing binary CM Dra (C. Lacy 1977, private information) consisting of two identical red dwarfs seems to be rather old; its spectra taken at Victoria looks quite similar to those of the Barnard Star, a Population II object. It is a lower-mass analogon and flares were observed in it; its components rotate in synchronism with the orbital revolution (about 1.2 days). It seems to be a good proof that rotation (irrespective of its cause) gives rise to all the other stellar activities, including chromospheric, flaring, spot, etc., phenomena.

KIPPENHAHN: I think we can roughly tie the T Tauri stars into a scheme of stellar evolution, can we do that also with flare stars? They have many things in common with T Tau stars. They appear in young associations, they lie above the main sequence. Recently Hartman and Anderson (Ap. J., 213, L67) reported that an absorption line in the flare star EQ Her indicates infall of material with a velocity of 70 km/sec. Does this indicate that they have an infalling envelope? Or do flare stars have nothing to do with star formation as indicated by the population II flare stars, Rucinski just told us about?

MIRZOYAN: Yes. The problems connected with evolutionary significance of flare stars, in particular their place in the scheme of stellar evolution, have been discussed in the paper of Ambartsumian and the author, presented at the previous Bamberg Colloquium (see also, Ambartsumian and Mirzoyan, in V. Sherwood and L. Plaut, Variable Stars and Stellar Evolution, Reidel,Dordrecht, p. 3). The main conclusion is that flare activity follows after the T Tauri activity, that is the stage of flare stars follows the T Tau stage of stellar evolution. The observations of flare stars in the galactic field in different regions of the sky made in Byurakan during about 200^h of observing, showed only one single flare. Such a result can be expected if we believe that flare stars present one of the early stages of stellar evolution and that all of them are formed in stellar aggregates.

KOPAL: Is it necessary for flares to signify a specific evolutionary stage of the respective star? They constitute essentially atmospheric phenomena, which are controlled only very indirectly by the deep interior.

MIRZOYAN: The conclusion that the flare stars present one of the earlier stages of the evolution of the stars followed from the observational fact of unusually high abundance of flare stars in young stellar systems.- in stellar aggregates.

GEYER: Concerning Dr. Kippenhahn's comment, I would like to stress that we observe radio emission from flare stars, which is not known from T Tauri objects, as far as I know.

HJELLMING: T Tauri has been shown by Sherwood and Schwartz to be a weak radio source.

KRAFT: Isn't it true that the absence of radio emissions from T Tau stars (in comparison to flare stars) is simply a question of flux? That is, flare stars are all nearby M-dwarfs, whereas T Tau variables are distant giants. A few flare stars have strange positions in the (U,V) diagram - so not all are young from the kinematical point of view.

MATTEI: Gurzadyan suggested an interesting evolutionary sequence between T Tau stars and flare stars; in that T Tauri stars may precede flare stars. They may have continuous flaring activity which may give rise to UV excess. As they evolve, flaring activity decreases and becomes only occasional, as in flare stars. UV excess then is seen only during flares. In view of your extensive work with flare stars, do you feel there may be an evolutionary sequence between these type of variables?

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MIRZOYAN: The problem of the relation of flare stars to T Tau stars has been discussed by Ambartsumian in 1953, mentioning some physical similarities between them. Aterwards, Haro found some evidence in favor of the idea, that T Tau stage of stellar evolution precedes the flare stage. This question has been considered in detail by Ambartsumian (Astrofizika, 6, 31,1970), showing that the T Tau stage and flare stage of evolution are mutually overlapping, and that flare activity arises only at a later phase of variability, just in the end of the T Tauri stage.

ROSINO: Is the systematic survey of flare stars still continuing at the Byurakan Observatory, and in which fields? Is the new large telescope employed also to take spectra of known flare stars?

At Asiago, the survey of the Pleiades cluster has been discontinued at the end of 1973. Two nebular fields are under observation now, to discover flare stars, namely: the region around MH_2 190 and that of NGC 2264 in Monoceros. Several flare stars have been identified, and the results will be published within the next few months.

MIRZOYAN: Yes. In Byurakan we continue the photographic observations of flares in the Pleiades and around V1057 Cyg regions. Besides, one of our post-graduate students from Hungary, I. Jankovics, made a survey of flare stars in the Praesepe aggregate (he will present here a short report on obtained results), and another post-graduate student from Bulgaria, M. Tsvetkov, made a survey of flare stars in the region around V1057 Cyg (see, for instance, Flare Stars, Proceedings of Byurakan Symposium, Ac. Sci. Armenian SSR, Erevan, 1977).

We also intend to use our new 2.6-m telescope for spectral observations of the known flare stars in the Pleiades aggregate.

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