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Membership, fundamental parameters and luminosity function of the open cluster NCG 5662

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SUMMARY

New photoelectric *UBV* photometry of 237 stars brighter than $V=14.0$ as well as DDO and Washington photometry of three red stars in the open cluster NGC 5662 are presented. Nearly one-third of the stars sampled are found to be members of the cluster based on photometric and astrometric indicators. NGC 5662 contains two red giants and two photometric variable stars. The reddening across the cluster is found to be variable, the mean value being $E(B-V)=0.31\pm0.04$. A distance of (790 ± 55) pc, an age of 7.9×10^7 yr, a metal abundance of [Fe/H]$=-0.03\pm0.13$ relative to the Sun, and other fundamental parameters are also derived. On the basis of the improved cluster parameters derived here, it is concluded that the $5^{\rm d}.5$ Cepheid V Cen is almost certainly a member of NGC 5662.

1 INTRODUCTION

The open cluster NGC 5662 (C1431−563, $l=316^\circ.9$, $b=3^\circ.5$) is a loose concentration of late B- and A-type stars lying in the Centaurus section of the Milky Way. It is an intermediate richness, intermediate brightness, detached cluster of Trumpler class II3m (Ruprecht 1966) with a somewhat peculiar spatial distribution of likely member stars. In addition to a northern centre there is a southern part, which is not included in Hogg's (1965) cluster diameter of 12 arcmin. The latter is separated from the former by a region containing few bright stars. There seems to be a reasonable possibility that the bright Cepheid V Cen ($p=5.494$ d), situated ~35 arcmin south-west of the cluster centre, is an outlying member of NGC 5662 (Tsarevsky, Ureche & Efremov 1966). A detailed study of this cluster is therefore of some interest, particularly in view of the importance of cluster Cepheids for the calibration of the Cepheid period–luminosity relation.

Relatively few investigations on this cluster have been carried out so far. Moffat & Vogt (1973) reported *UBV* photometry for 30 comparatively bright stars in the cluster field and derived a reddening of $E(B-V)=0.31$ and a distance of 580 pc. These results, however, are rather uncertain since they are based on only one observation per star. Haug (1978) observed 28 stars photoelectrically in the *UBV* system and derived a reddening and distance both in good agreement with the values found by Moffat & Vogt. However, a re-analysis of the existing photometric data led Mermilliod (1981a) to a cluster distance of 700 pc, i.e. somewhat larger than the previous values.

Relative proper motions of 188 stars in the cluster area were determined by King (1980) with an average standard error of ±0.0009 arcsec yr^{-1} and the probability of cluster membership for individual stars has also been derived. Out of these 188 stars, only 90 have $P>50$ per cent. Photoelectric *UBV* magnitudes are available for only 21 out of these 90 stars. The lack of photoelectric *UBV* mgnitudes for a good number of probable cluster members made the present study desirable.

In this paper new photoelectric *UBV* data of 237 stars in the cluster region are used to search for more cluster members, to derive some improved cluster parameters, and to present some additional arguments for the possible membership of V Cen. Three probable red giants were also observed in the DDO and Washington photometric systems. These data are useful to evaluate cluster membership as well as to derive reddening and metallicity of the red cluster giants.

2 OBSERVATIONS AND REDUCTIONS

The photoelectric *UBV* observations were secured within a 13-night run in 1985 February at Las Campanas Observatory (LCO) in Chile, with the University of Toronto's 0.61-m reflecting telescope. The data were obtained using a dry-ice cooled 1P21 single-channel photomultiplier in pulse-counting mode equipped with a standard *UBV* filter set. Mean coefficients were employed to correct for atmospheric extinction and nightly observations of about 13 E-region

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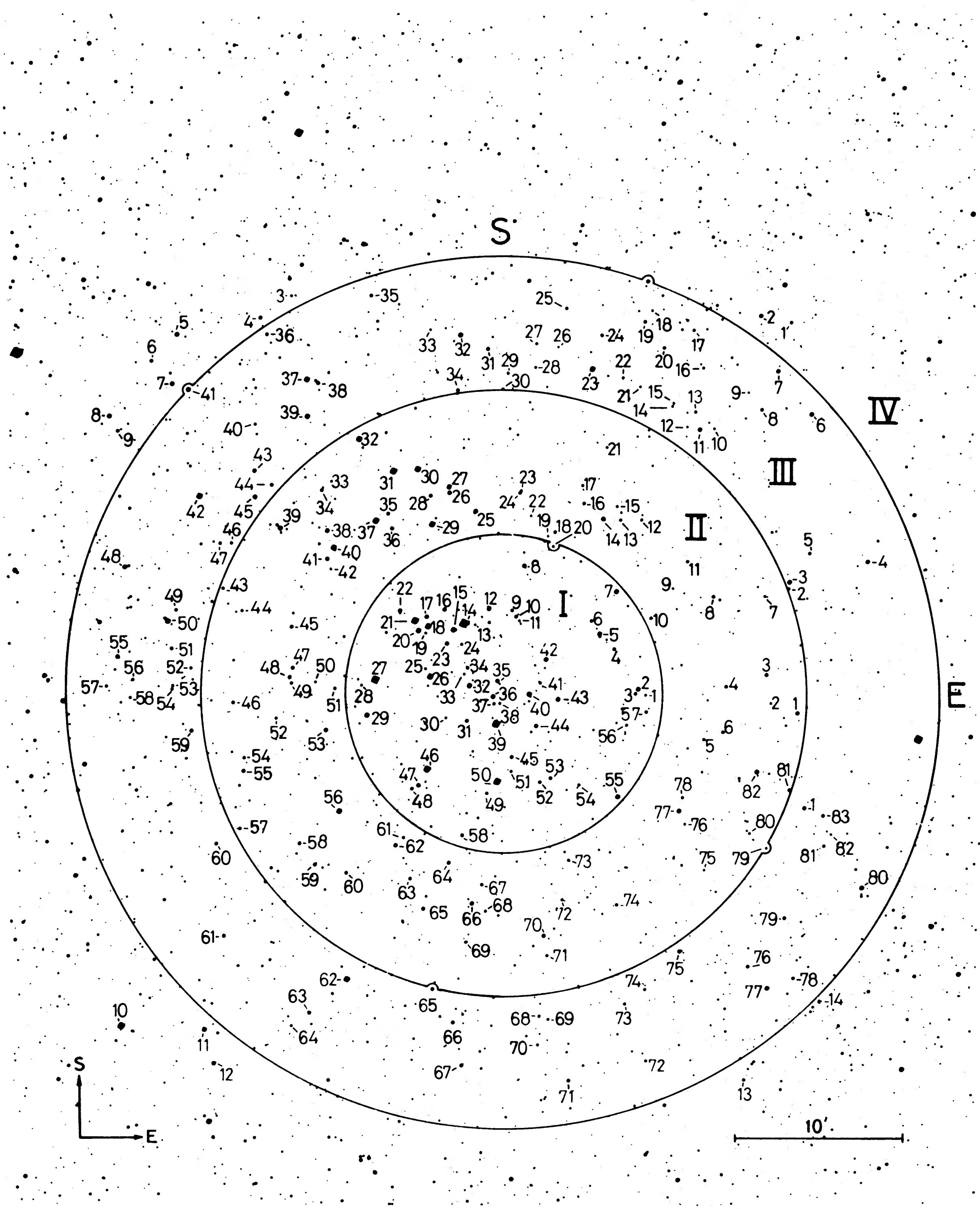

Figure 1. Identification chart for stars in NGC 5662 for which photometry is given in the text. The original plate is a 20-min exposure Kodak IIa-O taken with the Curtis Schmidt telescope at CTIO in very good seeing. The radii of the circles are approximately 9.4, 18, and 26 arcmin. Region I is called the inner region in the text.

primary standards (Cousins 1973, 1974; Graham 1982) were used to transform to the *UBV* system.

Additional photoelectric observations were obtained in 1985 April with the 0.91- and 0.61-m telescopes at the Cerro Tololo Inter-American Observatory (CTIO). For these observations we used a single-channel photometer equipped with a RCA 31034A photomultiplier. The same standards were used as for the Las Campanas observations, and mean extinction coefficients were also employed.

A total of 237 stars were measured in the field of NGC 5662. All but 10 stars were observed more than once. The star numbers and regions are identified in Fig. 1. The measurements were essentially made inside three annular regions around the adopted cluster centre. The outer radii of regions I, II and III in Fig. 1 are 9.4, 18 and 26 arcmin, respectively. A few stars were also measured beyond $r=26$ arcmin (region IV).

