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NEW FLARE STARS AND REPETITIONS IN THE ORION ASSOCIATION REGION. II.

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RESUMEN

Se encuentran 20 nuevas ráfagas y 20 repeticiones de ráfagas conocidas en material fotográfico obtenido con la cámara Schmidt del Observatorio de Tonantzintla en la región de la asociación de Orión. Las ráfagas de las estrellas T12 y T143 se consideran como ráfagas lentas. Se dan datos sobre las ráfagas observadas en las Subfuors V1118 Ori y V1143 Ori.

ABSTRACT

20 new flare stars and 20 repetitions of known flare stars were found on photographic material obtained with the Schmidt telescope of Tonantzintla Observatory in the Orion association region. Flare of stars T12 and T143 may be considered as slow ones. Data on flares observed in Subfuors V1118 Ori and V1143 Ori are given.

Key words: **STARS-FLARE**

1. INTRODUCTION

During the examination of the photographic observational material of Tonantzintla Observatory obtained in 1977-1982, and re-examination of plates obtained since 1959, 20 new flare stars and 20 repetitions of flares in known flare stars were found.

Flare star investigations are of special interest in the case of extremely young star formation regions, such as associations of Orion, Cygni (NGC 7000), NGC 2264, etc. The most widely observed is the Orion association. This region was intensively observed in Tonantzintla Observatory according to the program suggested by Haro (1968, 1976) from 1952 till 1982. From the 548 flare stars and 825 flares known up to day, 288 flare stars and 186 repetitions were detected in Tonantzintla (Haro 1968; Haro & Chavira 1969; Parsamian, Chavira, & González 1978; Parsamian & Chavira 1990; Chavira & Parsamian 1991; present work).

The search of flare stars in stellar aggregates were made by multiple exposure observations, used first by Haro & Morgan (1953).

2. OBSERVATIONS

The observations were carried out at the Tonantzintla Observatory with the 26″ Schmidt telescope in U and photographic region. The data on new flare stars and flare repetitions of known flare stars are presented in Tables 1 and 2 respectively. In the first column of Table 1 the Tonantzintla numbering of the new flare stars are given; in the second column the numbers from the Parenago's Catalog (1954) or General Catalog of Variable Stars (GCVS); the approximate equatorial coordinates for equinox 1950 (the uncertainties are $\alpha \pm 3^s$, $\delta \pm 10''$) are in the third and fourth columns; in the fifth to ninth columns the ultraviolet magnitudes of the stars at minimum brightness, the ultraviolet amplitude of the flares, the presence of Hα in emission, the dates of flares and the references are given respectively. On Figure 1 (Plate 19) the areas in which the new flare stars in Orion association region were detected are shown. Finding charts of these stars are given in Figure 2 (Plate 20). All the charts are oriented with north at the top and east to the right.

3. DISCUSSION

As a result of the present work 20 new flare stars and 20 repeated flares of the known flare stars were found. Some of these flares are of particular interest. This concerns the slow flares of stars T12 and T143.

A flare is considered as slow one if the rise time to maximum brightness lasts several tens of minutes instead of seconds or minutes as in the case of fast ones. Ambartsumian (1954) predicted the possibility of slow flares and Haro (1968) was the

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TABLE 1

NEW FLARE STARS IN THE ORION ASSOCIATION

No.	Star	α (1950)	δ	U	ΔU	Hα	Date Flare
340	...	$5^h24^m51.72^s$	$-5°42'21.70''$	16.7	1.3	...	27.01.65
341	...	27 07.02	−7 26 31.43	16.8	2.8	...	21.01.82
342	...	27 50.11	−6 30 34.50	18.4	3.4	...	03.01.82
343	...	28 21.53	−6 08 36.75	18.4	3	...	22.01.82
344	...	29 53.00	−6 35 43.37	18.6	2.6	...	05.02.65
345	...	30 26.54	−6 07 45.78	18.4	3.9	...	26.10.81
346	P1062	30 32.08	−4 48 46.12	16.8	2.6	...	26.10.81
347	...	31 22.17	−7 17 49.85	18.5	2.8	...	29.12.64
348	...	31 33.58	−4 22 50.55	17.6	0.5	...	26.01.65
349	V1118[a,b]	32 17.16	−5 35 53.75	18.8	2.0	eα	07.02.67
350	P1631	32 24.42	−4 30 54.23	16.2	1.6	...	19.01.66
351	...	32 51.67	−4 17 56.19	18.6pg	2.2pg	...	21.10.62
352	P2220	33 23.02	−3 59 58.45	16.1	0.6	...	19.01.82
353	...	33 26.76	−4 12 58.73	18.4	2.4	...	24.12.65
354	...	34 48.95	−4 03 04.67	18.2	2.8	...	11.02.78
355	P2612	35 25.87	−6 41 07.46	15.2	2.9	...	26.01.82
356[c]	...	35 39.78	−5 03 08.40	16.5	0.9	eα	21.01.82
357	P2685	36 04.74	−5 05 10.21	15.0	1.3	...	07.01.81
358	...	37 38.17	−5 34 17.00	17.0pg	0.9pg	...	23.10.62
359	...	39 54.26	−5 29 26.87	16.6	0.9	...	23.01.82

