

THE YOUNG OPEN CLUSTER NGC 2384

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ABSTRACT

Combined photoelectric - photographic UB_V-photometry for NGC 2384 is discussed. The results achieved so far are summarized and indicate that this cluster is young enough to be used as spiral arm tracer out to a distance of 3.27 kpc. The colour excess $E_{(B-V)}$ is 0.31, the apparent distance modulus is 13^m50 and its earliest spectral type is B0.

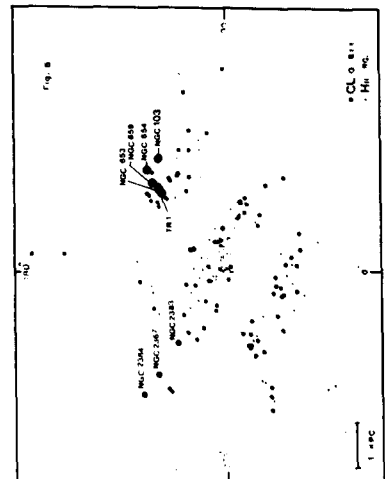
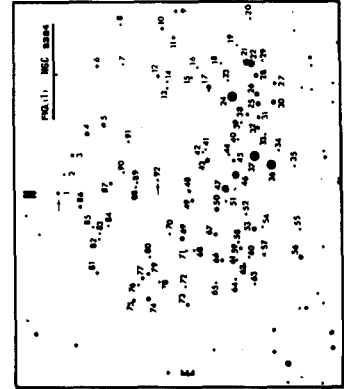
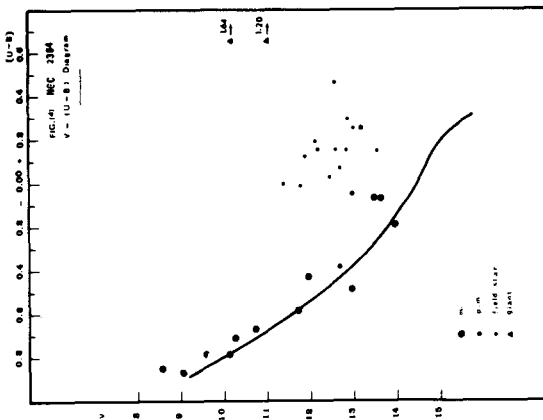
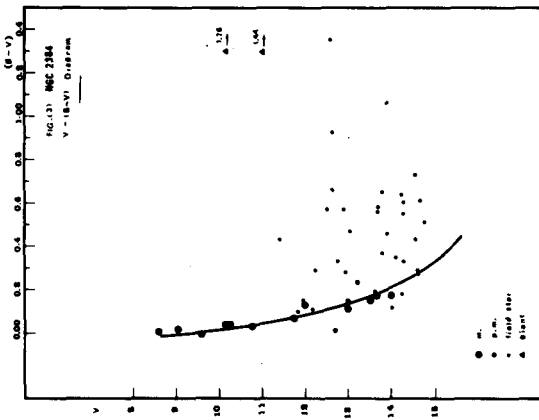
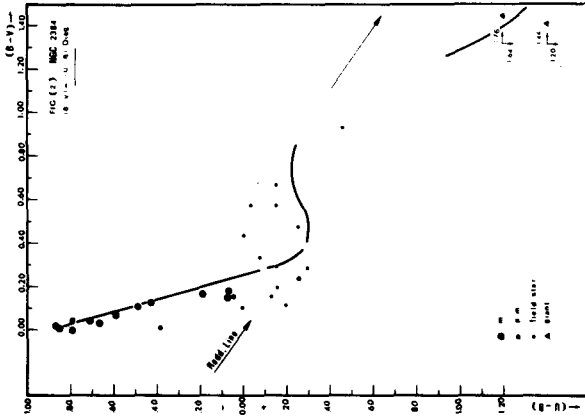
INTRODUCTION

NGC 2384 is an irregular chain like object of the type IV3p (Ruprecht, 1966) lying in Canis Major at the coordinates:

R.A.	07 ^h	20 ^m 7	1 ^{II} = 235°4
Dec.	-20°	50' (1950.0)	b ^{II} = - 294

This cluster has been previously investigated by few authors. Distance determinations of 2600, 4550, 2400 and 2200 pc have been quoted by Trumpler (1930), Collinder (1931), Zug (1933) and Barkhatova (1950) respectively. Angular diameters of 4.5', 2.8', and 2.5' as well as linear diameters of 3.4, 3.7, 3.2 and 4.5 pc have been estimated for NGC 2384 by the same authors. Hayford (1932) assigned a B0-BI spectral type while Zug (1933) noted the same spectral type for the cluster under consideration together with 0.31 as an estimate for the colour excess in front of it.