The new *UBV* data are presented in Table 1, where the column labelled *n* refers to the number of independent observations. The first column in Table 1 lists the star identification (the Roman number refers to the annular region on the finding chart in Fig. 1). Column (2) gives the HD or CPD number, while column (3) lists the MK spectral types taken from Fitzgerald *et al.* (1979) or Houk & Cowley (1975), the latter given in parentheses. Column (8) indicates King's (1980) probabilities of membership, *P* (in per cent), based on relative proper motions.

A comparison of the multiple observations with the observed means for the cluster stars yields the internal mean errors of a single observation; a comparison of the observed mean value with the published ones for the standard stars yields the external mean errors of a single observation, an indication of how closely the standard system has been reproduced. The external and internal mean errors are summarized in Table 2. As shown in this table, the internal errors for stars with $V<12.0$ are in close agreement with the results from the standard stars. For stars fainter than $V=12.0$, however, the internal uncertainties appear to be somewhat larger. A few individual results having internal errors larger than 0.05 mag are indicated by a colon (:) in Table 1.

Thirty of the stars measured in the present study have been previously observed by Moffat & Vogt (1973). Omitting stars 19 and 27 of Moffat & Vogt for which the two sets of observations do not agree, the average differences (Δ = previous minus present value) are: $\Delta V = -0.04 \pm 0.02$ (sd), $\Delta(B-V) = 0.00 \pm 0.02$ (sd), and $\Delta(U-B) = 0.03 \pm 0.03$ (sd). A comparison with Haug's (1978) data for 20 stars in common yields: $\Delta V = -0.04 \pm 0.03$ (sd), $\Delta(B-V) = 0.03 \pm 0.02$ (sd)

Table 1. *UBV* photometry of stars in NGC 5662.

Star No.	HD/CPD	Sp.Type	V	B-V	U-B	n	Membership P(%)	Class	Adopted
I-1			13.381	0.785	0.152	2	–	2	pm
I-2	-56°6353		11.187	0.380	0.239	2	79	3	nm?
I-3			12.380	0.746	0.216	2	0	3	nm
I-4			11.748	1.009	0.585	2	0	3	nm
I-5	-56°6348		11.300	0.252	0.092	2	79	1	m
I-6			12.649	0.451	0.344	2	–	1	m
I-7	-56°6351		10.570	0.676	0.230	2	0	3	nm
I-8			11.435:	0.385	0.124:	3	1	3	nm,var
I-9			12.534	0.616	0.273	2	–	2	pm
I-10			12.247	0.408	0.304	3	60	1	m
I-11			13.643	0.707	0.189	3	–	1	m
I-12	-56°6344		11.385	0.408	0.221	2	88	3	nm
I-13			12.738	1.042	0.557	1	–	3	nm
I-14	127866	B7III(B8III)	8.323	0.157	-0.231	3	87	1	m
I-15	-56°6337	A1V	10.700	0.225	-0.018	2	68	1	m
I-16			11.736	0.310	0.225	2	88	1	m
I-17	-56°6332		11.582	0.302	0.214	2	89	1	m
I-18	-56°6333	B7IV	9.899	0.177	-0.228	2	80	1	m
I-19			13.397	0.717	0.294	1	–	1	m
I-20	-56°6330	A2IIIp	10.661	0.263	-0.108	4	4	2	nm
I-21	127817	B7IV(B7/9II/III)	9.196	0.176	-0.247	2	89	1	m
I-22			11.467	0.363	0.291	2	46	2	pm
I-23			10.701	1.299	1.067	3	0	3	nm
I-24			12.506	1.190	0.873	3	–	3	nm
I-25			13.282	0.656	0.297	2	–	1	m
I-26	-56°6334	B8V	9.930	0.224	-0.057	2	60	1	m
I-27	127753	K3III(K5III)	7.070	1.870	2.023	2	83	1	m
I-28			13.266	0.895	0.305	2	–	3	nm
I-29	-55°6061	B9V	10.756	0.178	-0.015	2	89	1	m
I-30			13.021	0.894	0.296	2	–	3	nm
I-31			11.744	0.618	0.371	4	38	3	nm,var
I-32	-56°6341	A1V	10.863	0.289	0.093	3	85	1	m
I-33			13.554	0.663	0.264	2	–	1	m
I-34			12.478	0.491	0.351	4	62	1	m
I-35			11.609	0.374	0.281	3	0	2	nm
I-36	-55°6066	B9V	11.166	0.225	0.077	2	79	1	m
I-37			12.896	0.477	0.236	2	–	1	m
I-38			13.172	0.674	0.701	3	–	1	m
I-39	127900	B8IV(B8II/III)	8.853	0.132	-0.262	2	88	1	m
I-40	-55°6071	B7V	10.609	0.315	-0.160	2	1	3	nm
I-41			12.736	0.732	0.184	2	–	3	nm
I-42	-56°6346	B9V	11.107	0.295	0.088	2	88	1	m
I-43	-55°6073	A0V	11.056	0.242	0.048	2	89	1	m
I-44	-55°6072		11.337	0.577	0.191	2	0	3	nm
I-45			11.863	0.490	0.311	2	0	3	nm
I-46	127835	B7V(B7/9V)	9.399	0.119	-0.280	3	87	1	m
I-47	-55°6063		11.594	0.230	0.093	2	86	1	m
I-48			11.176	1.843	1.982:	2	–	3	nm
II-40	-56°6321		10.179	0.223	-0.126	2	2	1	pm
II-41			11.632	0.287	0.148	4	89	1	m
II-42			13.322	0.912	0.441	2	–	3	nm
II-43			12.929	0.424	0.093	2	–	3	nm
II-44			13.025	0.573	0.286	2	–	1	m
II-45			12.046	0.354	0.267	2	81	1	m
II-46			12.525	0.297	-0.062:	3	–	3	nm
II-47			11.615	0.722	0.330	2	0	3	nm
II-48			11.929	0.522	0.322	2	44	3	nm
II-49			12.536	0.656	0.414	2	3	3	nm

