BOLETIN DE LOS OBSERVATORIOS DE TONANTZINTLA Y TACUBAYA Nº 38, 6, 1972.

A RE-EXAMINATION OF THE PLEIADES TONANTZINTLA PHOTOGRAPHIC MATERIAL: 1963-1970. II

Guillermo Haro and Graciela González

SUMARIO

En un trabajo anterior anunciamos la necesidad de una segunda revisión del material fotográfico obtenido en el Observatorio de Tonantzintla sobre la región de las Pléyades durante los años de 1963 a 1970 y presentamos nuestros resultados preliminares. El presente trabajo contiene los resultados de nuestra segunda revisión, durante la cual se re-examinó cuidadosamente el material existente hasta el año de 1970 cubriendo toda el área comprendida en nuestras placas, sin restringir nuestra atención a un grupo particular de estrellas tal y como se hizo en la ocasión pasada. Además de encontrar algunas nuevas estrellas Ráfaga o la repetición de explosiones en otras ya conocidas, se llega a la conclusión de que mediante nuestro método fotográfico de imágenes múltiples en una misma placa las estrellas más tempranas, en las cuales se ha detectado el fenómeno ráfaga, corresponden al tipo espectral K2-K3 y que la estrella más brillante durante el mínimo tiene magnitud visual igual a 12.57.

ABSTRACT

In a previous work we announced the necessity of a second revision of all the photographic material on the Pleiades region obtained at the Tonantzintla Observatory during the years 1963 through 1970. The present work contains the results of this second re-examination. From the 148 outbursts detected, 12 correspond to "new" Flare stars. The rest are flare-up repetitions of previously known Flare stars discovered at the Tonantzintla, Asiago, Byurakan and Konkoly Observatories. We have found, among the "new" Flare stars, that the brightest of all the known ones is $H_{II}2034$ with visual magnitude 12.57 and spectral type probably K2-K3.

I. Introduction

In an earlier article by Haro and González (1970; "Paper I") we revised 550 plates, centered in Alcyone, containing 3,417 different exposures obtained during a total observational time of 703^h50^m. In that occasion our attention was mainly focused in the stars for which either Kraft and Greenstein or McCarthy had obtained slit spectrograms, and in a rather small sample of known very faint Flare objects in the Tonantzintla lists we were looking for possible outbursts or flare-up repetitions.

In the present work we have carefully re-examined the whole field covered by our material without restricting our attention to a given group of stars, thoroughly checking all our plates. Notwithstanding, all the Flare stars found previously were marked, and thus —with or without intention— we introduced some kind of an observational selection in our rechecking. A good number of the new Flare stars found, or the flare-up repetitions detected, had already been marked during our first examination but, for one reason or other, we had not published them. Anyways, we also found flare-ups that escaped our attention in the first and second revisions.

II. New Flare Stars and Repeated Outbursts Found

The results of the present re-examination are summarized in Tables 1 and 2. In Table 1 a provisional new serial numbering is used, adding a *b* to each number in order to distinguish the new Flare stars from the ones listed and numbered before. This has been done because there is some confusion and mixing-up of serial numbers published by different Observatories. In a general catalogue that is under preparation by one of the authors (G. H.) we will put together all the Flare stars found in the Pleiades region in various Observatories, using a more definite serial numbering that will be arranged in order of increasing right ascension and avoiding —as far as possible— different numbers for the same star or repeating the same number for different Flare stars. Stars 2b and 6b in Table 1 have shown two different flare-ups in the re-examined material. Star 9b corresponds to $H_{II}2034$ which is up to now the brightest Flare star, at minimum, in the Pleiades ($V = 12.57$) and probably with a spectral type as early or earlier than K2. Flare star No. 11b was found independently at the Asiago Observatory and listed by them as No. 83.