Besides, it has been concluded by Isserstedt & Schmidt-Kaler (1964) and Neckel (1967) that interstellar absorption, in this section of the Milky Way, limited by galactic longitudes 231° and 256°, is small. This gives a higher probability of reaching the outer spiral arms in this region in which, until now, no open clusters have ever been observed. That is why NGC 2384, together with some other objects, has been scheduled for observations in our program. Unfortunately, at the time when observations have been secured, it was impossible to reduce the photographic plates because of the inavailability of a photoelectric standard sequence. However, in 1972, Vogt and Moffat published the first photometric



results of the cluster based on 15 stars - for two of which H_{β} photometry is available - observed photoelectrically. They could reach a distance of 3.28 kpc to the cluster as well as an estimated total visual absorption (A_V) of $0^m.95$ along the direction towards it. Also, an earliest spectral type B0 has been assigned to NGC 2384 according to their investigation.

The plate material secured in the Newtonian focus of the 74" Reflector at KOTTAMIA, which consists of:

4 Plates : 103 aD + GG 14
 4 Plates : 103 aO + GG 13
 4 Plates : 103 aO + UG 2

has been measured using the Askania Astrophotometer available at Helwan. The 15 photoelectrically observed stars by Vögt & Moffat (1972), when combined with their corresponding iris readings, enable smooth V, B and U calibration curves to be attained. It is to note that neither magnitude nor colour equations could be detected, while controlling the calibration curves used in the reductions.

In the overall, 92 stars have been measured for the present study. They are identified, with the same numbers as those given in the catalogue enclosed at the end of this paper, in Fig. (1). The limits of completeness of our photometry are 15.00, 15.30 and 14.00 in the V, B and U spectral bands respectively.

The mean error of the V-magnitudes and colours for the program stars given in the catalogue at the end of the manuscript are as follows:

V	:	±	0.02	magn.
(B-V)	:	±	0.02	"
(U-B)	:	±	0.03	"

COLOUR-COLOUR AND COLOUR-MAGNITUDE DIAGRAMS

The visual magnitudes (V) and the (B-V) & (U-B) colour indices, for the stars which could be measured and which are tabulated in the catalogue enclosed, have been utilized in constructing the CCD presented in Fig. (2) and the CMDS illustrated in Figs. (3) and (4).

The fitting of the Standard Zero Age Main Sequence (Schmidt-Kaler, 1965), to our apparent diagrams, applying Becker's method (1954) could yield the following results for NGC 2384:

(m - M)	$13^m.50$	Distance	3.27 kpc
E_{B-V}	0.31	No. of probable Physical Members	12
E_{U-B}	0.22		
A_V	$0^m.93$	No. of possible Members	3
(m - M) _o	$12^m.57$	Spectral type	B0

It is worthy to point out that the sliding method along the reddening line, oftenly used by Johnson (1958), for reddening determination, has led to values of 0.31 and 0.22 for the excesses E_{B-V} and E_{U-B} exactly the same as those achieved using the CMDS illustrated in Figs (3) and (4). Moreover, the value of E_{B-V} achieved in this paper is in a good agreement with that given by Zug (1933). Generally, our results are comparable to those noted by Vögt & Moffat (1972).