Table 1 – *continued.*

Star No.	HD/CPD	Sp.Type	V	B–V	U–B	n	Membership P(%)	Class	Adopted
II-50			13.434	0.428	0.331	3	–	3	nm
II-51			12.635	0.443	0.320	3	88	1	m
II-52			12.621	0.801	0.396	2	–	3	nm
II-53	-55°6057		11.372	0.347	-0.059	2	6	3	nm
II-54			12.423	0.733	0.252	2	0	3	nm
II-55			11.782	0.301	0.217	2	86	1	m
II-56	127722	(B8V)	10.290	0.103	-0.237	2	74	1	m
II-57			12.407	0.753	0.245	2	–	3	nm
II-58			12.213	0.260	0.021	3	56	2	pm
II-59			12.034	0.330	0.245	2	82	1	m
II-60			12.235	0.376	0.265	2	–	1	m
II-61			12.714	0.620	0.250	2	–	1	m
II-62	-55°6062		11.663	0.227	0.133	2	76	1	m
II-63			11.459	1.470	1.312	2	–	3	nm
II-64			11.431	0.716	0.159	2	0	3	nm
II-65			11.779	0.302	0.166	2	23	1	pm
II-66			10.694	1.172	0.855	2	0	3	nm
II-67			12.398	0.594	0.311	2	17	3	nm
II-68			12.980	0.631	0.172	2	–	1	m
II-69			12.608	1.048	0.520	2	–	3	nm
II-70			11.757	0.265	0.149	2	0	1	pm
II-71			12.656	0.588	0.283	2	–	1	m
II-72			12.344	1.356	0.977	2	–	3	nm
II-73			12.336	1.250	0.881	2	–	3	nm
II-74			11.602	1.565	1.482	2	–	3	nm
II-75			13.670	0.563	0.385	2	–	3	nm
II-76			13.367	0.582	0.399	2	–	3	nm
II-77	-55°6078		10.980	0.215	0.050	3	14	1	pm
II-78			11.662	1.512	1.380:	3	–	3	nm
II-79			13.724	0.505	0.401	4	–	3	nm
II-80			12.671:	1.415	1.215	2	–	3	nm
II-81			11.997	0.759	0.238	2	–	3	nm
II-82	-55°6984		10.885	0.481	0.335	2	0	3	nm
III-1			11.697	0.344	0.249	2	34	1	pm
III-2			13.016	0.735	0.319:	2	–	2	pm
III-3	-56°6361		10.931	0.591	0.387	3	85	3	nm?
III-4			11.096	0.653	0.143	2	0	3	nm
III-5			12.478	0.375	0.328	2	–	1	m
III-6	-56°6362		10.891	0.482	0.345	2	43	3	nm
I-49			11.523	1.755	1.819	2	–	3	nm
I-50	127924	B8IV(B7/9III/IV)	9.231	0.109	-0.311	3	89	1	m
I-51			13.021	0.564	0.292	2	–	1	m
I-52			12.367	0.384	0.280	2	0	1	pm
I-53			12.158	0.640	0.428	2	65	3	nm
I-54			12.714	0.596	0.354	4	–	1	m,var
I-55	-55°6075		10.689	0.433	0.358	3	62	3	nm
I-56			12.687	0.932	0.431	2	–	3	nm
I-57			12.436	0.532	0.362	2	0	1	pm
I-58			12.068	0.445	-0.046	2	0	3	nm
II-1	-55°6087		11.648	0.275	0.178	3	76	1	m
II-2			13.411	0.564	0.168	3	–	3	nm
II-3			11.919	0.429	-0.081	3	71	3	nm?
II-4			12.102	0.550	0.071	2	18	3	nm
II-5			13.546	0.885	0.168	1	–	3	nm
II-6			12.246	0.713	0.294	2	–	3	nm
II-7			13.082	0.669	0.336	2	–	1	m
II-8			12.320	0.585	0.275	2	12	3	nm
II-9			13.358	0.858	0.465	2	–	3	nm
II-10			12.342	0.699	0.321	2	10	3	nm
II-11			11.848	1.374	1.249	2	–	3	nm
II-12			13.195	0.454	0.202	2	–	3	nm
II-13			13.200	0.392	0.241	2	–	3	nm
II-14	-56°6349		11.095	0.456	-0.079	2	0	3	nm
II-15			12.319	1.538	1.363	2	–	3	nm
II-16			12.388	0.676	0.182	2	0	3	nm
II-17			13.189	0.395	0.221	2	–	3	nm
II-18			12.323	0.794	0.330	2	0	3	nm
II-19			13.924	0.701	0.201	2	–	1	m
II-20			13.659	0.751	0.274	2	–	1	m
II-21			13.177	0.743	0.226	2	–	2	pm
II-22			13.231	1.414	0.978	2	–	3	nm
II-23			13.522	0.830	0.239	3	–	2	pm
II-24			12.756	0.809	0.497	3	–	3	nm
II-25	-56°6342		10.220	1.336	1.204	2	0	3	nm
II-26			11.856	0.421	-0.002	2	26	3	nm
II-27	-56°6336		10.994:	0.245	-0.093	2	83	1	m
II-28			11.358	1.394	1.233	2	0	3	nm
II-29	127836	B8V(B9/A0IV/V)	9.836	0.244	-0.129	2	84	1	m
II-30	127818	(F6/8IV/V)	9.535	0.569	0.165	2	0	3	nm
II-31	127782	B8V(B8V)	9.369	0.175	-0.275	2	87	1	m
II-32	127733	K2III(K2/3III)	8.638	1.689	1.798	3	0	2	nm
II-33			13.112	0.646	0.256	1	–	1	m
II-34			12.334	0.393	0.333	2	48	1	m
II-35			12.108	0.493	0.265	2	89	1	m
II-36			11.911	0.341	0.252	2	88	1	m
II-37	127754	(B8V)	9.587	0.211	-0.198	2	89	1	m,var
II-38	-56°6320		11.189	0.242	0.082	4	81	1	m
II-39	-56°6315		10.988	0.272	0.016	2	87	1	m
III-7			11.357	0.481	0.180	2	75	3	nm?

Table 1 – *continued.*

Star No.	HD/CPD	Sp.Type	V	B–V	U–B	n	Membership P(%)	Class	Adopted
III-8			12.160	0.743	0.293	2	1	3	nm
III-9			13.763	0.727	0.195:	2	–	1	m
III-10			13.706	0.579	0.300	2	–	3	nm
III-11	-56°6357		11.354	0.295	0.086	2	56	1	m
III-12			12.871	1.436	1.274	2	–	3	nm
III-13			12.791	0.602	0.237	3	–	1	m
III-14			13.833	0.571	0.380	2	–	3	nm
III-15			13.065	1.387:	0.856	2	–	3	nm
III-16			12.566	1.367	1.153	2	–	3	nm
III-17			12.785	0.526	0.372	2	–	1	m
III-18			13.430	0.610	0.419	2	–	3	nm
III-19			11.750	0.997	0.519	2	0	3	nm
III-20			12.157	0.947	0.511	2	0	3	nm
III-21			13.264	1.054	0.568	1	–	3	nm
III-22			12.193	1.686	1.534:	2	–	3	nm
III-23	-56°6347		9.947	0.565	-0.001	2	0	3	nm
III-24			12.339	0.445	-0.085	2	8	3	nm
III-25			12.563	0.588	0.264	2	62	1	m
III-26			13.671	0.835	0.319	2	–	2	pm
III-27			13.091	0.532	0.134	3	–	3	nm
III-28			12.413	1.411	1.065	2	–	3	nm
III-29			13.183	0.569	0.314	2	–	1	m
III-30			12.567	1.527	1.512	2	–	3	nm
III-31			11.911	0.310	0.190	2	54	1	m
III-32	-56°6339		10.885	0.207	0.016	2	85	1	m
III-33			13.622	0.691	0.160	2	–	1	m
III-34			12.320	0.380	-0.119	2	0	3	nm
III-35			12.105	0.514	0.331:	2	15	2	pm
III-36			12.283	0.485	0.271	4	68	1	m
III-37	127864		10.258	0.202	-0.173	2	87	1	m
III-38			11.142	1.301	1.120	2	0	3	nm
III-39	-56°6319		10.638	0.225	0.090	2	89	1	m
III-40			13.049	0.490	0.273	2	–	1	m
III-41	-56°6311		11.342	0.242	-0.010	2	85	1	m
III-42	127515	(B7/8Vn(e))	9.891	0.219	-0.210	2	88	1	m
III-43			11.596	0.287	0.150	2	79	1	m
III-44			12.019	0.575	0.306	2	5	3	nm
III-45	-56°6313		11.374	0.264	0.150	2	88	1	m
III-46			11.744	1.767	1.703	2	–	3	nm
III-47			12.203	0.903	0.303	2	–	3	nm
III-48	-56°6306		11.303	0.273	0.062	2	89	1	m
III-49			12.614	0.472	0.259	2	59	1	m
III-50	127487	(A2/4V)	10.553	0.200	-0.021	2	87	1	m
III-51			12.273	0.404	0.312	2	84	1	m
III-52			12.988	0.403	0.193:	2	–	3	nm
III-53			13.139	0.600	0.120	2	–	1	nm
III-54			13.054	0.764	0.187	2	–	2	pm
III-55			10.784	1.290	1.144	2	1	3	nm
III-56			11.442	1.888	1.974	2	–	3	nm
III-57			12.391	0.736	0.206	2	0	3	nm
III-58			13.060	0.539	0.137	2	–	3	nm
III-59			11.939	0.497	0.292	2	15	3	nm
III-60			12.203	0.379	0.253	2	78	1	m
III-61			12.094	0.329	-0.041	2	–	3	nm
III-62	127721	(B8V)	10.005	0.131	-0.207	2	66	1	m
III-63			11.948	0.494	0.300	2	15	3	nm
III-64			13.194	0.540	0.255	1	–	1	m
III-65			12.090:	0.315	0.027	2	12	3	nm,var
III-66			11.838	0.292	0.163	2	0	2	nm
III-67			10.980	1.364	1.094	2	–	3	pm
III-68			13.020	0.435	0.145	2	–	3	nm
III-69			12.962	0.927	0.289	1	–	3	nm
III-70			12.671	0.928	0.604	2	–	3	nm
III-71			12.073	0.293	-0.034	2	–	3	nm
III-72			12.590	0.439	0.330	2	–	1	m
III-73			12.500	0.793	0.315	2	–	3	nm
III-74			12.583	0.705	0.333	2	–	3	nm
III-75			9.968	1.942	2.121	3	–	3	nm
III-76			12.218	0.330	0.124	2	–	3	nm
III-77	-55°6085		10.985	0.213	0.114	2	67	1	m
III-78			12.436	0.369	0.215	2	14	3	nm
III-79			12.204	0.386	-0.139	2	18	3	nm
III-80	-55°6089		10.907	0.332	0.269	1	20	3	nm
III-81			12.009	1.526	1.175	2	–	3	nm
III-82			13.519	0.698	0.136	1	–	1	m
III-83			11.386	1.304	1.093	2	–	3	nm
IV-1			12.518	0.507	0.110	2	–	3	nm
IV-2			11.527	0.453	0.005	2	74	3	nm?
IV-3			12.800	1.092	0.529	1	–	3	nm
IV-4			11.221	1.192	0.844	2	20	3	nm
IV-5			10.192	1.438	1.438	2	0	3	nm
IV-6			12.296	0.453	0.453	2	1	3	nm
IV-7	-56°6309		10.965	0.685	0.305	2	0	3	nm
IV-8	-56°6305		11.124	0.292	0.094	2	88	1	m
IV-9			12.523	0.413	0.353	4	88	1	m
IV-10	127427	(G8II/III)	7.763	1.478	1.299	2	70	1	m
IV-11	-55°6050	(A0/1IV)	10.810	0.271	0.186	2	7	3	nm
IV-12			10.882	0.247	0.111	2	–	1	m
IV-13			12.211	0.614	0.126	2	–	3	nm
IV-14			11.615	0.395	0.213	2	–	2	pm

Table 2. Mean errors of the *UBV* photometry.