Table 2 contains the Flare stars that have been found and published previously by the Asiago, Byurakan, Konkoly and Tonantzintla Observatories. In column one we give the original serial number

TABLE 1

New Flare Stars in the Pleiades Region (1963-1970)

No.	*Star*	*R. A. (1900)*	*Dec. (1900)*	*Mag. in U*	*ΔmU*	*Date of Flare-up*
1b		3^h33^m6	+23°11′	16.6	0.8	6 Feb. 1970
2b		3 33.8	23 36	20.5	6.3	22 Nov. 1963
3b		3 36.2	23 53	18.4	2.5	21 Dec. 1968
4b	HII 979	3 40.4	24 08	17.8	1.1	27 Oct. 1968
5b		3 41.3	22 03	21.0	5.1	10 Nov. 1963
6b		3 41.5	24 51	19.5	5.1	11 Nov. 1963
7b		3 42.7	23 55	18.8	3.4	12 Jan. 1970
8b		3 42.7	24 43	18.5pg.	1.0pg.	26 Oct. 1968
9b	HII 2034	3 42.8	23 40	14.2	0.8	6 Nov. 1966
10b		3 42.9	22 35	18.9	3.8	14 Nov. 1969
11b		3 45.9	25 30	20.0	4.5	16 Dec. 1968
12b		3^h47^m3	+25°38′	18.3	3.1	14 Jan. 1969

TABLE 2

Repeated Flare-ups Found in the Revised Tonantzintla Material 1963-1970

Original Number	*Star*	*ΔmU*	*Date of Flare-up*	*Other Numbers or Designations*	*Total No. of Flare-ups Observed**	*Notes*
T1		0.4	1966, XI-13		T = 2	
T6		5.3	1970, I- 7		T = 2	
T12		3.4	1970, II-27		T = 3	
T15	vM16	2.7	1969, XII-10	A13-24-61	4 + 2 = 6	
T18		3.0	1963, XI-11	A106	16 + 15 = 31	1
,,		3.4	1964, XI-1	,,		
,,		2.0	1965, XI-17	,,		
,,		1.2	1965, XI-28	,,		
,,		3.7	1966, XI-12	,,		
,,		1.8	1966, XI-16	,,		
,,		2.0	1967, XI-24	,,		
,,		3.3	1967, XI-29	,,		
,,		2.8	1968, XI-22	,,		
,,		2.3	1968, XII-20	,,		
,,		2.2	1969, I-12	,,		
,,		2.6	1969, XI-10	,,		
T18		3.0	1969, XI-12	A106		
T22		4.7	1967, XI-29		T = 2	2
T23		3.0	1965, XI-17	A93	2 + 2 = 4	
T30	$H_{II}3030$	1.0	1966, XII-8		2 + 1 = 3	
T35		1.0	1968, XII-21		2 + 2 = 4	
T36		1.8	1963, XI-21		4 + 4 = 8	2
,,		4.0	1965, XI-18			2
T36		2.1	1968, XII-21			
T40		1.0pg.	1968, X-27		3 + 2 = 5	
T40		2.5	1968, XI-23			
T46	$H_{II}793$	0.5	1965, XI-21		T = 3	
T46	$H_{II}793$	0.4	1967, XII-3			
T51	$H_{II}1827$	0.5	1968, XII-22		2 + 1 = 3	
T56	$H_{II}2601$	0.7	1963, XI-11		2 + 2 = 4	
T56	$H_{II}2601$	1.0	1965, XI-21			
T67		4.0	1966, XI-13		T = 3	

TABLE 2 (cont.)

