

THE COLOUR MAGNITUDE DIAGRAM OF THE GALACTIC CLUSTER NGC 6383

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ICHTISAR

Hampir semua bintang dalam sebuah daerah bundar dengan jari² kira² 12 menit busur, telah diukur setjara photometris sampai $V = 13.80$ magn., dengan menggunakan katja² potret jang didapatkan dengan teropong Schmidt Uppsala di Observatorium Mt. Stromlo dan teropong Schmidt di Lembang. Kumpulan² bintang jang terletak pada tempat² jang berbeda-beda pada diagram warna magnitudo daripada NGC 6383 telah dibahas sehubungan dengan idee Herbig mengenai tidak dilahir-kannya bintang² dalam sebuah gugus bintang pada saat² bersamaan.

ABSTRACT

Almost all the stars in a circular area with a radius of about 12 min. of arc, were measured photometrically down to $V = 13.80$ magn., using plates obtained with the Uppsala Schmidt telescope Mt. Stromlo and the Schmidt telescope at Lembang. The photographic measurements generally confirm Enggen's remarkable result that NGC 6383 is a very young cluster, similar to NGC 2264. Groups stars lying on different parts of the colour magnitude diagram NGC 6383, are discussed in connection with Herbig's idea about non-coevalness of stars in stellar cluster.

INTRODUCTION.

The galactic cluster NCC 6383 has been studied by Eggen (1961) photoelectrically. The most interesting feature which Eggen had found is that the colour magnitude diagram of this cluster resembles that of the very young galactic cluster NCC 2264 studied by Walker (1956). This colour magnitude diagram consists of a normal main sequence to about AO beyond which stars are located above the main sequence, they are interpreted as stars still in the state of contraction. Some red giant stars are about 4 magn. fainter than the brightest cluster star.

According to Walker (1956) these red giants if they are members of the cluster, are also stars in the process of contracting gravitationally to the main sequence. However, Herbig (1964) believes that these stars are old giant stars. The fact that these stars are found together with young OB stars in a galactic cluster supports his idea of non-coevalness of members of stellar clusters.

Dark as well as bright nebulosities are not known to be associated with NGC 6383; on the contrary, NGC 2264 is embedded in bright and dark nebular matter.

It is of interest to point out here that the region of the cluster NGC 2264 was surveyed for M-type stars by Blanco (1963), who found three M0, three M1 and two M2 stars to form a prolongation to the red of the above the main sequence branch of the colour magnitude diagram of NGC 2264. One M5 star is believed by Blanco to be a background giant star.

The true distance modulus for NGC 6383 was found by Eggen to be $+10.5$ magn., while the color excess $E_{(B-V)} = +0.30$ magn. thus the absorption $A_V = 3 E_{(B-V)} = 0.90$ magn.

In connection with the above facts it is of considerable interest to study:

1. The location in the colour magnitude diagram of the other stars in the cluster region, not measured by Eggen,
2. The probable existence of more red giant stars in the cluster region, as possible members of NGC 6383,
3. The probable existence of H_{α} -emission stars among the cluster members,
4. The probable existence of faint H_{α} -emission stars which may be T Tauri stars, in the cluster region.

PHOTOGRAPHIC MATERIAL.

For the study of the above mentioned aspects of NGC 6383, existing and new prism plates were examined, and direct plates measured. The plates used in this study are listed in Table I of which the headings are self-explanatory.

The direct plates numbers 3484, 3485, 4467, 4468 and the prism plates numbered 3332 and 3334 were obtained with the Uppsala Schmidt type telescope at Mt. Stromlo Observatory by Mr. S. Nitisastro who has kindly put these plates at my disposal.

TABLE I
Photographic plates used in the present study:

Direct plates					
No.	Date	Emulsion	Filter	Exp.	Remarks
177	30-5-'65	103aD	CC11	1 min.	
178	"	"	"	"	
3484	19-9-'60	"	GG14	"	
3485	"	"	"	"	
180	30-5-'62	11aO	CC13	"	
181	"	"	"	"	
4467	17-7-'61	103aO	"	1/2 min.	
4468	"	"	"	"	
Prism plates					
385	11-4-'65	IN	RG2	30 min.	unwidened
387	11-4-'65	103aL	RG1	20 min.	"
50	29-6-'60	"	"	20 "	"
17	21-6-'60	"	"	60 "	"
3332	18-3-'60	11aO	—	18 "	"
3334	20-8-'60	"	—	5 "	"

THE PHOTOMETRY.

