

ΑΣΤΡΟΝΟΜΙΑ.— **New Flare Stars in Camelopardalis**, by *C. Poulakos**.

Ἀνεκοινώθη ὑπὸ τοῦ Ἀκαδημαϊκοῦ κ. Ἰω. Ξανθάκη.

INTRODUCTION

Several reports have been published by different authors on the surveys for flare stars carried out in some galactic clusters (NGC 2264, Orion, Pleiades etc.). The results of Haro (Haro, 1962, 1964, 1966, 1969) and Rosino (Rosino, 1962, 1966a, 1969) and their colleagues have demonstrated the importance of these objects in relation to the early evolutionary stages of stars and clusters of stars.

The close association between flare stars and regions of emission nebulosity and obscuring gas and dust clouds has been pointed out by several investigators such as Westerlund (1960) and Hidajat (1962) and Sanduleak (1968, 1969). Sanduleak (1969) has found that flare stars appear also on the edges of regions of heavy obscuration. Guided by these results we considered that an intensive search for rapid variables, which might form a group, in the heavy obscured regions of Camelopardalis was worthwhile.

The paper reports on the discovery of 7 new flare stars in a region approximately 14 sq deg in area and centered on $\alpha = 3^{\text{h}} 4^{\text{m}}$ and $\delta = +60^{\circ}58'$ (1950). The results are based on direct multiple exposure plates in the U and B ranges as well as on objective prism IN plates.

OBSERVATIONS

The search for flares was made with the 25/40/90 cm Schmidt-type telescope of the Heidelberg Observatory. For the survey of flares the Haro's multiple exposure method was used.

The observational material obtained from May to July 1975 and consists of 21 Eastman kodak plates covering 798 min of effective observation. Four II_a-O plates have been taken through an UG 2 filter with 4 successive exposures each of 20 minutes. The limiting magnitude

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παρδάλεως.

was found equal to $U = 16.9$. Eleven $II_a - O$ plates have been taken through a BG 12 + GG 13 filter with 4 successive exposures each of 6.5 minutes reaching a limiting magnitude of $B = 15.60$. Six $II_a - O$ plates have been taken without filter with 4 successive exposures each of 8 minutes. The time interval between two successive exposures for the multiple exposure plates was less than 15 seconds. In addition to this material the region was covered with direct $103_a - D$, $II_a - O$ and $103_a - E$ plates (one exposure only) in the V, B and R ranges taken through a GG 14 and a BG 12 + GG 13 and an OG 5 filter respectively. The mean limiting magnitudes were estimated near to $V = 15.5$, $B = 16.6$ and $R = 15.0$ respectively.

Spectra were secured with a 10° objective prism attached to the telescope. Sensitized kodak IN plates, exposed through an RG 5 filter, were used for the near infrared (6800 to 8800 Å) spectral region. The exposures were of 35 min duration. The dispersion at the atmospheric A - band was 3500 Å/mm and the limiting magnitude $I = 12.5$. The criteria used for the spectral classification were those described by Nassau and van Albada (1949), Cameron and Nassau and Velgue (1964).

PHOTOMETRY

The 21 multiple exposed plates were examined with the VIDEOMAT Comparator of the Max-Planck-Institut für Astronomie in Heidelberg as well as with a binocular microscope.

The Photometry was carried out with the iris photometer of the Research Center for Astronomy and Applied Mathematics of the Academy of Athens. The measurements were reduced to the B and V of the UBV - system using photoelectric observations of the NGC 1027, given by Hoag et al. (1969), extending to about $B = 16.0$, supplemented with 6 stars i. e. Nos. 3108, 3111, 3178, 3201, 3212, 3268 of the Blanco's photoelectric catalogue (Blanco et al. 1960).

The probable error of an adopted magnitude from the internal consistency of measures made on the plates were ± 0.12 for B, ± 0.07 for V and ± 0.05 mag. for the R magnitudes.

Stars found during the survey, were then identified on the blue and the red Palomar Sky Survey (hereafter referred to as PSS) prints.

B^{PSS} and R^{PSS} magnitudes for all the stars determined by measurements of the diameters on the blue and the red plates as suggested by Perek (1958). To determine the B^{PSS} and R^{PSS} magnitudes of the stars the diameters, d , of the stellar images were measured with a binocular microscope. All measurements were done with an optimal magnification, which was found by experiments to be 32 X. The diameter - magnitude - relation can be approximated by a straight line :

$$m = C_1 d + C_2 \quad (1)$$

The standard curve for the blue PSS plates was derived from the B magnitudes of the UBV system and for the red plates from the red magnitudes R_k of Kron and Smith (1951). After Kron and Smith it is :

$$B - R_k = 1.64 (B - V) \quad (2)$$

The errors in the diameter estimates give an uncertainty of B^{PSS} or R^{PSS} of about ± 0.3 mag.

