

STUDIES ON STAR CLUSTERS: THE OPEN CLUSTER T9

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SUMARIO

Se ha efectuado fotometría fotográfica en *UBV* de las estrellas en la región del cúmulo abierto T9, calibrando las magnitudes con las determinaciones hechas fotoeléctricamente de algunas estrellas en el cúmulo mismo. Los diagramas color-magnitud y color-color están presentados. Este último muestra que el enrojecimiento del cúmulo es del orden de 0.2 magnitudes, indicando así que la absorción visual total es alrededor de 0.6 magnitudes. El tipo espectral más temprano de las estrellas en T9 es A0. La distancia del cúmulo basada en los datos espectrales de sus tres estrellas más brillantes es de 900 parsecs. Conteos de las estrellas han proporcionado un valor para el diámetro del cúmulo de 7.2, lo cual corresponde a un diámetro lineal de 1.8 pc. El número total de las estrellas pertenecientes al cúmulo es 63 hasta la magnitud $V = 16.5$.

ABSTRACT

Photographic photometry in *UBV*, calibrated with standards determined photoelectrically, is performed on stars in the region of the open cluster T9. The color-magnitude and color-color diagrams are presented. The latter diagram shows that the interstellar reddening of the cluster stars is not larger than 0.2 magnitudes; thus the visual total absorption is around 0.6 magnitudes. The earliest spectral type is A0. The spectral data obtained of the three brightest stars have yielded a distance of 900 parsecs for the cluster. Furthermore the starcounts of the region have shown that the cluster has a diameter of 7.2 corresponding to a linear diameter of 1.8 pc. The total membership is found to be 63 stars to a limiting magnitude $V = 16.5$.

The star cluster T9 (1950 coordinates: $7^{\text{h}}51.1; -25^{\circ}40'$) appears for the first time in Trumpler's Catalogue where it is designated as An. 9 (Trumpler 1930). No detailed study is done on it so far. It is a rather poor cluster, classified as II3p.

The photometric work presented in this article forms part of a program on open clusters in the region of Puppis. Of the photographic material taken with the Tonantzintla Schmidt Camera¹ only those of best quality are used for the photometry in the *UBV* system. The plate material is listed in Table 1.

TABLE 1
Plates Used for Photographic Photometry

<i>Plate Number</i>	<i>Coordinates of Center (1950)</i>	<i>Spectral Region</i>	<i>Exposure Minutes</i>
AC 7771	$7^{\text{h}}48^{\text{m}}; -25^{\circ}12'$	V	2
7773	" "	V	2
7829	" "	V	10
7799	" "	B	10
7828	" "	B	10
6083	$7^{\text{h}}48^{\text{m}}; -26^{\circ}08'$	U	6
7769	" $-25^{\circ}12'$	U	6
ST 1555	$7^{\text{h}}53^{\text{m}}; -24^{\circ}27'$	U	40
4347	$7^{\text{h}}50^{\text{m}}; -25^{\circ}15'$	U	10
4348	" "	U	9
4349	" "	U	3

The calibration of the photographic magnitudes was done using a set of stars within T9 of which photoelectric magnitudes in the *UBV* were determined mostly at the 40-inch reflector at Tonantzintla Observatory on three nights. A fourth determination was done using the 60-inch reflector of the Catalina Station of the University of Arizona.² Fig. 1 is a chart of the region of T9 where I have marked the standard stars as well as those measured photographically. The *V*-magnitudes of the standards and the (*B-V*) and (*U-B*) colors are listed in Table 2. They are mostly averages over 3-4 nights' observations.

¹ The plates were taken by E. Chavira.

² I am indebted to H. L. Johnson for facilities and to Braulio Iriarte for this set of observations.