The photometric measurements of the direct plates were carried out with the Eichner iris-diaphragm astrophotometer at Lembang. For the calibration and zero point determination the photoelectric sequence of Eggen (1961) in NGC 6383 was used. In order to avoid adjacency effects only those stars which are not too close together were included as sequence stars. Only plates of good quality were measured.

After measurements, the photographic B and V magnitudes and (B - V) colour indexes of the sequence stars were examined for magnitude and colour equations, by comparing them the photoelectric values. No correction for these effects proved to be necessary. The magnitudes and colours obtained are thus on Eggen's B,V system. From a study of the errors of the measurements, it was found that the probable errors of the V magn. and B - V colour indexes are both $\pm 0,06$ magn.

A total number of 97 stars, as faint as $V = 13.80$ magn. located in a circular area with a radius of about 12 min. of arc were measured. Two M. type stars numbered 98 and 99 located just outside the circular area were also measured. The result of the measurements is listed in Table II. A finding chart is given in Figure 1. The numbers in this figure refer to the numbers

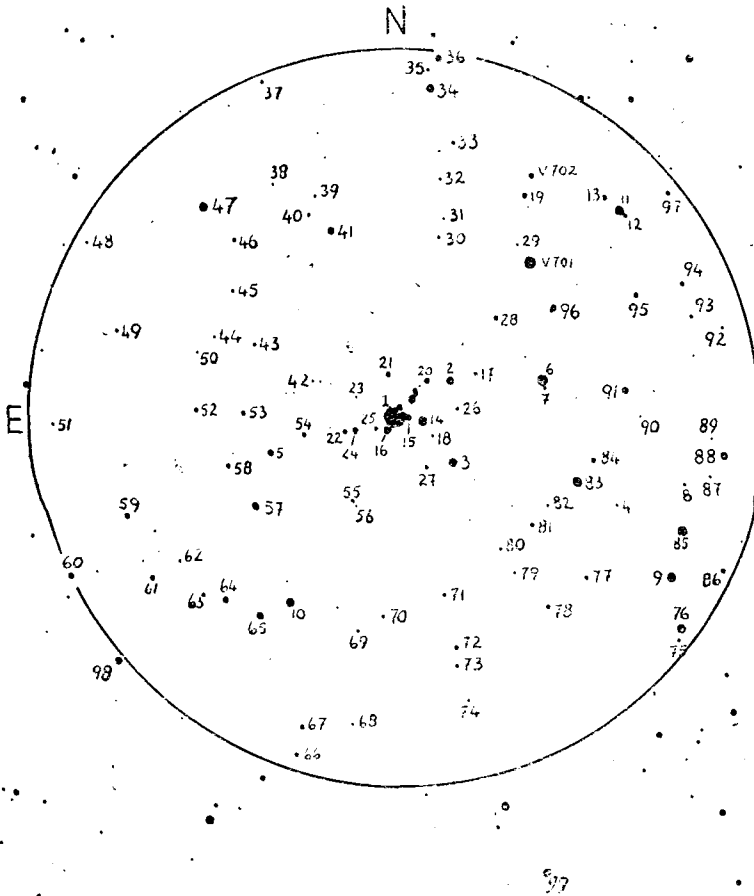


Fig. 1

in the first column of Table II. The numbers of the first 25 stars are those used by Eggen. Eggen's number 13a is changed into 17.

The photographically measured visual magnitudes of star No. 4 deviate considerably from the photoelectrically determined visual magnitudes of Eggen, on all 4 visual direct plates. No star in the vicinity of No. 4 could have disturbed the photographic photometry. Since this star was measured by Eggen only once it might be that its V magnitude given by Eggen is in error. However this discrepancy could have been caused also by the variability of the light of the star.

Star No. 5 is according to the Henry Draper Catalogue of spectral type AO. Therefore, the photographically determined B-V colour index, in connection with the the colour excess of 0.30 magn. of the cluster, is better

TABLE II

Photographically determined V magnitudes and B-V colour indexes of stars in NGC 6383.