Original Number	*Star*	*ΔmU*	*Date of Flare-up*	*Other Numbers or Designations*	*Total No. of Flare-ups Observed**	*Notes*
T67		1.2pg.	1968, X-28			
T70	$H_{II}212$	0.6	1967, XI-27		2 + 2 = 4	
T70	$H_{II}212$	1.2	1970, II-5			
T73	$H_{II}335$	0.6	1965, XI-17		2 + 1 = 3	3
T79		0.6pg.	1965, X-23		2 + 1 = 3	
T80	$H_{II}1069$	0.8	1963, XI-16		T = 3	
T81	$H_{II}1173$	2.7	1969, XI-9		T = 3	
T83		1.0pg.	1968, X-27	A79-K9	5 + 4 = 9	
„		2.0	1968, XII-18			
T83		2.5	1969, I-12			
T88	$H_{II}2193$	0.7	1969, X-19		2 + 2 = 4	
T88	$H_{II}2193$	0.7	1970, I-12			
T90		4.6	1969, X-18	A67	3 + 1 = 4	2
T92		2.8	1965, XI-21	A59	3 + 1 = 4	
T95		1.5	1963, XI-18		T = 3	
T96		4.3	1969, X-9		2 + 1 = 3	2
T97		4.0	1968, XII-18		2 + 1 = 3	
T99		1.8	1965, XI-21	A46	3 + 4 = 7	
T99		2.0	1965, XI-28			
T103		0.4	1963, XI-9	A63	5 + 10 = 15	4
„		0.9	1963, XI-10	„		
„		0.7	1963, XI-17	„		
„		0.8	1963, XI-18	„		
„		0.7	1963, XI-18	„		
„		0.9	1963, XI-19	„		
„		0.5pg.	1965, X-24	„		
„		0.6	1966, XI-10	„		
T103		0.8	1966, XII-12	A63		
T105		1.3	1963, II-17		2 + 1 = 3	
T106		2.6	1965, XI-26		T = 3	
T107	$H_{II}2208$	1.0	1968, XI-23		2 + 2 = 4	
T107	$H_{II}2208$	1.5	1969, XII-11			
T108		1.3	1963, XI-17	A44	3 + 1 = 4	
T109	$H_{II}2927$	0.8	1963, II-24		T = 4	
„	„	1.0pg.	1965, X-23			
T109	$H_{II}2927$	0.9	1965, XI-18			
T110	$H_{II}3019$	0.9pg.	1965, X-25		T = 2	
T111	$H_{II}3104$	1.0	1967, XI-27		3 + 3 = 6	
„	„	0.9	1968, XI-22			
T111	$H_{II}3104$	0.5	1969, X-8			
T112		>4.0	1965, X-26		T = 2	
T150		2.7	1968, XII-21		T = 2	
T151	$H_{II}1103$	0.6pg.	1965, X-25		T = 3	
T157	$H_{II}2144$	0.5pg.	1968, X-26		5 + 2 = 7	
T157	$H_{II}2144$	1.4	1969, XII-13			
T158		4.5	1963, XI-17	B169	2 + 4 = 6	
„		3.2	1965, XI-26			
T158		3.0	1968, XII-20			
T160	$H_{II}347$	1.0	1963, II-18	A72	3 + 3 = 6	
T160	$H_{II}347$	0.8	1970, I-13			
T162	$H_{II}676$	0.6	1967, XI-2		T = 2	
A1		0.5pg.	1968, X-24	T52	A + T = 2	
A3		1.5	1969, I-12	T54-A69	3 + 1 = 4	
A7		0.5	1966, XI-15	T38	A + T = 4	
„		0.4	1967, XI-27			
A7		0.6	1970, II-5			
A10	$H_{II}435$	0.5	1969, I-14		A + T = 2	

TABLE 2 (cont.)

