

## NEW FLARE STARS IN THE PLEIADES

*(A Re-examination of the Tonantzintla Photographic Material: 1963-1970)*

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## SUMARIO

El material fotográfico obtenido en el Observatorio de Tonantzintla sobre la región de las Pleiades durante los años de 1963 a 1970 ha sido cuidadosamente revisado, enfocando nuestra atención especialmente en todas aquellas estrellas de las cuales Kraft y Greenstein han obtenido espectrogramas. 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 que se ha detectado el fenómeno ráfaga, corresponden al tipo espectral K3.

## I. Introduction

The publication of the spectroscopic studies of field Pleiades stars by Kraft and Greenstein (1969) and McCarthy (1969), together with the preprint edition of an article by Ambartsumian *et al.* (1969) dealing with the Pleiades flare stars, reinforces our feeling about the convenience of a careful re-examination of all the multiple exposure photographic material obtained at the Tonantzintla Observatory on the Pleiades region. In the present work our attention has been focused mainly in the stars for which either Kraft and Greenstein or McCarthy have obtained slit spectrograms, and in a rather small sample of known very faint flare objects—namely flare stars Nos. 2, 62, 63, 101 and 102 in the Tonantzintla lists—looking for possible outbursts or flare-up repetitions. As a by-product of this partial re-examination we found several *bona fide* flare stars which, although marked previously in our plates, for one reason or other were not published before.

The results to be described here show, among other things, that rather conspicuous outbursts in some of the brightest Pleiades flare stars escaped detection in our previous works. Although it is quite understandable that it is more feasible and secure to find large and especially small amplitude flare-ups in a given group of stars which beforehand have been marked as possible flare candidates, the convenience of re-examining the already large amount of photographic material available by different, independent observers, is also obvious. As a consequence of the present experience we are planning: 1st, to again check up thoroughly all our plate material, examining one by one all the Pleiades flare stars already known including the proper motion member stars as bright as or fainter than the 12th visual magnitude, and 2nd to re-examine more exhaustively and with an improved technique all our single or multiple exposure plates.

## II. The Re-examined Photographic Plate Material

Since February 1963 up to March 1970 we have been obtaining, with the Tonantzintla Schmidt camera, single and multiple exposure plates using 103aO and 103aD Eastman Kodak plates with and without an ultraviolet filter and centering in Alcyone. The great majority of the plates taken through an ultraviolet filter cover a usable area of 16 square degrees, the average *U* limiting magnitude being  $\sim 17.3$ . The general results have been published in several articles by Haro (1963, 1968), Haro and Chavira (1966, 1969, 1970), and by Parsamian and Chavira (1969). In most of the *U* plates 5 or 6 consecutive exposures of 10 or 15 minutes each were made but in some instances, due to bad weather, the number of regular exposures per plate was reduced drastically or the quality of the different images and limiting magnitudes was seriously affected. It is more difficult to normally use this latter photographic material for the detection of flare-ups. In Table 1

TABLE 1

*Tonantzintla Photographic Observations in the Pleiades Field (1963-1970)*

<i>Spectral Region</i>	<i>Number of Plates</i>	<i>Number of Exposures</i>	<i>Total Obs. Time (Hours)</i>	<i>Flare Stars Found</i>	<i>Different Flare-ups Observed</i>
<i>U</i>	495	3044	663 <sup>h</sup> 30 <sup>m</sup>	121	224
<i>B</i>	55	373	40 <sup>h</sup> 20 <sup>m</sup>	1	2

we can synthesize the Tonantzintla observations and results up to March 1970, including all the "good" or just "usable" photographic plates.

### III. New Flare Stars and Repeated Outbursts Found

As mentioned before, the focusing of our attention in a given group of preselected stars was indeed rewarding. We included in this group the 49 stars observed by Kraft and Greenstein (1969) and the McCarthy stars (1969) having Hertzsprung (1947) and van Maanen (1945) numbers. Besides, in all our plates we revised —as a test sample— five of the very faint flare stars lying in the west edge of our Pleiades plates. The results are summarized in Table 2, in which the Tonantzintla serial numbers in italics (first column) indicate that the flare-up repeats in the given stars.

The more outstanding data contained in Table 2 refer to the already large incidence of outbursts in the faint flare star No. 101 and the flare-ups in the K3Ve stars — HII 2588 and 2908— and K3.5Ve star HII 676. In Fig. 1 we reproduce some samples of the outbursts listed.

TABLE 2

*Additional Flare-ups Found in the Second Revision of the Tonantzintla Photographic Material (Pleiades, 1963-1969)*

No.	Star	R. A. (1900)	Dec. (1900)	Mag. in U	$\Delta m_U$	Spectral Type	Date of Flare	Ref*
<i>101</i>		3 <sup>h</sup> 33 <sup>m</sup> 2	+24°25'	~19.5	~2.5	(≥M2)	1963 11/22	
<i>101</i>		"	"	"	~2.5	"	1965 11/17	
<i>101</i>		"	"	17.8B	0.6B	"	1968 10/27	
<i>62</i>		3 33.9	24 56	18.5	1.7		1965 11/25	
<i>62</i>		"	"	"	1.3		1965 11/28	
<i>102</i>		3 34.8	24 50	~20.0	~3.5		1963 11/18	
<i>39</i>		3 37.1	24 30	17.5	2.2		1968 12/13	
<i>40</i>		3 37.2	24 22	19.0	4.0		1968 12/25	
<i>149</i>	HII 146	3 37.7	23 08	17.0	0.5	K7-M0Ve	1963 11/23	1,2
<i>149</i>	"	"	"	"	0.5	"	1964 11/ 3	
<i>149</i>	"	"	"	"	3.0	"	1968 11/24	
<i>160</i>	HII 347	3 38.5	24 32	16.6	0.6	K7Ve-d M1	1964 12/ 4	1,2,3
<i>161</i>		3 39.0	23 37	~19.5	~2.5		1966 12/12	
<i>162</i>	HII 676	3 39.5	23 27	16.1	0.5	K3.5Ve	1966 12/12	1,2
<i>163</i>		3 41.1	24 39	~21.0	~4.0		1963 11/22	
<i>164</i>		3 42.0	22 09	~20.0	~3.0		1964 11/ 7	
<i>165</i>	HII 2588	3 44.2	24 14	15.3	1.5	K3V (e?)	1965 11/17	1,2
<i>166</i>	HII 2908	3 45.0	24 45	15.5	0.9	K3Ve	1968 12/13	1,2
<i>96</i>		3 45.9	22 37	19.4	2.5	(M)	1966 12/11	