Flare stars were accepted when $m^{\min} - m^{\max} \geq 0.5$ mag. and when more than one image were visible. When only one image was visible, the star was accepted as flare star if the image was found coincident with a star visible either on the direct B, V and R plates or on the blue or red PSS prints.

THE RESULTS

The qualitative survey on the basis of the multiple exposure plates and the objective prism spectra yielded 7 new flare stars listed in Table 1. The information, given in this table, includes the star number, the coordinates α_{1950} , δ_{1950} , the difference $\Delta m(B)$, (i. e. $m^{\min} - m^{\max}$), the photometric results for B, V and R colours and the B^{PSS} and R^{PSS} magnitudes, the spectra, when available, and finally the dates of flare up.

Identification charts for the flares are given in Figure 1. East is at the top north is to the right. All charts have the same scale (33,5 mm correspond to 8.3 arc min). The order of the exposures is from left to right.

T A B L E 1
New flare stars in Camelopardalis

N ^o	α (1950)	δ (1950)	$\Delta m(B)$	R	V	B-V	V-R	B ^{PSS}	R ^{PSS}	Sp.	Date
1	3 ^h 6 ^m 48 ^s	+62° 31' 30''	2 ^m 15	12 ^m 50	13 ^m 20	1 ^m 10	0 ^m 70	14 ^m 45	12 ^m 50	?	11-6-75
2	» 7 ^m 30 ^s	+60° 57' 40''	2.60	10.60	11.40	2.00	0.80	13.30	10.45	M2	7-6-75
3	» 7 ^m 10 ^s	+60° 40' 10''	1.40	13.30	14.25	1.30	0.95	15.60	13.10	M1	11-6-75
4	» 7 ^m 39 ^s	+60° 38' 50''	0.90	12.60	13.85	1.10	1.25	15.00	12.80	M0-M1	12-6-75
5	» 8 ^m 23 ^s	+61° 47' 20''	0.85	12.35	13.45	1.85	1.10	15.20	12.50	M2	16-5-75
6	» 7 ^m 48 ^s	+60° 25' 40''	1.55	11.85	12.40	1.50	0.55	13.75	11.65	M2	13-5-75
7	» 8 ^m 34 ^s	+60° 53' 00''	2.70	12.70	13.55	1.05	0.85	14.80	12.60	M1	17-5-75

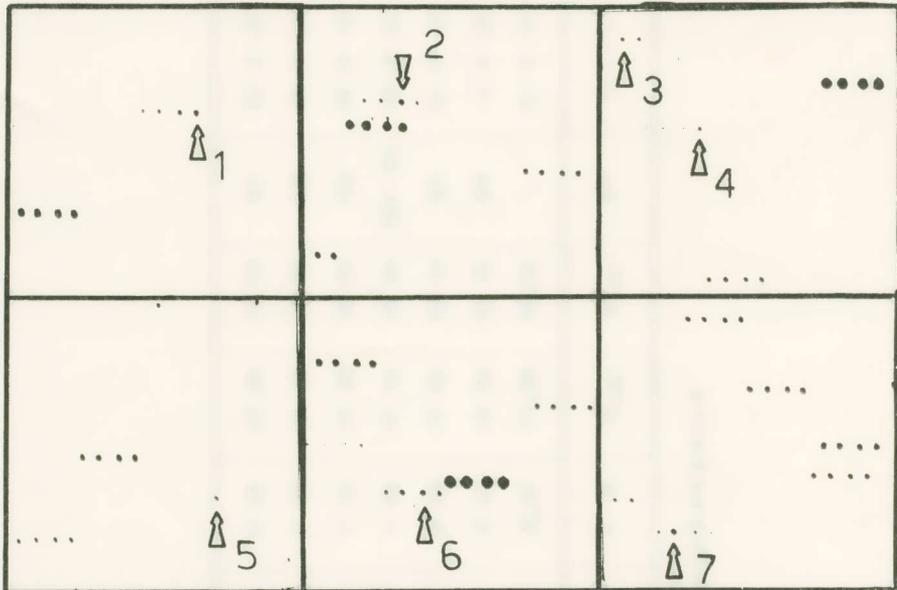


Fig. 1. Identification charts for the flares. East is at the top, north is to the right. All charts have the same scale (33.5 mm correspond to 8.3 arc min). The order of the exposures are from left to right.