Original Number	*Star*	*ΔmU*	*Date of Flare-up*	*Other Numbers or Designations*	*Total No. of Flare-ups Observed**	*Notes*
A14	$H_{II}924$	1.0	1969, I-13	B131	A + T = 2	2
A17		1.3	1969, XII-13	B134	A + T = 2	2
A18		2.0	1969, XII-11	B135	A + T = 2	
A23		1.0pg.	1968, X-27	B139-A57-86	3 + 1 = 4	
A33		0.5	1968, XII-13	B175	A + T = 2	
A34		0.8pg.	1968, X-28	B176	A + T = 2	
A36		4.0	1964, XI-7	B182	A + T = 2	
A40		2.0	1966, XI-13	B187	A + T = 2	
A45		3.0	1967, XI-28	B189	A + T = 2	
A47		1.5	1963, XI-19	B197	A + T = 2	
A50		3.0	1963, II-20	B201	A + T = 5	
,,		3.5	1965, X-27	,,		2
,,		3.2	1967, XI-8	,,		2
A50		3.8	1969, XII-11	B201		
A54		2.0	1965, XI-24	B238	A + T = 3	
A55		0.5pg.	1968, X-29	B239	A + T = 2	
A74		3.0	1970, I-12	B225	A + T = 2	
B113	$H_{II}624$	0.7	1964, XI-7		B + T = 2	
B115		1.0	1964, XII-7	T159-A95	2 + 8 = 10	
,,		0.6pg.	1965, X-24	,,		
,,		0.7	1965, XI-29	,,		
,,		1.8	1966, XII-14	,,		
B115		1.6	1970, III-3	T159-A95		
B116		3.5	1968, XII-21		3 + 1 = 4	
B127		1.3	1966, XII-8		B + T = 3	
B127		1.2	1969, X-19			
B173		2.0	1967, XI-25		3 + 1 = 4	
B180		5.5	1963, II-17	B221?	2 + 4 = 6	5
,,		2.3	1963, II-24	,,		2
B180		2.7	1970, II-6	B221?		
B194		4.8	1969, XI-9		B + T = 2	2
B202		5.0	1967, I-5		B + T = 3	2
B202		3.8	1970, I-29			
B203		2.3	1967, XI-8		5 + 2 = 7	
B205		4.0	1969, I-20	K4	2 + 1 = 3	2
B208		4.0	1968, XII-22		B + T = 2	2
B216		4.5-3.2	1964, XI-8		B + T = 3	6
B228		0.8	1966, XI-17		B + T = 2	
B289		2.5	1963, II-24		B + T = 2	
T2b		3.5	1967, XI-26		T = 2	2-7
T6b		2.7	1968, XII-20		T = 3	7
T14b		3.0	1963, XI-16		T = 3	2-7
T14b		3.2	1966, XII-9			2-7
T27b		0.5	1964, XII-4		T = 3	7
T28b		1.0	1963, II-17		T = 2	7
T29b		3.3	1966, XI-8		T = 2	2-7
T29b		3.2	1966, XI-9		T = 2	2-7

* The total number of flare-ups observed for a given star is the same as in column six, Table 2, of Haro and Chavira (1972).

Notes to Table 2

1. Flare star T18 clearly shows an elongated image. Undoubtedly it is a double one. The spectral type is M3-4eHα. Probably a non-member of the Pleiades cluster.
2. A single image and in most cases it corresponds to the last exposure of a multiple exposure plate.
3. A single image that repeats two hours after the flare-up listed by Haro and Chavira, 1969.
4. This Flare star repeats in the Byurakan plates and behaves as a "slow" flare with a rising time between 30 to 40 minutes, according to a communication by E. Parsamian. Apart from the different outbursts listed, it shows many small variations of the order of $\leq$ 0.3 U mag.