Telescope	External Mean Errors				Internal Mean Errors		
	V	B-V	U-B	Range	V	B-V	U-B
61-cm (LCO)	0.012	0.009	0.016	V<12.0 V>12.0	0.014 0.025	0.010 0.028	0.017 0.027
61-cm (CTIO)	0.013	0.008	0.017	V<12.0	0.012	0.009	0.018
91-cm (CTIO)	0.010	0.006	0.011	V>13.2	0.018	0.022	0.029

and $\Delta(U-B)=0.01\pm0.03$ (sd). Although the standard deviations show a scatter somewhat higher than our internal errors for stars with $V<12.0$, our V magnitudes are systematically fainter by 0.04 mag than those obtained by Moffat & Vogt (1973) and Haug (1978). This fact could be ascribed to the probably larger diaphragms used in the former photometric investigations. Nevertheless, the main findings derived in the following sections cannot be influenced by this systematic error in V, except perhaps for the cluster distance.

3 PROBABLE VARIABLES

A comparison of the photoelectric *UBV* data of Moffat & Vogt (1973) with the present observations shows that for stars I-31 (MV No. 19) and II-37 (MV No. 27) the magnitudes and colours differ significantly in comparison to their observational errors. These are very likely variable stars. Also, for stars I-8, I-54, and III-65, the *UBV* values obtained by us on different nights differ by more than three times the expected error of our observations. We believe that these stars may also be variables.

4 THE *UBV* DIAGRAMS

The observed colour–magnitude (C–M) diagrams of NGC 5662, constructed from the photoelectric data for stars in the inner region (0–9.4 arcmin from the cluster centre) and the outer region (beyond $r=9.4$ arcmin), are presented in Figs 2 and 3. These diagrams reveal a relatively wide main sequence consisting of late B, A and F stars that extends over a V range of about 8–14 mag. There are two reasons why many of the stars in these diagrams scatter off the principal sequences. First, many observed stars are not cluster members. The galactic latitude of NGC 5662 being only ~4°, many foreground or background stars are included. Secondly, as noted previously by Moffat & Vogt (1973), differential reddening is present in the cluster field. The turnoff point on the main sequence seems to occur in the late-type B-star range, which suggests a cluster age nearly similar to that of the Pleiades. Only three stars (I-27, II-32 and IV-10) could be giant cluster members.

Fig. 4 shows the colour–colour (C–C) diagrams for the same stars as in Figs 2 and 3. For comparison, the unreddened sequence of Schmidt-Kaler (1982) for luminosity class I stars (solid line) is shown.

5 CLUSTER MEMBERSHIP

There are different photometric and kinematic methods to discern whether an individual star is or is not a cluster member. The most obvious and trustworthy procedure is perhaps the proper motion analysis. If all the stars in a cluster are formed from a single cloud, then they would share a common proper motion within observational errors. We note, however, that the probability of membership based on the proper

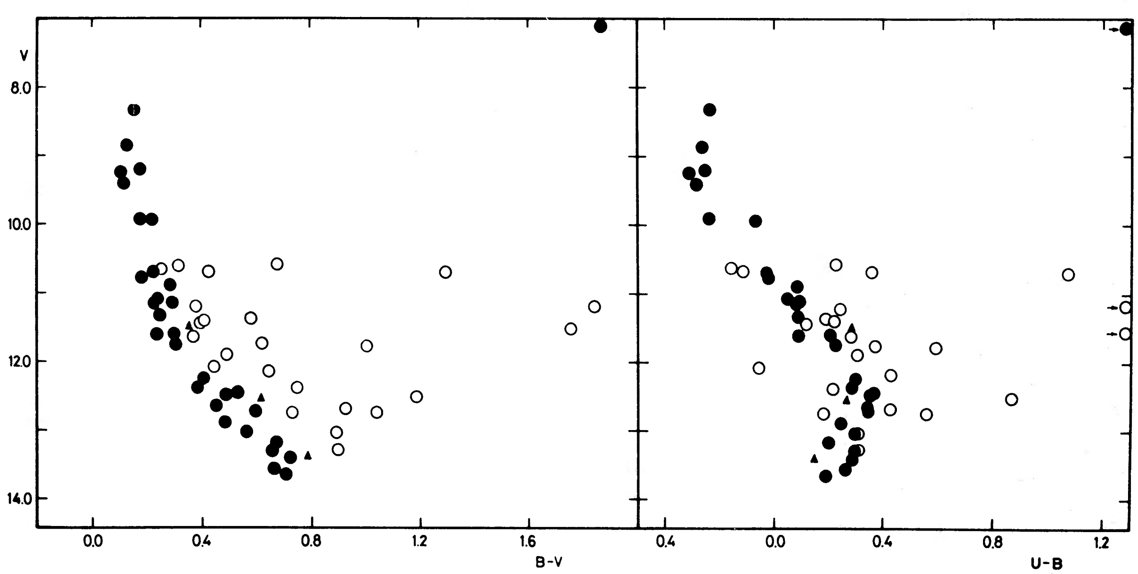

Figure 2. Photoelectric colour-magnitude diagrams for the inner region of NGC 5662 (region I). Stars with photometric membership classes 1, 2 and 3, are represented by filled circles, triangles and open circles, respectively.

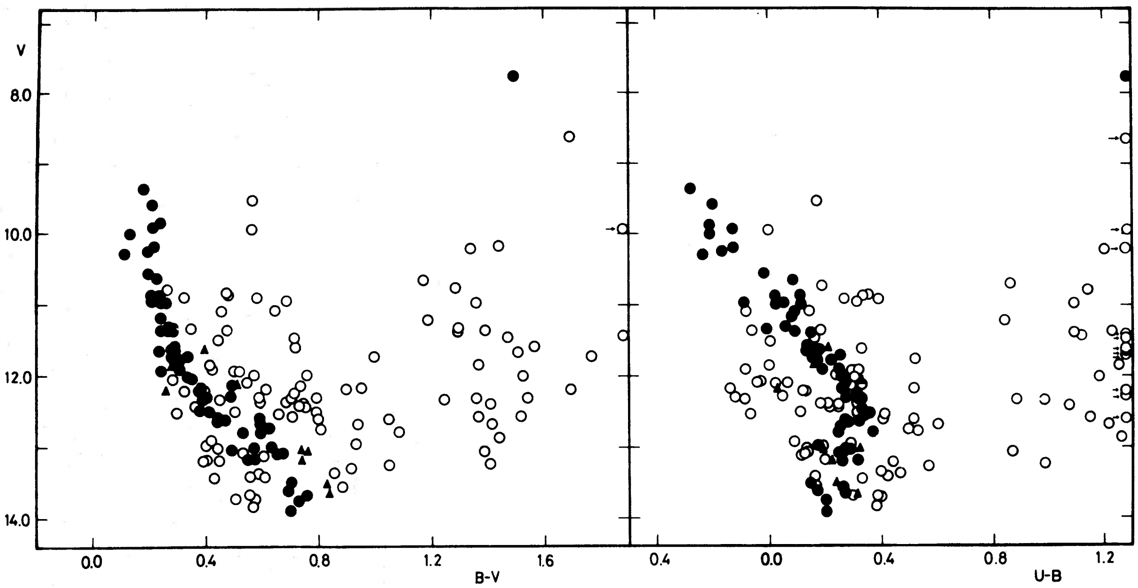

Figure 3. Photoelectric colour–magnitude diagrams of NGC 5662 for stars in the outer region (beyond $r = 26$ arcmin). Symbols are as in Fig. 2.