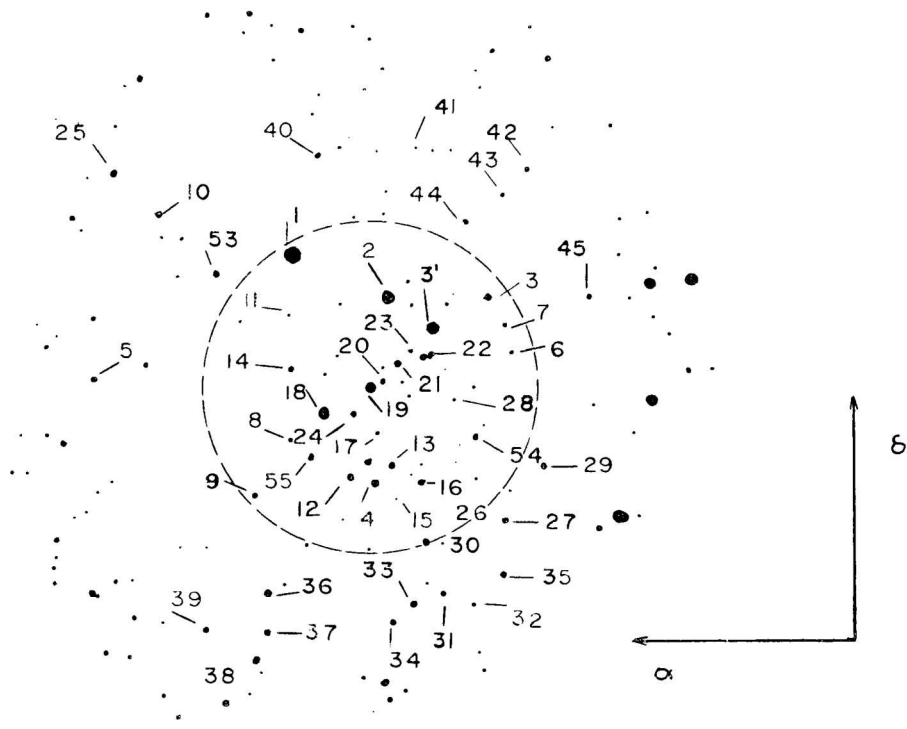


Fig. 1.—Chart of T9. 1 cm = 1'.6. The circle is the adopted limit of the cluster.

TABLE 2
Photoelectric Standards in the Region of T9

Star	<i>V</i>	<i>B</i> − <i>V</i>	<i>U</i> − <i>B</i>	Spectral Type
1	8.32 ± 0.02	+0.28 ± 0.01	+0.28 ± 0.01	A3 II
2	10.03 ± 0.02	−0.09 ± 0.00	−0.25 ± 0.01	A0 IV
3	10.80 ± 0.04	+0.33 ± 0.03	+0.11 ± 0.05	F2
3'	10.79 ± 0.04	+0.08 ± 0.02	+0.29 ± 0.04	A0 V
4	13.41 ± 0.03	+0.23 ± 0.01	−0.15 ± 0.02	
5	12.03	+0.26	+0.07	
6	13.64 ± 0.01	+0.13 ± 0.03	−0.15 ± 0.02	
7	13.86 ± 0.05	+0.16 ± 0.03	−0.04 ± 0.03	
8	13.64 ± 0.03	+0.49 ± 0.03	−0.26 ± 0.01	
9	13.31 ± 0.02	+0.45 ± 0.06	+0.04 ± 0.02	
10	13.27 ± 0.02	+0.44 ± 0.01	+0.43 ± 0.09	
11	14.12 ± 0.05	+0.15 ± 0.04	0.00 ± 0.01	
25	13.23	+0.18	+0.17	
53	13.00	+0.62	+0.36	

The photographic magnitudes were measured on an Eichner astrophotometer by Miss Teresa Gómez. Due to overlap not more than 80% of the stars in the cluster region could be measured. Table 3 gives the adopted mean values of the *V* magnitudes as well as the color indices (*B*−*V*) and (*U*−*B*). The probable errors of the means were comparable to those of an earlier report (Pişmiş 1970, Table 4) therefore they are not given here.

A preliminary color-magnitude diagram of all measured stars listed in Tables 1 and 2 indicated that quite a few of the stars probably fell outside the limits of T9. An estimate of the radius of the cluster (details will be given below) was therefore made and all stars within it were considered to be members of the cluster. The circle drawn in Figure 1 represents the extension of T9 adopted

ed in here. The color-magnitude diagram of stars in this zone is plotted in Figure 2, while Figure 3 is the $(U-B)$ vs $(B-V)$ diagram. In both of these the scatter is somewhat large, even for the photoelectric data. Still T9 appears to be a physical grouping, albeit not a rich one. The color-color diagram is not incompatible with a maximum reddening of 0.2 magnitudes. With $R = 3$ this would yield a total visual absorption of 0.6 magnitudes, which we adopt in the determination of the distance of T9.

TABLE 3
Magnitudes and Colors Obtained Photographically in the Region of T9

<i>Star</i>	<i>V</i>	<i>B-V</i>	<i>U-B</i>
12	11.49	-0.05	-0.13
13	12.42	+0.26	0.00
14	12.64	+0.16	-0.13
16	12.50	+0.37	-0.42
17	12.18	+0.03	-0.58
18	9.97	+0.66	+0.51
19	10.24	-0.19	-0.14
20	12.49	-0.05	-0.11
21	11.47	-0.15	-0.13
22	12.95		
24	13.75	+0.12	+0.22
26	13.43	+0.61	-0.15
28	13.48	+0.42	-0.05
29	13.85	+0.26	-0.28
30	13.69	+0.18	+0.02
31	12.58	+0.66	+0.20
32	12.81	+0.36	-0.02
33	12.53	+1.44	
34	11.78	+0.14	-0.09
36	11.55	+1.50	+0.88
37	11.78	+0.40	-0.05
38	12.18	+1.31	-0.40
39	13.42	+0.46	+0.23
40			+0.14
41	13.44	+0.67	
42	12.49	+0.62	+0.11
43	13.18	+0.28	-0.09
44	13.55	+0.31	-0.28
45	12.06	+1.46	
54	13.40	+0.29	+0.14
55	13.23	+0.45	+0.21