DISCUSSION

The 7 flare stars, listed in Table 1, have not been found to coincide with other stars listed either in the General Catalogue of Variable stars by Kukarkin et al. (1972), or in the Catalogue of Cool Stars by Stephenson (1973). No further coincidences of the 7 objects with objects in other catalogues were found. The observed flare stars are located on the edges of very obscured regions in Camelopardalis. The distribution over the field shows no group formation.

Six out of seven of the discovered flare stars have been observed to be relatively weak at minimum with the exception of the star No. 6.

The duration of the flares is generally within 27 min and we must consider these stars as fast flare stars.

The observed amplitudes, between minimum and maximum, have been mostly between 0.8 and 2.70 magnitudes. The average B magnitudes at minimum were near to $B = 15.50$.

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Π Ε Ρ Ι Λ Η Ψ Ι Σ

Τῇ βοήθειά ἀμέσων φωτομετρικῶν πλακῶν ὡς καὶ φασματικῶν πλακῶν εἰς τὴν περιοχὴν τοῦ ὑπερύθρου (6800 \AA ἕως 8800 \AA) ληφθεισῶν διὰ τοῦ τηλεσκοπίου τύπου Schmidt τοῦ Ἀστεροσκοπεῖου τῆς Ἀϊδελβέργης ἀνευρέθησαν εἰς τὴν περιοχὴν τοῦ Ἀστερισμοῦ τῆς Καμηλοπαρδάλεως 7 νέοι ἀστέρες ἐκλάμψεως. Τὰ φωτομετρικά των στοιχεῖα ὡς καὶ ὁ φασματικὸς τύπος τῶν ἀνευρεθέντων ἀστέρων παρέχονται ὑπὸ τοῦ πίνακος I.

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‘Ο Ἀκαδημαϊκὸς κ. Ἰωάννης Ξανθάκης, παρουσιάζων τὴν ἀνωτέρω ἀνακοίνωσιν, εἶπε τὰ ἑξῆς :

‘Ὡς γνωστὸν εἰς τὸν ἀστερισμὸν τῆς Καμηλοπαρδάλεως παρατηροῦνται πολλοὶ ἀστέρες τοῦ τύπου T Tauri, ἦτοι ἀστέρες οἵτινες παρουσιάζουν ἀνωμάλους μεταβολὰς εἰς τὴν λαμπρότητά των. ‘Ο κ. Κ. Πουλᾶκος, ἐπιμελητὴς τοῦ Κ.Ε.Α.Ε.Μ. τῆς Ἀκαδημίας Ἀθηνῶν ἠσχολήθη κατὰ τὴν διάρκειαν τοῦ θέρους 1975 μὲ τὴν ἔρευναν τῆς περιοχῆς ταύτης διὰ τοῦ τηλεσκοπίου τύπου Schmidt τοῦ ἀστεροσκοπείου τῆς Ἀϊδελβέργης.

Σκοπὸς τῆς ἐρέυνης του ἦτο ἡ ἀναζήτησις ἀστέρων ἐκλάμψεως διὰ τοὺς ὁποίους μοῦ ἐδόθη ἡ εὐκαιρία νὰ ὀμιλήσω καὶ εἰς προηγουμένας ἀνακοινώσεις ἐργασιῶν τοῦ καθηγητοῦ κ. Λυσιμάχου Μαυρίδου καὶ τῶν συνεργατῶν του γενομένας εἰς τὸν Ἀστρονομικὸν Σταθμὸν Στεφανίου - Κορινθίας.

‘Ο κ. Πουλᾶκος ἔλαβε διὰ τοῦ τηλεσκοπίου τύπου Schmidt τῆς Ἀϊδελβέργης σημαντικὸν ἀριθμὸν φωτογραφικῶν πλακῶν εἰς τὴν φασματικὴν περιοχὴν τῶν UBVR καθὼς καὶ φωτογραφικὰς πλάκας μὲ τὴν βοήθειαν ἀντικειμενικοῦ πρίσματος προσαρμοσθέντος εἰς τὸ προαναφερθὲν τηλεσκόπιον.

‘Η ἔρευνα τῶν πολυαρίθμων τούτων φωτογραφικῶν πλακῶν ἀπεκάλυψεν 7 νέους ἀστέρας ἐκλάμψεως. ‘Η διαφορὰ τοῦ μεγίστου καὶ τοῦ ἐλαχίστου τῆς λαμπρότητός των κυμαίνεται μεταξὺ 0.8 καὶ 2.7 ἀστρικῶν μεγεθῶν, τὰ δὲ φάσματά των κυμαίνονται μεταξὺ τῶν τάξεων M1 καὶ M2.