[a] Parsamian et al. (1992); [b] Gasparian et al. (1990); [c] Parsamian & Chavira (1982).

first to observe them. According to the shape of the light curves, slow flares were divided into three types (Parsamian 1980). The slow flare of the star T12 (Figure 3) is of type II. In the case of slow flare of type II the star after slow rise to maximum brightness remains at that brightness for several tens of minutes. One of the possible explanations of type II flares is to regard them as a rare case of superposition of several slow flares which take place in the same layer of the star atmosphere at small time interval, perhaps having a common source (Parsamian & Oganian 1990). Only 8 out of 25 known slow flares in the Orion association may be regarded as of type II.

The most prominent slow flare was observed in Orion flare star T177 (Haro & Parsamian 1969).

Flare star T12 is variable, m_{pg} = 16.8 − >17, (Rosino & Cian 1962). Before the flare its ultraviolet magnitude was 17.4 mag. A flare was observed on 19.01.1982, when its ultraviolet magnitude reached 15.6 mag. The exposure time for every six images on the plates was 15 minutes. The error of magnitude measure is ±0.1 mag. The star remained at that brightness about 90 minutes. On the next plate which was taken after seven minutes the star reached 15.4 mag and remained at that maximum brightness level another 90 minutes. The decrease of brightness was very slow. After 150 minutes its brightness decreased to only 15.7 mag.

On the next day the star magnitude was m_u = 16.8. The rise time of T12 is not known, but the duration of flare in maximum brightness showed that it was of the type II. The star showed strong variation in Hα (Haro 1968). We suggest that it is possibly a T Tau type star.

The flare of another star, T143, showed a combination of slow and fast flares (type III). The rise by less than 0.5 mag continued about 30

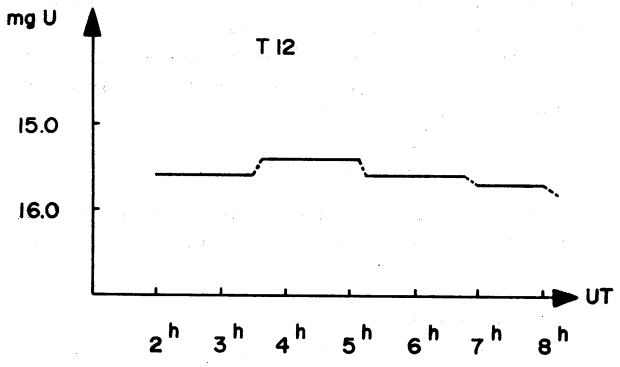

Fig 3. Light curve of slow flare of star T12.

TABLE 2

REPEATED FLARES IN THE ORION ASSOCIATION

No.	Star	U	ΔU	Hα	Date Flare	Ref.[a]
12	...	17.3	2.1	eα	19.01.82	1,2
71	...	17.5	2.0	...	23.01.82	1
143	P1502	17.6	1.5	eα	21.01.82	1,2
150	...	18.3	2.9	...	22.01.82	1
176	...	16.8	0.8	eα	29.12.81	1,2
219	P1609	16.8	2.2	...	19.01.82	3
224	P1790	16.2	1.1	...	23.12.81	3
257	...	17.2	1.9	...	08.01.65	4
260	...	17.4	1.9	...	29.01.65	4
294	...	18.5	2.7	...	14.02.66	5
296	...	17.3	2.1	...	13.12.72	5
328	P2186	17.2	4.3	eα	31.01.81	4,2
333	P2326	16.0	2.4	eα	24.01.82	5,2
349	V1118	18.8	2.6	eα	12.01.77	6,7
349	V1118	18.8	3.1	eα	11.01.81	6,7
350	P1631	16.2	0.8	...	24.12.76	8
B32[b]	V1143	18.6	...	eα	20.01.63	9,10
B32	V1143	18.6	2.0	eα	07.04.88	11
AB18	...	18.0	1.0	...	28.12.59	12
AB105	...	16.1	0.9	...	13.12.72	13

[a] References: (1) Haro 1968; (2) Parsamian & Chavira 1982; (3) Haro & Chavira 1969; (4) Parsamian et al. 1978; (5) Chavira & Parsamian 1991; (6) Parsamian et al. 1992; (7) Gasparian et al. 1990; (8) present work; (9) Parsamian et al. 1991; (10) Kosai 1983; (11) Natsvlishvili 1991; (12) Kiladze 1972; (13) Natsvlishvili 1982.