No.	V	B - V	Sp.	No.	V	B - V	Sp.
1	—	—	Oe5	51	13.17	1.01	—
2	10.40	0.13	B8	52	12.44	0.73	—
3	10.35	0.28	A2	53	12.51	0.64	—
4	13.44	0.62	—	54	12.45	0.70	—
5	11.32	0.21	AO	55	12.90	0.36	—
6	9.11	0.01	B5	56	13.58	—	—
7	—	—	—	57	10.76	0.32	A5
8	13.49	0.79	—	58	12.39	0.50	—
9	9.81	0.95	K7	59	11.82	0.78	(B9)
10	10.04	0.14	B8	60	11.45	0.26	—
11	—	—	KO	61	12.15	0.70	—
12	—	—	—	62	13.00	0.93	—
13	12.16	0.13	—	63	12.61	0.78	—
14	9.91	—	B5	64	11.25	0.74	—
15	—	—	—	65	10.68	1.19	—
16	—	—	—	66	12.27	0.96	—
17	12.70	0.53	—	67	12.12	0.83	—
18	13.35	0.64	—	68	13.30	0.84	—
19	11.60	1.26	—	69	12.63	1.26	—
20	11.39	0.21	—	70	13.10	0.71	—
21	11.83	0.70	AO	71	12.81	0.98	—
22	12.23	0.65	—	72	12.54	0.61	—
23	13.70	1.02	—	73	12.92	0.97	—
24	11.32	0.16	—	74	13.41	1.01	—
25	—	—	—	75	13.00	0.42	—
26	12.87	0.76	—	76	9.88	0.19	Be
27	12.98	0.44	—	77	12.50	0.85	—
28	12.59	0.33	—	78	12.35	0.83	—
29	13.45	1.00	—	79	13.48	0.84	—
30	13.39	1.06	—	80	13.30	0.95	—
31	13.95	0.82	—	81	12.64	1.92	—
32	13.55	0.84	—	82	13.17	0.98	—
33	12.99	1.02	—	83	9.61	0.11	B3
34	10.41	1.19	G5	84	12.32	0.21	—
35	13.11	0.76	—	85	9.57	0.39	FO
36	11.19	1.20	—	86	12.14	1.30	—
37	13.10	0.63	—	87	13.61	0.85	—
38	13.50	1.11	—	88	10.99	0.13	B9
39	13.25	1.11	—	89	13.89	0.49	—
40	12.99	—	—	90	13.80	0.86	—
41	10.99	1.05	—	91	11.18	1.27	—
42	13.61	0.82	—	92	13.40	1.18	—
43	13.04	0.78	—	93	13.14	0.90	—
44	13.59	0.63	—	94	12.56	1.15	—
45	13.01	—	K	95	12.12	0.82	—
46	12.80	0.86	—	96	11.37	0.67	—
47	10.03	0.34	A5	97	12.51	0.42	—
48	13.55	0.90	—	98	10.41	1.78	M1
49	13.09	0.68	—	99	10.13	1.80	M2
50	13.54	1.25	—	—	—	—	—

than the photoelectrically determined B-V value. For these reasons the photographic values of V and B-V of stars No. 4 and 5 were plotted in the colour magnitude diagram, instead of their photoelectric values.

SPECTRAL TYPES.

The spectral types of the brighter stars are taken from the Henry Draper Catalogue and its extension. These are given in the 4th column of Table II. Approximate spectral types of the somewhat fainter stars were also determined using unwidened objective prism plates (Nos. 3332 and 3334 in Table I).

DISCUSSION.

The colour magnitude diagram of all the stars in the cluster region is given in Figure 2. The lines in this figure represent the standard main sequence and giant branch of Johnson and Morgan (1953) fitted to the colour magnitude diagram of NGC 6383. Large dots represent stars measured photoelectrically, and the cross and plus sign represent, respectively, V 701 and V 702 Sco.

The photographic measurements, small dots, generally confirm Eggen's remarkable result that NGC 6383 is a very young cluster with a normal main sequence to about AO and elevated main sequence for redder stars. It is of great importance to study fainter stars in order to know their behavior in the colour-magnitude diagram. For this purpose an extension of the magnitudes sequence to fainter magnitudes is necessary.

From an examination of Figure 2 we can put forward the following facts.

The encircled dot in Figure 2 represents a Be star (No. 76), which, together with star no. 1 are the only bright stars in NGC 6383 with emission lines in their spectra.

Just to the right of this Be star there are 3 A-type stars (Nos. 3, 47 and 57) and an early F-type star (No. 85). Their location in the colour magnitude diagram suggests that they are foreground stars. However, if in some way their cluster membership can be proven then, following Herbig's (1964) idea about noncoevalness of members of stellar clusters, these stars can be interpreted as stars which are in the process of evolving away from the main sequence.