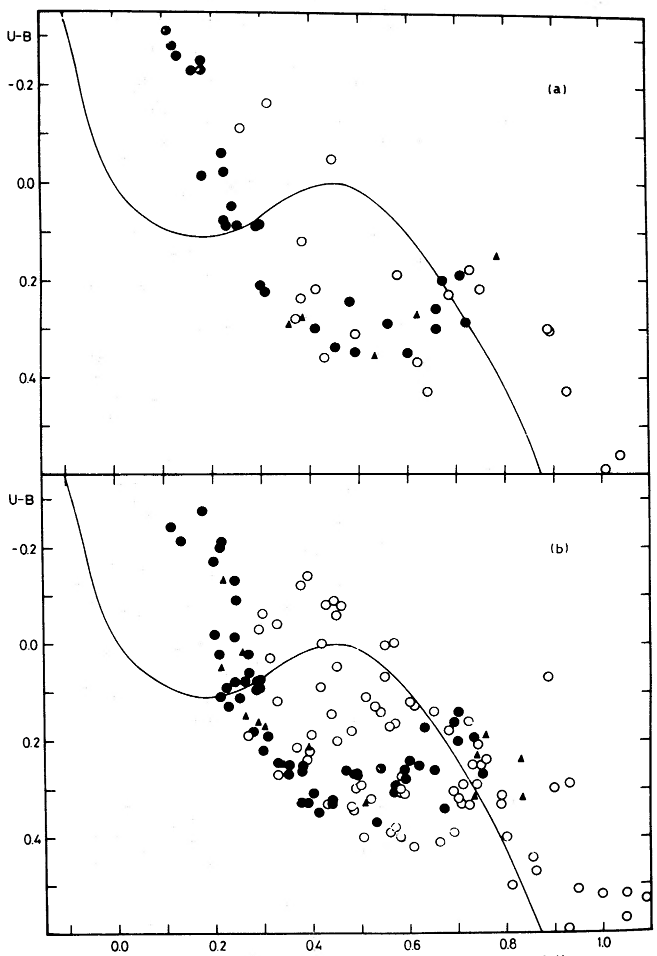

Figure 4. Colour–colour diagram of NGC 5662 for stars in the inner (a) and outer (b) regions. The full line is the standard relation of Schmidt-Kaler (1982) for main sequence stars. Symbols are as in Fig. 2.

motion study alone is not always sufficient to evaluate cluster membership. Accurate radial velocity data as well as a careful consideration of the photometric evidence are needed to discriminate between members and non-members.

Membership in NGC 5662 has been determined by examining the position of the observed stars in the C–C and C–M diagrams. Here, we have assumed that a cluster member must satisfy two conditions. First, its position in the two C–M diagrams must correspond to the same possible evolutionary status which, in turn, must be compatible with the MK spectral type (when available). Since many factors such as duplicity, rotation, and others contribute to increase the dispersion in the *UBV* diagrams, a star located just or at most 0.75 mag above the cluster main sequence in the two C–M diagrams is considered to belong to it. Secondly, the location of the star in the C–C diagram must be close to the cluster main sequence. Photometric membership classes 1, 2 and 3 were then assigned as follows: class 1, both criteria imply membership; class 2, the position of the star in the *UBV* diagrams does not allow unambiguously to retain or reject it as cluster member; class 3, one or both criteria clearly do not imply membership. Column (9) of Table 1 shows the photometric membership classes assigned to the stars. We thus find that 60 per cent of the stars observed in the central part (region I) are very likely members, whereas in the outer part (regions II, III and IV) this percentage corresponds approximately to the field stars.

In Fig. 5 King's (1980) probabilities of membership, based on relative proper motions, are plotted as a function of the observed V magnitude. Filled circles, triangles, and open circles, represent photometric membership classes 1, 2 and 3, respectively. It can be seen that 88 per cent of the stars with membership class 1 have $P > 50$ per cent, while 86 per cent of the stars with membership class 3 have $P < 50$ per cent. We then conclude that, in general, the kinematic and photometric membership criteria yield results in reasonably good agreement. Only eight membership class 3 stars show

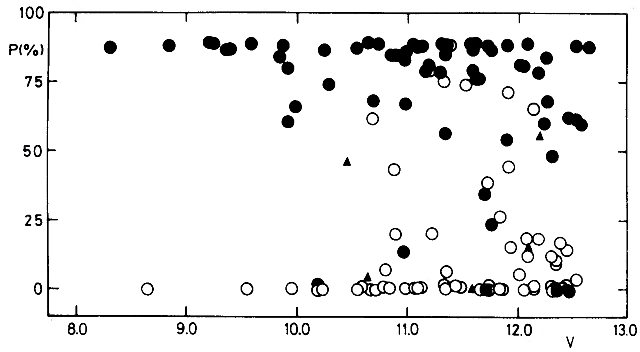

Figure 5. King's (1980) probabilities of membership, based on relative proper motions, plotted as a function of the observed V magnitude. Filled circles, triangles and open circles, represent photometric membership classes 1, 2 and 3, respectively (see text). Probable red giants have not been plotted.

$P>50$ per cent. These are probably field stars which have acquired by chance a proper motion similar to that of the cluster. On the other hand, seven membership class 1 stars with $P<50$ per cent are considered to be probable members. Column (10) of Table 1 lists the membership status finally adopted for each observed star.

6 INTERSTELLAR REDDENING, DISTANCE AND BINARY FREQUENCY

Fig. 6 shows the C–C diagram for all the members (filled circles) and probable members (triangles) of NGC 5662. The scatter in this diagram is clearly larger than the quoted photometric errors for the colour indices, which indicates that the interstellar reddening does vary across the cluster. For this reason, individual $E(B-V)_{UBV}$ and $E(U-B)_{UBV}$ colour excesses for cluster members with $(B-V)\leqslant 0.30$ were calculated from the equations (2) and (8) given by García, Clariá & Levato (1988). Although this method is strictly valid for main-sequence stars earlier than about A2, its application to stars of luminosity class III–IV does not introduce major errors, provided supergiants are excluded.

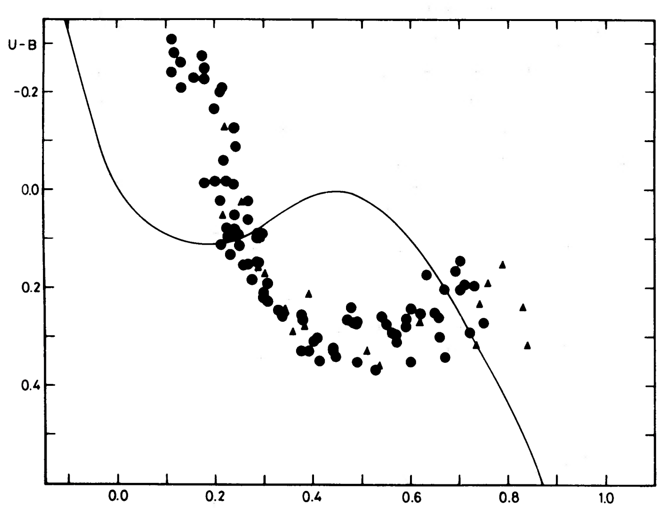

Figure 6. Colour-colour diagram for all the stars considered to be members (filled circles) or probable members (triangles) of NGC 5662.

The individual reddening estimates are given in Table 3. The measured full width of the observed C-C diagram for stars with $(B-V)\leqslant 0.30$ is $\Delta E(B-V)=E(B-V)_{max}-E(B-V)_{min}=0.14$ mag, i.e. larger than the lower limit of 0.11 mag estimated by Burki (1975) for clusters with differential reddening. The mean colour excesses and standard deviations from 41 stars of Table 3 are:

$\langle E(B-V)_{UBV}\rangle=0.33\pm0.04$ (sd);

$\langle E(U-B)_{UBV}\rangle=0.24\pm0.03$ (sd).

The resulting total visual absorption A_v in front of the cluster is then 0.99 mag, assuming a value of 3.0 for the ratio $A_v/E(B-V)$.

The foreground reddening of NGC 5662 was also calculated from the available MK spectral types, using the relation between intrinsic colour and spectral type given by Schmidt-Kaler (1982). We thus find from 19 early-type members $\langle E(B-V)\,\mathrm{MK}\rangle=0.28\pm0.05$ (sd). We will adopt for NGC 5662 the average of the two reddening estimates, i.e. $E(B-V)=0.31\pm0.04$.