[b] This flare was observed spectroscopically.

minutes more. It means that the flare was a very slow one. Afterward a fast flare began and the star brightness arose by 1.5 mag and remained at 16.1 mag about 45 min and then decreased very fast. The total time of flare duration was about 2 hrs. Only one flare of type III was known before in the Orion association.

In the lists of flare stars (Tables 1,2) are included also Subfuors (Exors) V1118 Ori (T349) and V1143 Ori (B32), which showed fuorlike brightness variations (Kosai 1983; Shanal 1984; Natsvlishvili 1984; Parsamian et al. 1991, 1992). The first flare of V1143 Ori was observed in Byurakan Observatory (Parsamian & Gasparian 1987). The flares of both Subfuors were detected earlier on direct (V1118 Ori) and on direct and spectral (20.01.1963) plates (V1143 Ori) at Tonantzintla Observatory by one of the authors (EP). The flare activity of Subfuors show that before their fuorlike brightness variations they demonstrate the characteristics of Orion population stars. During fuorlike variations their spectra were of T Tau type (Iijima & Rosino 1983; Herbig 1983; Gasparian et al. 1990).

4. CONCLUSION

During the examination and re-examination of the photographic material of the Tonantzintla Observatory (1959–1982) 20 new flare stars and 20 repetitions of known flare stars were found. The flare of the star T12 is a slow one of the type II. The star T143 shows a combination of slow and fast flares (type III). The data on the flares of Subfuors V1118 Ori and V1143 Ori are given. It shows that besides the fuorlike variation of brightness they show flare activity as well.

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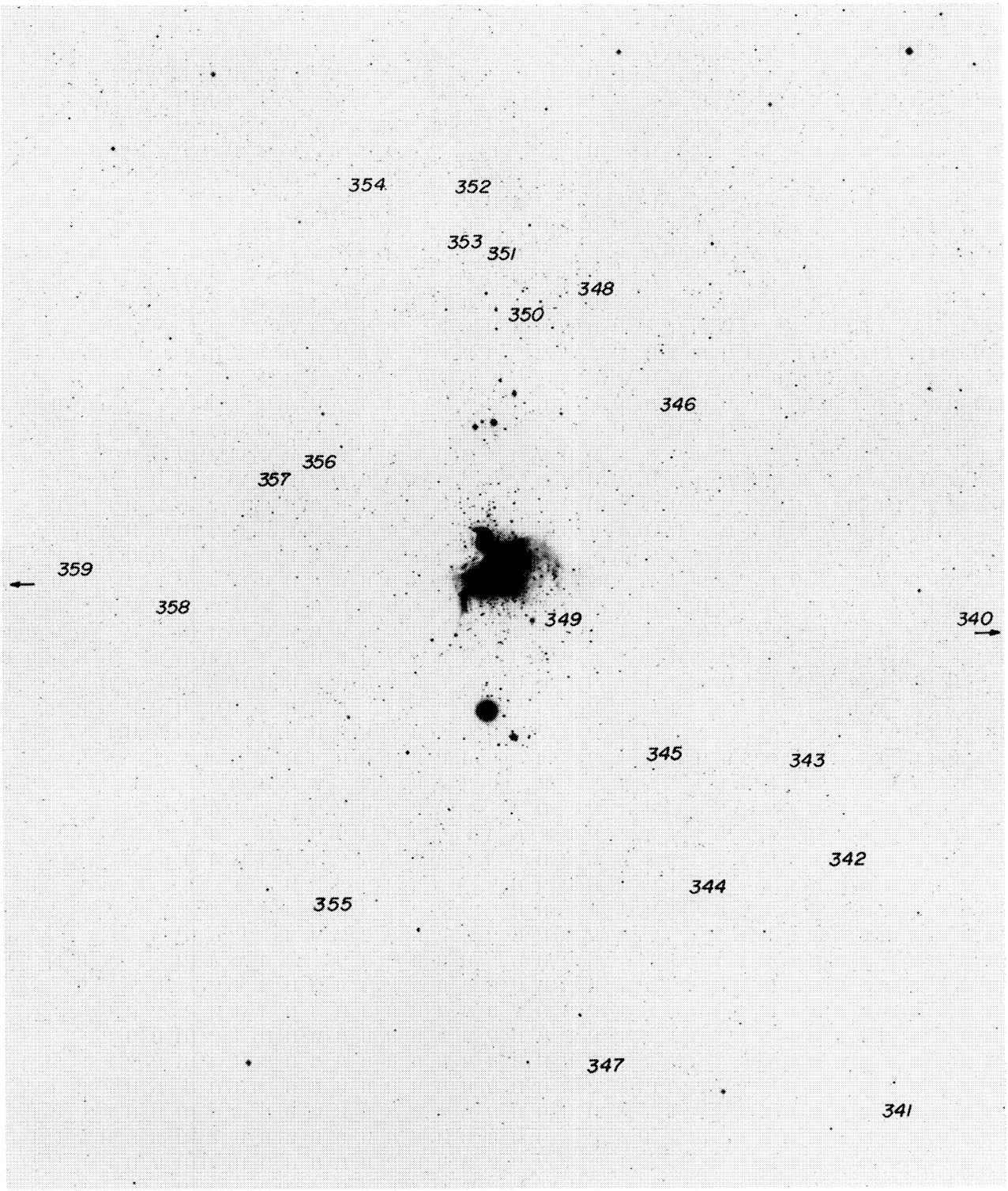