References: (1) Hertzsprung (1947); (2) Kraft and Greenstein (1969); (3) McCarthy (1969).

It is of interest to emphasize that from the Kraft and Greenstein list of 49 Pleiades field stars, in our photographic material not a single one without spectral emission lines has shown the flare phenomenon and that of the three K3Ve stars observed by these authors, two have shown conspicuous outbursts.

*Note added in proof* After sending this article to press and as mentioned in the Introduction, we started re-checking some of the already known flare stars outside the area of Hertzsprung's *et al.* proper motion work. We consider it worth while to mention, at least, that flare star No. 18 (McCarthy LLP 121) of spectral type M3-4 eH $\alpha$ , which is located in the southern edge of our plates, shows a large incidence of outbursts — probably only comparable to flare star HII 2411. Further details will be supplied after finishing this re-checking.

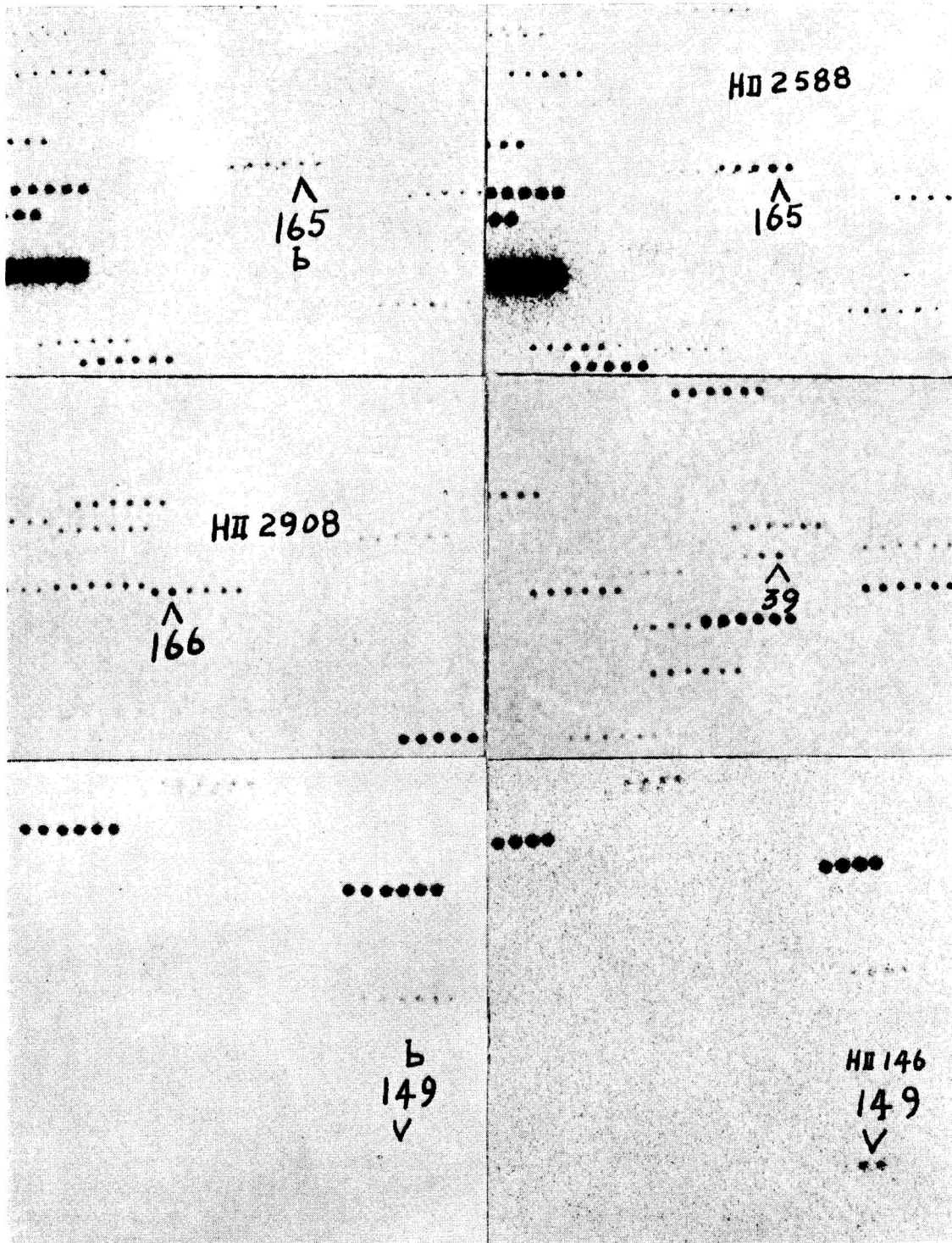


Fig. 1.—Multiple-exposure plates showing flare-ups in some of the stars contained in Table 2 (marked with arrows and the corresponding serial numbers). The order of the exposures goes from right to left.

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