A relatively clear spatial correlation of reddening with position for individual blue members is observed in Fig. 7, in which all members with $(B-V)\leqslant 0.30$ have been plotted. It appears that stars with larger reddening tend to lie towards the southern part of the cluster. This result seems to be consistent with an apparent decrease in the field star density across the cluster from north to south-east (see Fig. 1).

The intrinsic $V_0[=V-3E(B-V)]$, $(B-V)_0$ and $(U-B)_0$ values for blue members, i.e. stars with $(B-V)\leqslant 0.30$, were computed from the individual $E(B-V)_{UBV}$ and $E(U-B)_{UBV}$ determinations. The intrinsic parameters for the remaining member stars were determined adopting the above mean values for the cluster. All these quantities are given in columns (2)–(4) of Table 4.

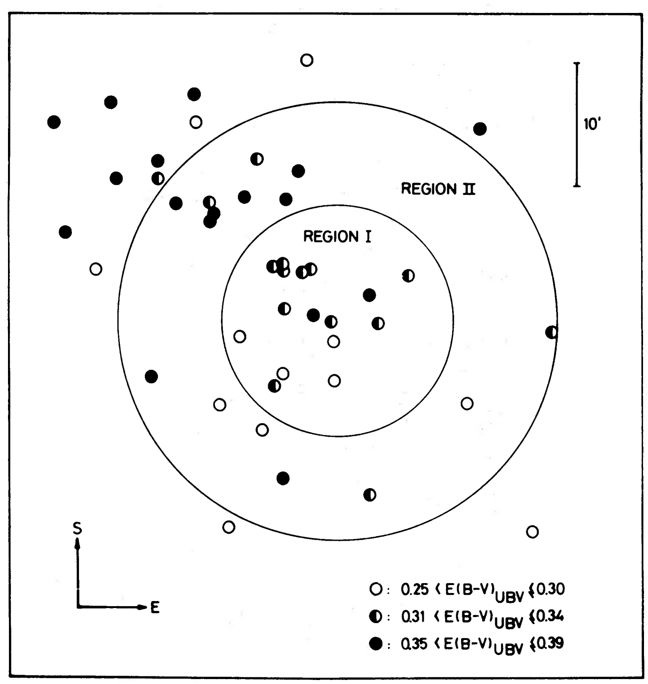

Figure 7. $E(B-V)_{UBV}$ colour excesses of blue cluster members with $(B-V)\leqslant 0.30$ plotted spatially. Regions I and II of Fig. 1 are identified.

Table 3. Individual colour excesses of cluster members derived from photometric and spectroscopic data.

Star No.	MK	Source	$E(B-V)_{UBV}$	$E(B-V)_{UBV}$	$E(B-V)_{MK}$	$V_0-M_V(MK)$
I-5	B7III	(1)	0.34	0.24		
I-14	A1V	(1)	0.31	0.22	0.29	8.95
I-15			0.33	0.24	0.22	9.04
I-17	B7IV	(1)	0.36	0.26		
I-18	B7IV	(1)	0.33	0.24	0.31	10.07
I-21	B8V	(1)	0.33	0.24	0.31	9.37
I-26	B9V	(1)	0.34	0.24	0.33	9.19
I-29	A1V	(1)	0.28	0.20	0.25	9.81
I-32	B9V	(1)	0.38	0.27	0.28	9.02
I-36	B8IV	(1)	0.31	0.22	0.30	10.07
I-39	B9V	(1)	0.29	0.20	0.24	8.83
I-42	A0V	(1)	0.39	0.28	0.37	9.80
I-43	B7V	(1)	0.34	0.24	0.26	9.63
I-46		(1)	0.27	0.20	0.25	9.25
I-47			0.31	0.22		
I-50	B8IV	(1)	0.27	0.19	0.22	9.27
II-1			0.34	0.24		
II-27			0.38	0.27		
II-29	B8V	(1)	0.38	0.23	0.35	9.04
II-31	B8V	(1)	0.34	0.24	0.29	8.75
II-37	B8V	(2)	0.36	0.26	0.32	8.88
II-38			0.33	0.23		
II-39			0.38	0.27		
II-41			0.36	0.26		
II-55			0.36	0.26		
II-56	B8V	(2)	0.25	0.18	0.22	9.88
II-62			0.30	0.21		
III-11			0.39	0.28		
III-32			0.30	0.22		
III-37			0.35	0.25		
III-39			0.30	0.22		
III-41			0.35	0.25		
III-42	B7/8Vn(e)	(2)	0.38	0.27	0.34	9.27
III-43			0.36	0.26		
III-45			0.34	0.24		
III-48[a]			0.37	0.27		
III-50[a]	A2/4V	(2)	0.30	0.22	0.12	8.69
III-62	B8V	(2)	0.27	0.19	0.24	9.54
III-77			0.28	0.20		
IV-8			0.38	0.28		
IV-12			0.32	0.23		

[a]Omitted for reddening and distance determination. Source: (1) Fitzgerald *et al.* (1979); (2) Houk & Cowley (1975).

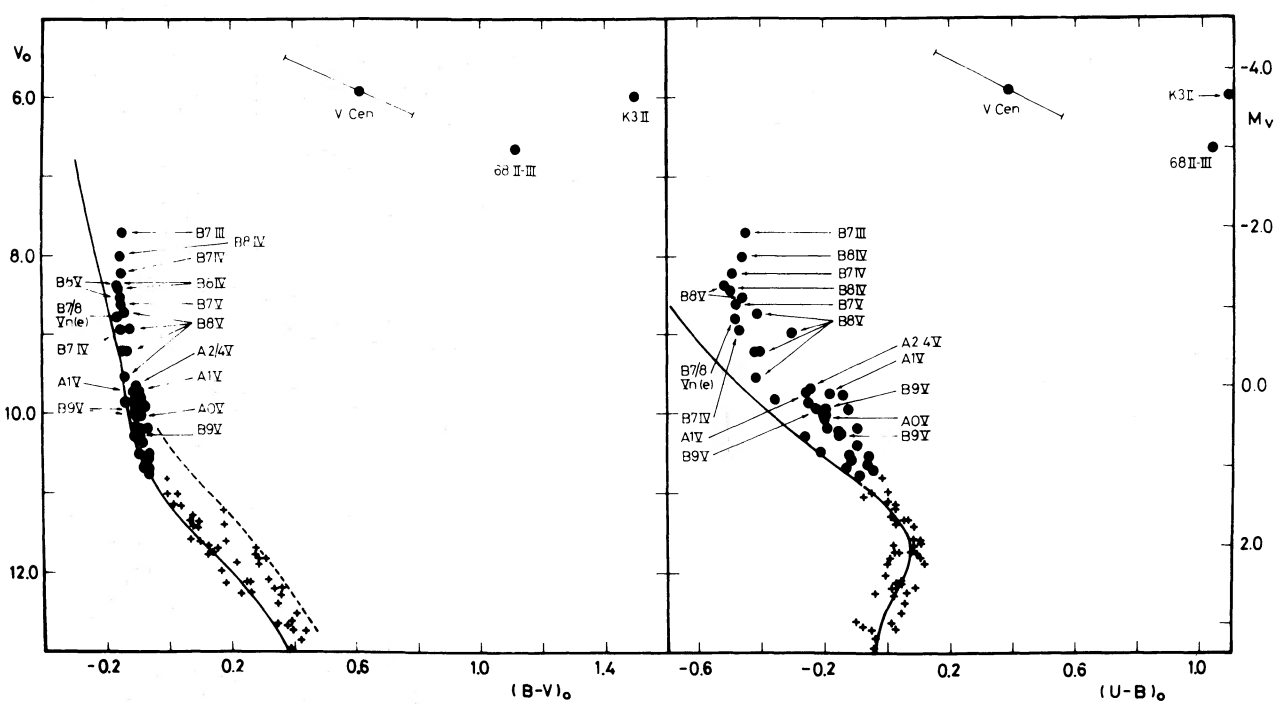

Figure 8. The unreddened colour–magnitude diagrams constructed with all the stars believed to be members of NGC 5662. The full curve in both diagrams is the ZAMS of Schmidt-Kaler (1982), whereas the dashed curve is the 0.75 brightened ZAMS. Stars individually corrected for differential reddening are represented by circles, whereas crosses indicate stars corrected by reddening using the mean value $E(B-V)=0.31$. The extremes of variability for V Cen are indicated.

Table 4. Unreddened magnitudes and colours of stars considered to be cluster members.