On two objective prism plates of good quality taken with the Tonantzintla Schmidt Camera (dispersion: 250 Å at H γ) 4 of the brightest stars could be classified. The estimated types are given in Table 2. No star of this cluster appears to be of type earlier than A0. Thus it is not possible to obtain the photometric distance modulus by the method of Johnson (1960) as that method is not applicable to stars of type later than A0. I have therefore made an estimate of the distance of T9 by the use of the spectral data of three stars, namely numbers 1, 2 and 3; if T9 is a physical grouping these three stars are certainly members of it. The absolute magnitudes corresponding to the spectral types are taken from Keenan (1963). With a total visual absorption of 0.60 magnitudes as mentioned previously, one obtains the distance to the cluster as 900 parsecs, namely the mean over the three stars.

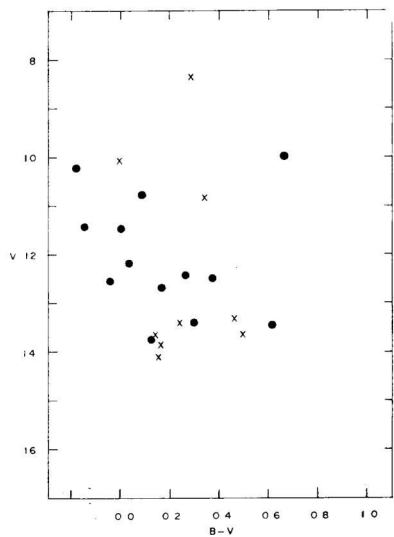


Fig. 2.—The color magnitude diagram of stars within the circle drawn around T9. Filled circles and crosses refer to photographic and photoelectric data respectively.

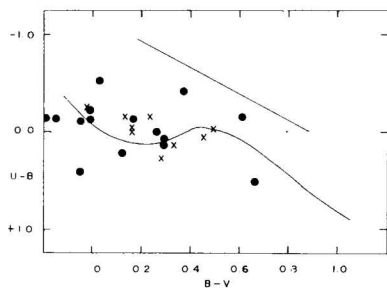


Fig. 3.—The $(U-B)$ vs $(B-V)$ diagram of stars within the circle drawn in Fig. 1. Filled circles and crosses refer to photographic and photoelectric data, respectively.

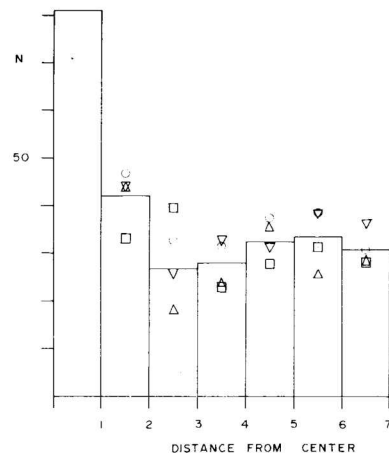


Fig. 4.—Histogram showing the variation of density of the stars from center outwards, in T9. Unit area = 10.17 square minutes of arc. Densities in individual quadrants are shown by different symbols. Unit of abscissa is 1.8 minutes of arc.

Starcounts were performed on a yellow plate of 27 min exposure, taken again with the Tonantzintla Schmidt. A polar réseau was placed centered on star number 19, and the stars were counted to the plate limit, 16.5 magnitudes, in 5 concentric zones. The average number of stars in each zone—the density—is shown in the histogram of Figure 4. The unit of area is that of the innermost réseau circle, namely ~~10.17~~ 10.17 sq. minutes of arc. Also the density of stars in quadrants of each of the annular zones is derived from the starcounts, in order to have a measure of the smoothness of the field around the cluster. These are represented by different symbols on the histogram. It appears from Figure 4 that T9 extends through the second zone of the réseau. The upper limit to the radius is thus 3.6 minutes of arc. Adopting as the density of the background the average over the three remaining zones, namely 30 stars, the total number of stars belonging to T9, to the limiting magnitude of $V = 16.5$ is found to be 63.

REFERENCES

- Trumpler, R. J. 1930, *Lick Obs. Bull.* 14, 154.
 Pişmiş, P. 1970, *Bol. Obs. Tonantzintla y Tacubaya*, 5, 219.
 Johnson, H. L. 1960, *Lowell Obs. Bull.* 5, 17.
 Keenan, P. C. 1963, in *Basic Astronomical Data*, ed. K. Aa. Strand (Chicago: University of Chicago Press) p. 78.