Figure 1

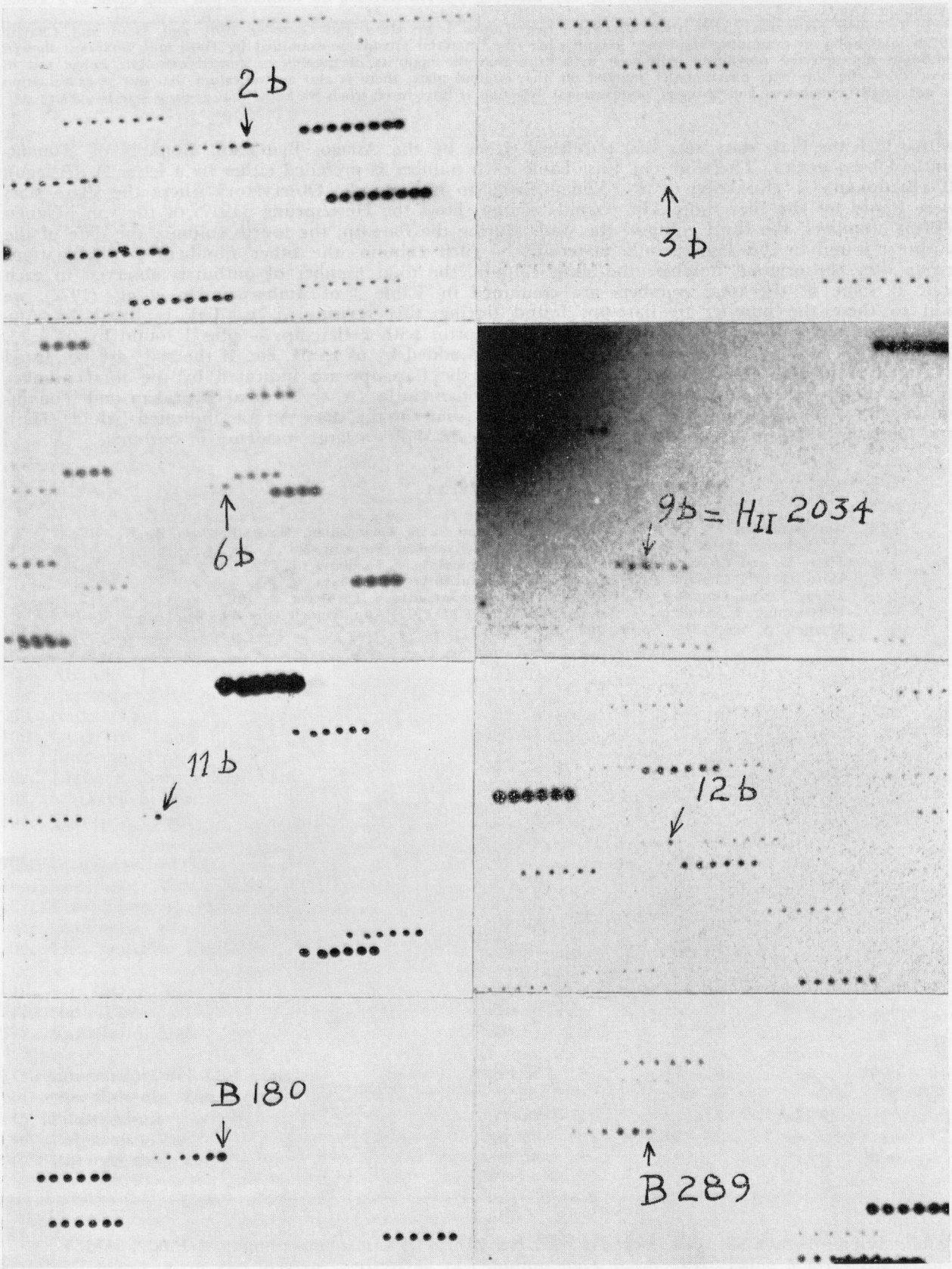

Figure 1 shows photographic reproductions of a sample of some of the flare-ups found.

5. The rising is very rapid and bright. Decline is rather slow.

6. It rises to a first maximum ($\Delta mU = 4.5$), declining without reaching the minimum and rising again to a second maximum ($\Delta mU = 3.2$).

7. These Flare stars, after their discovery (see Tables 1 by Haro and González 1970, and Haro and Chavira 1972) and upon re-examining for the second time the material already re-examined by Haro and González, showed outbursts not detected previously. Although it is true that the majority of these stars showed only one image and in most cases the star was provisionally marked in the original plate, there is also an indication that our re-examination is not totally exhaustive and that an observational selection is introduced when we know that a given star is a Flare star.

with which the Flare stars were first published either by the Asiago, Byurakan, Konkoly or Tonantzintla Observatories. Therefore, in this Table each number is preceded either by a letter A (Asiago), B (Byurakan), K (Konkoly) or T (Tonantzintla) to indicate the Observatory where the Flare stars were found for the first time. The second column shows the Hertzsprung (1947) or the van Maanen (1945) numbers; the third column, the ΔmU during the flare-up; the fourth column, the date of the outburst found in the Tonantzintla material; the fifth column, the other numbers or designations given after the original number; the sixth column, the total number of outbursts observed in each star. If some of the total numbers are contained in Table 3 of Ambartsumian *et al.* (1972), we add to these the number of flare-ups found during this revision, i. e. T51 is listed by Ambartsumian *et al.* in Table 3 of the mentioned preprint with 2 flare-ups − plus 1 found by us = 3, or T18 with 16 flare-ups reported by them plus 15 added by us = 31, etc. If the stars are not listed in Ambartsumian's Table 3 of Preprint No. 5, then the flare-ups are indicated by the total number of those found at Tonantzintla (T), Asiago and Tonantzintla (A + T) or at Byurakan and Tonantzintla (B + T). Column seven gives the notes to some of the stars. As was indicated before (Haro and González 1970), the Tonantzintla Flare star No. 18 shows a large incidence of outbursts.

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