Star No.	V_o	$(B-V)_o$	$(U-B)_o$
I-5	10.28	-0.09	-0.15
I-6	11.72	0.14	0.10
I-10	11.32	0.10	0.06
I-11	12.71	0.40	-0.05
I-14	7.69	-0.15	-0.45
I-15	9.71	-0.11	-0.26
I-16	10.81	0.00	-0.01
I-17	10.50	-0.06	-0.05
I-18	8.91	-0.15	-0.47
I-19	12.47	0.41	0.05
I-21	8.21	-0.15	-0.49
I-25	12.35	0.35	0.06
I-26	8.91	-0.12	-0.30
I-27	5.96	1.50	1.75
I-29	9.92	-0.10	-0.22
I-32	9.72	-0.09	-0.18
I-33	12.62	0.35	0.02
I-34	11.55	0.18	0.11
I-36	10.24	-0.09	-0.14
I-37	11.97	0.17	0.00
I-38	12.24	0.36	-0.04
I-39	7.98	-0.16	-0.46
I-42	9.94	-0.10	-0.19
I-43	10.04	-0.10	-0.19
I-46	8.59	-0.15	-0.48
I-47	10.66	-0.08	-0.13
I-50	8.42	-0.16	-0.50
I-51	12.09	0.25	0.05
I-54	11.78	0.29	0.11
II-1	10.63	-0.07	-0.06
II-7	12.15	0.36	0.10
II-19	12.99	0.39	-0.04
II-20	12.73	0.44	0.03
II-27	9.85	-0.14	-0.36
II-29	8.70	-0.14	-0.41
II-31	8.35	-0.17	-0.52
II-33	12.18	0.34	0.02
II-34	11.40	0.08	0.09
II-35	11.18	0.18	0.03
II-36	10.98	0.03	0.01
II-37	8.51	-0.15	-0.46
II-38	10.20	-0.09	-0.15
II-39	9.85	-0.11	-0.25
II-41	10.55	-0.07	-0.11
II-44	12.10	0.26	0.05
II-45	11.12	0.04	0.03
II-51	11.71	0.13	0.08
II-55	10.70	-0.06	-0.04
II-56	9.54	-0.14	-0.42
II-59	11.10	0.02	0.01
II-60	11.31	0.07	0.03
II-61	11.78	0.31	0.01
II-62	10.76	-0.07	-0.08
II-68	12.05	0.32	-0.07
II-71	11.73	0.28	0.04
III-5	11.55	0.07	0.09
III-9	12.83	0.42	-0.04
III-11	10.18	-0.10	-0.19
III-13	11.86	0.29	0.00
III-17	11.86	0.22	0.13
III-25	11.63	0.28	0.02
III-29	12.25	0.26	0.07
III-31	10.98	0.00	-0.05
III-32	9.99	-0.09	-0.20
III-33	12.69	0.38	-0.08
III-36	11.35	0.18	0.03
III-37	9.21	-0.15	-0.42
III-39	9.74	-0.08	-0.13
III-40	12.12	0.18	0.03
III-41	10.29	-0.11	-0.26
III-42	8.75	-0.16	-0.48
III-43	10.52	-0.07	-0.11
III-45	10.35	-0.08	-0.09
III-48	10.49	-0.10	-0.21
III-49	11.68	0.16	0.02
III-50	9.65	-0.10	-0.24
III-51	11.34	0.09	0.07
III-60	11.27	0.07	0.01
III-62	9.20	-0.14	-0.40
III-64	12.26	0.23	0.02
III-72	11.66	0.13	0.09
III-77	10.15	-0.07	-0.09
III-82	12.59	0.39	-0.10
IV-8	9.98	-0.09	-0.19
IV-9	11.59	0.10	0.11
IV-10	6.65	1.11	1.03
IV-12	9.92	-0.07	-0.12

Fig. 8 shows the reddening-free C–M diagrams for stars considered to be members of NGC 5662. It can be noted that the scatter in these diagrams clearly decreases for the stars with individually determined reddening values. A fit of the cluster sequence to the zero-age main sequence (ZAMS) of Schmidt-Kaler (1982) in these two diagrams leads to a true distance modulus $V_0 - M_v = 9.64$ mag, the maximum error estimated by this procedure being about 0.15 mag. The absolute magnitude scale in Fig. 8 as well as the ZAMS (full line) have been adjusted to this value.

The distance to NGC 5662 was also calculated from the available MK spectral types. Individual absolute magnitudes M_v(MK) were derived from the calibration of Schmidt-Kaler (1982) The mean distance modulus of the 19 members with available MK spectral types turned out to be $\langle V_0 - M_v \rangle = 9.35 \pm 0.42$ (sd). Averaging the two distance estimates we obtain

$$\langle V_0 - M_v \rangle = 9.50 \pm 0.15, \tag{1}$$

equivalent to 790 ± 55 pc, which has been adopted. This value appears to be fairly larger than those previously found by other authors (see Table 5). We note, however, that the comparatively small distance modulus obtained by Moffat & Vogt (1973) comes from a ZAMS fitting to a cluster sequence extending scarcely to about $V \simeq 11.8$. Precisely, at about $V = 12.0$ the ZAMS changes its slope in the $V/(B-V)$ diagram so that the lack of observed stars with $V > 12.0$ may lead to underestimate the distance modulus. Furthermore, the cluster sequence observed by Moffat & Vogt has not been corrected for differential reddening effects, which introduces an additional source of uncertainty in the distance derived through the fitting procedure. We also note that the distances obtained by Haug (1978) and Turner (1982), although nearly coincident, should both be treated with caution since they have been derived from mainly photographic *UBV* data, in the first case, or from photoelectric data of only six stars in the second. Finally, a re-analysis of the existing *UBV* data led Mermilliod (1981a) to a true distance modulus of 9.23, in close agreement with the value we obtained from the available MK types. Therefore, we do not

Table 5. Reddening and distance determinations of NGC 5662.

E(B-V)	$V_o - M_V$	d(pc)	Reference
0.31 ±0.06	8.82	580	Moffat and Vogt (1973)
0.32	8.98	625	Haug (1978)
0.32	9.23	700	Mermilliod (1981a)
0.31 ±0.01	9.10	661	Turner (1982)
0.32	-	-	Schneider (1987)
0.31 ±0.04	9.50	790	This study

have any reason to suspect that our distance has been overestimated.

As it is well known, duplicity is probably the main cause of scatter in the *UBV* diagrams. Another source of dispersion comes from stellar rotations of individual cluster members. Theory suggests (Hardorp & Strittmatter 1968; Maeder & Peytremann 1970) and observations of Praesepe (Dickens, Kraft & Krzeminski 1968) and other clusters indicate that the spread of the main sequence by stellar rotation is at most 0.2 mag, for a fixed $(B-V)$ value. Looking in particular at Fig. 8, one then might suspect that a sequence of binaries does exist in NGC 5662. If we call binaries those stars falling between 0.50 and 0.75 mag above the cluster main sequence, then a lower limit to the binary frequency of about 25 per cent is found.

7 CLUSTER DIAMETER

In order to estimate the extent and stellar density of NGC 5662, star counts in concentric circles around the adopted cluster centre have been made. Numbers of stars per square arcmin as a function of the distance from the cluster centre were counted to limiting magnitudes of $V=10$, 12, 14 and ~ 17 (plate limit). The results for the counts down to $V=12$ and $V=17$ are shown in Fig. 9. The concentration of stars within a radius of approximately 15 arcmin seems to be important only for the bright stars, but not for the fainter ones because the maximum star density in the latter case is hardly 30 per cent larger than the background star density. It must be noted, however, that some of the results obtained from the star counts are difficult to interpret due to the effects of the variable absorption across the cluster.

Anyway, the following conclusions may be drawn from the starcounts: (1) the brighter stars ($V<12$) are clearly concentrated in the central region within a radius of approximately 15 arcmin, which will be adopted for NGC 5662. (2) The star distribution down to $V=14$ and to $V=17$ seems to be much more uniform with a slight central concentration. (3) The adopted angular radius leads to a linear diameter of 6.9 pc, so that the minimum stellar density amounts to 0.50 stars pc^{-3}.