As in NGC 2265 in the present studied cluster there are 7 red giant stars located in the colour magnitude diagram about 4 magn. below the brightest-

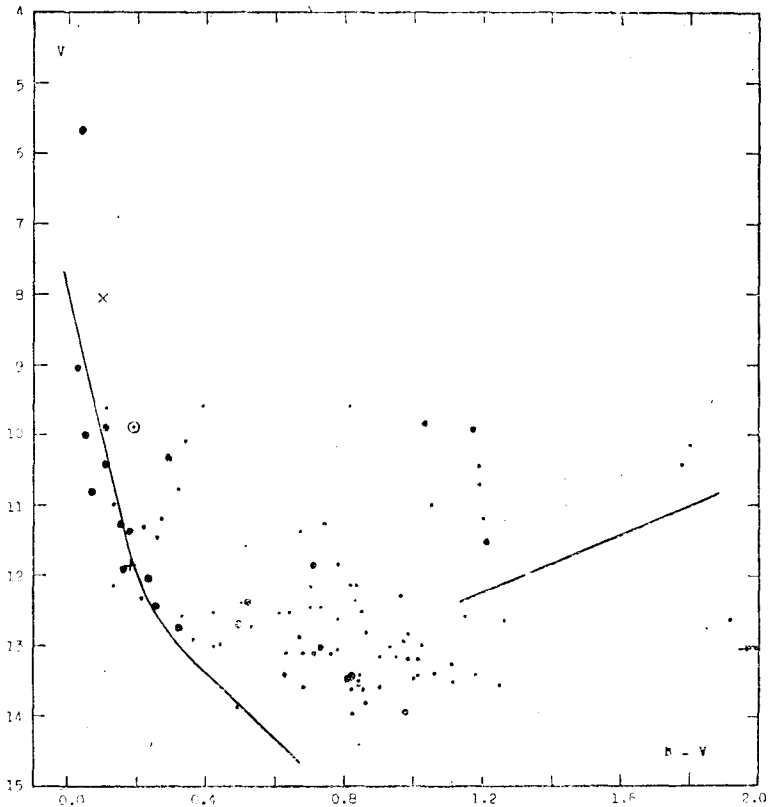


Fig. 2

member of the cluster. These stars probably are non members which are located in front of the cluster. But again if they can be proven to be members of the cluster, then these stars support Herbig's idea about non-coevalness of stars in stellar clusters, and represent stars advancedly evolving away from the main sequence.

In order to survey the cluster region for M-type stars the infrared prism plate No. 383 was examined. One M8 star located just to the east of star No. 59, in Fig. 1 indicated by a cross, was found. Unfortunately this star is too faint to be measured on the direct plates.

Because of their importance the two M-type stars (Nos. 98 and 99), which are lying just outside the circle in Figure 1, were also measured. Plotted in Figure 2 these stars are located somewhat above the giant branch of the colour magnitude diagram. It is of considerable interest to know whether these stars are members of NGC 6383. If they are members of the cluster this will again support Herbig's idea about non-coeval-

ness of the members of stellar cluster. Their measured apparent visual magnitudes and colour indexes indicate that the two M-type stars are foreground stars, but more accurate measurements have to be made before a definite conclusion can be drawn about this interesting question.

Unlike NGC 2264, NGC 6383 apparently does not contain early M-type stars which form a prolongation to the red of the elevated branch of the main sequence. However, there are two stars which are lying on this part of the colour magnitude diagram of NGC 6383. These are stars No. 45 and 81. Their infrared spectra on plate No. 385 (Table I), indicates that they are Probably K-type stars. It must be mentioned here that the blue magnitude of star No. 45 is just fainter than the limit of the blue photometry.

Some stars are located above the elevated branch of the main sequence. Again it is of great interest to about the membership of these stars.

Only one star No. 89 is found to be situated close to the main sequence of the cluster.

T TAURI STARS.

In order to find out whether NGC 6383 contains T Tauri type variables the region of cluster was examined for faint H_{α} -emission stars. For this purpose two 20 min. and one 60 min. unwidened H_{α} -plates (Nos. 387, 50 and 17 in Table I) were examined. The 60 min. plate goes as deep as $V = 16.0$ magn. As pointed out by Eggen (1961) if T tauri stars are present in NGC 6383, they should, as in NGC 2264, appear at about $V = 14.80$ magn. However, on all the H_{α} -plates no faint H_{α} -emission stars are found in the cluster area.

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