Fig 1. Approximate location of the new flares.

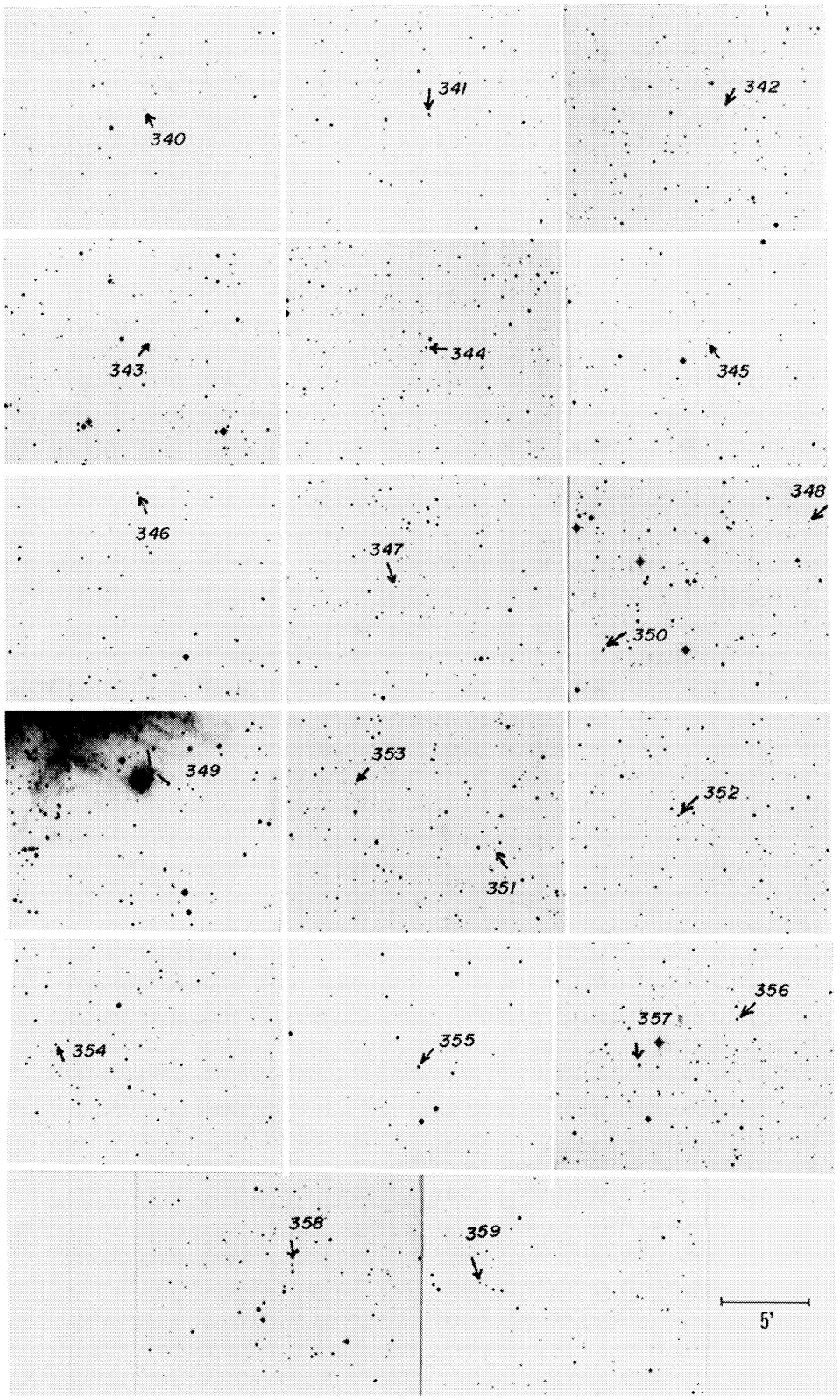

Fig 2. Identification charts for the flare stars.

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