NGC 2384
 Catalogue

Star No.	V	(B-V)	(U-B)	Star No.	V	(B-V)	(U-B)
1	13.51	0.15	-0.07 m	41	15.03	-	-
2	15.06	-	-	43	12.98	0.15	-0.05 p.m.
3	13.04	0.47	0.25	45	13.78	0.37	-
4	11.40	0.43	0.00	46	11.73	0.07	-0.59 m
5	11.93	0.15	0.12	47	10.75	0.03	-0.67 m
6	13.78	0.65	-	48	13.68	0.56	-
9	12.60	1.35	-	49	14.00	0.12	-
10	13.92	0.46	-	50	10.22	1.76	1.64
11	12.62	0.92	0.46	53	12.68	0.01	-0.39 p.m.
12	12.74	0.33	0.07	55	14.22	-	-
15	14.88	-	-	56	12.64	0.66	0.15
16	15.01	-	-	57	14.60	0.29	-
17	12.22	0.29	0.15	58	14.35	-	-
19	14.61	0.27	-	59	14.24	0.18	-
20	14.27	0.60	-	62	14.67	-	-
21	9.59 _{pe}	0.00 _{pe}	-0.79 m	63	14.67	0.61	-
22	0.05 _{pe}	0.02 _{pe}	-0.87 m	64	14.87	-	-
24	10.26	0.04	-0.71 m	66	12.88	0.57	0.15
25	12.99	0.11	-0.49 m	67	13.61	0.19	0.15
26	12.50	0.57	0.03	68	15.02	-	-
27	13.22	0.23	0.25 _{pm}	69	12.17	0.11	0.19
28	11.82	0.10	-0.01	73	14.27	0.33	-
29	15.06	-	-	74	11.03	1.44	1.20
30	11.98	0.13	-0.43 m	75	14.21	0.64	-
31	14.54	0.43	-	76	14.54	0.73	-
32	13.98	0.17	-0.19 m	77	14.09	0.15	-
33	15.05	-	-	78	14.95	-	-
35	14.66	-	-	79	13.68	0.58	-
36	10.14	0.04	-0.79 m	81	13.92	1.06	-
37	8.58	0.01	-0.85 m	85	14.77	0.51	-
38	13.64	0.18	-0.07 m	86	12.92	0.28	0.29
39	15.02	-	-	87	14.27	0.55	-

The three stars No. 26, 28 and 69 (7,3,15 in Vögt list) are generally confirmed as probable field stars although the last two are almost lying on the main sequence curve in the V-(B-V) diagram illustrated in Fig. (3). According to the author's view stars No. 50 and 74 may be considered as member super giants in the cluster. Besides, star No. 27 lies

above the main sequence in Fig. (3) and if it is considered as a star in the phase of gravitational contraction (pre - main sequence contraction stage) due to the fact that its reddening is compatible with its membership as pointed out by Vögt & Moffat (1972), the star No. 43 in the author's notations can be considered to represent the same situation as star No. 27 (No. 4 in Vogt numbers) and consequently, the author considers it as a possible member belonging to NGC 2384. In this way, 12 stars could be discriminated as probable physical members in the region of the cluster under investigation together with 3 possible members belonging to it.

The large spread of the stars in the region of NGC 2384 and its rather irregular shape has made it difficult to determine an exact angular diameter and consequently a linear one for it. However, if one considers the area in which most of the probable physical members are populated, an approximate angular diameter of $4'.2$ as well as a linear one of 3 pc could be reached for the cluster under investigation.

Moreover, it is important to point out that the distance of NGC 2384 (3.27 kpc) - determined in the present investigation is large when compared with that distance of 1.97 kpc found out by Vögt & Moffat (1972) for NGC 2383, although these two objects are lying in the same direction (almost the same galactic longitudes and latitudes) and having almost the same interstellar reddenings. Also, a spectral type B0 could be assigned to the cluster under study here in this paper.

The spectral type B 3 for NGC 2383 as given by Vogt & Moffat (1972) and the spectral type B0 for NGC 2384 (the present work) together with the type B 1 achieved by the author for NGC 2367 (published elsewhere, 1975) indicates that these three stellar systems are young enough to be used as spiral arm tracers. They are located, as shown in Fig. (5), somewhat outside the extension of the local arm (Becker & Fenkart, 1970).

REFERENCES:

- Barkhatova, K.A., 1950, *Azh.*, 27, 182.
 Becker, W. and Stock, J., 1954, *Z.Astrophys.*, 34,1.
 Becker, W. and Fenkart, R., 1970, *IAU Symposium No. 38*, 205.
 Collinder, P., 1931, *Ld An*, 2Lk.
 , 1931, *Ld An*, 2Cr.
 Hassan, S.M. and Marei, M., 1975, *Helwan Obs. Bull. No. 116*.
 Hayford, P., 1932, *Lick Obs. Bull.* 16, 53.
 Isserstedt, J. and Schmidt-Kaler, Th., 1964, *Z. Astrophys.*, 59,182.
 Johnson, H.L., 1958, *Ap.J.*, 126,126.
 Neckel, Th., 1967, *Veröff. Landessternwarte Heidelberg-Königstuhl* 19.
 Ruprecht, J., 1966, *Bull. Astron.Czechosl.*
 Schmidt-Kaler, Th., 1965, in H.H.Voigt (ed.), *Group VI/1, Springer-Verlag*
 Trumpler, R.J., 1930, *Lick Obs. Bull.* 14,171. (Berlin), p.284
 Vögt, N. and Moffat, A.F.J., 1972, *Astron. & Astrophys. Suppl.Ser.*,7,2,
 134.
 Zug, R., 1933, *Lick Obs. Bull.* 16,132.