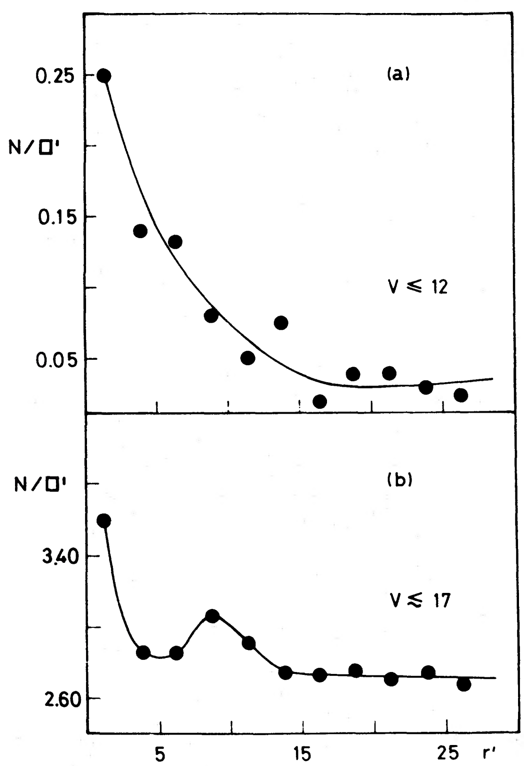

Figure 9. Star number density as a function of distance from the centre of NGC 5662: (a) $V<12.00$; (b) $V<17$.

8 RED STARS IN THE CLUSTER REGION

8.1 DDO and Washington photometry: cluster membership

The C–M diagrams of NGC 5662 stars show that three bright stars (Nos I-27, II-32 and IV-10) could be red giant members. Their positions in the C–C diagram are also consistent with those of reddened giants. The *UBV* criteria, however, do not by themselves allow one to fully decide the question of their membership. For this reason, we observed these three stars in the DDO and Washington photometric systems. The photometry reported here was obtained at CTIO by using the 91-cm telescope in 1985 April. A single-channel photometer was used in conjunction with dry-ice cooled S20 and RCA 31034 Ga-As photomultipliers, respectively. Only the four primary filters of the DDO system were used since these provide adequate information for the present purposes. Pulse-counting electronics was utilized for all measurements. Transformation to the DDO and Washington standard systems was done by nightly observing about 13 equatorial standards from the lists of McClure (1976) and Canterna (1976), respectively.

The results of the DDO and Washington photometry are listed in Table 6, where n_1 and n_2 indicate the number of nights on which each star was observed in the DDO and Washington systems, respectively. The standard deviations of the mean indices and T_1 magnitudes are given in units of 0.001 mag. The external mean errors of both photometries are smaller than 0.01 mag in all the measured indices.

To separate red field stars from red cluster giants we applied two photometric criteria – denoted A and B – based on our combined *UBV* and DDO data (Clariá & Lapasset 1983; Clariá 1985). We note, however, that the results obtained from criterion A should be taken with caution because of the presence of differential reddening across the cluster.

The results from applying criteria A and B are shown in columns (6) and (7) of Table 7. Columns (2)–(5) of this table give in succession the $E(B-V)_{GK}$ estimated from Janes' (1977) method, the standard deviation of $E(B-V)_{GK}$ computed from Clariá's (1985) equation (4), the luminosity class that the star would have in order to be a cluster member, and the MK spectral types taken from Fitzgerald *et al.* (1979) or Houk & Cowley (1975). Columns (8) and (9) list King's (1980) membership probability and the adopted membership status. As shown in Table 7, only two stars (I-27 and IV-10) are very likely red cluster members both from the photometric and kinematic data.

8.2 Metal abundance

Both the DDO and Washington systems have proved to be very useful to determine metal abundance of G and K giants.

Table 6. DDO and Washington photometry of probable red giants.

Star No.	C(41–42)	C(42–45)	C(45–48)	n_1	C–M	M–T_1	T_1–T_2	T_1	n_2
I-27	0.254 ± 5	1.334 ± 1	1.571 ± 2	2	2.330 ± 5	1.471 ± 4	1.039 ± 2	6.087 ± 6	4
II-32	0.350 ±11	1.198 ± 1	1.460 ± 3	2	2.088 ±11	1.316 ± 4	0.874 ± 7	7.747 ±15	3
IV-10	0.298 ± 4	0.999 ± 6	1.380 ± 2	2	1.734 ± 7	1.149 ± 4	0.762 ± 8	6.988 ± 4	2

Table 7. Results from applying photometric and kinematic membership criteria.

Star No.	$E(B-V)_{GK}$	σ_E	LC (predicted)	MK	Photometric membership (A)	(B)	Prop. motion Probability %	Adopted Membership
I-27	0.37	0.03	II	K3II	pm	m	83	member
II-32	0.40	0.03	II	K2III	nm	pm	0	non member
IV-10	0.37	0.03	II	G8II-III	pm	m	70	member

Table 8. Abundance parameters of NGC 5662 red giants.

Star No.	δCN	Δ(C–M)	Δ(M–T_1)	Membership	T_{eff} (K)	log g (cgs)	$M/M_{\odot}$
I-27	−0.12	−0.126	0.032	m	4000	1.0	6.9
II-32	−0.01	−0.160	0.019	nm	4150	1.7	?
IV-10	−0.01	−0.125	0.000	m	4680	1.8	8.4

The DDO metallicity index δCN and the Washington line-blanketing indices $\Delta(M-T_1)$ and $\Delta(C-M)$ have been found to correlate reasonably well with the spectroscopic metal abundance determinations for Population I giants (Janes 1975; Harris & Canterna 1979; Canterna *et al.* 1986). To determine these three abundance parameters, the observed DDO and Washington colours were first dereddened by using the $E(B-V)_{GK}$ values of Table 7 and the reddening ratios given by McClure (1973) and Harris & Canterna (1979). Table 8 shows the resulting abundance parameters.

The Washington abundance parameters of the two red cluster giants average to $\langle\Delta(M-T_1)\rangle = 0.016 \pm 0.023$ and $\langle\Delta(C-M)\rangle = -0.126 \pm 0.001$, implying $[Fe/H]_{MT} = -0.05 \pm 0.15$ and $[Fe/H]_{CM} = 0.10 \pm 0.01$, if the empirical calibration of Canterna *et al.* (1986) is used. On the other hand, the DDO metallicity cannot be accurately determined due to the very discrepant δCN values of the two red giants. Star I-27 exhibits an anomalously small δCN index and we have no explanation for it, whereas star IV-10, with $\delta CN = -0.01$, implies $[Fe/H]_{DDO} = -0.15$, if equation (4) of Clariá & Lapasset (1983) is used. The difference between the three [Fe/H] estimates is not significant considering the photometric and calibration errors so that we will adopt for NGC 5662 the average of them, i.e. $[Fe/H] = -0.03 \pm 0.13$.

9 AGE OF THE CLUSTER

The age of NGC 5662 may be estimated from both the bluest $(U-B)_0$ colour index and the earliest MK spectral type on the main sequence. The former is clearly a better age discriminator than the bluest $(B-V)_0$ colour because of its wider range of variation for a given age interval. Mermilliod (1981b) has calibrated the $(U-B)_0$ parameter versus age by using a grid of evolutionary models by Maeder & Mermilliod (1981) with overshooting in the core. The bluest $(U-B)_0$ colour and earliest MK spectral type in NGC 5662 are -0.52 and B7V, which imply ages of about 7.1×10^7 yr and 8.7×10^7 yr, respectively (Mermilliod 1981b). The resulting mean age for NGC 5662 is then 7.9×10^7 yr, i.e. identical to that of the Pleiades age group. This result is consistent with the fact that both the main-sequence shape and the location of the two red giants for NGC 5662 (Fig. 8) are nearly similar to those for a cluster belonging to the Pleiades age group. We note that using the adopted cluster distance, we derive an average absolute magnitude $\langle M_v \rangle = -3.20$ for the two red giants, which implies an age of 5.2×10^7 yr, if the relationship between age and red giant clump absolute magnitude of Mermilliod (1981b) is used.

10 TOTAL MASS AND STABILITY OF THE CLUSTER

Rough estimates of the masses of the two red giants were made following the procedure described by Clariá & Lapasset (1983). The resulting effective temperatures, surface gravities, and masses for these two red giants are shown in Table 8. On the other hand, the masses of the remaining stars considered to be cluster members were estimated from the mass–luminosity relations given by Schmidt-Kaler (1982), using $V_0 - M_v = 9.50$. The resulting total mass for NGC 5662 is $\sim 256\ M_{\odot}$, which implies a lower limit of the space density of $\sim 1.5\ M_{\odot}\ pc^{-3}$. This value greatly exceeds the limit of $\sim 0.1\ M_{\odot}\ pc^{-3}$ (Mineur 1939) beyond which a cluster is generally considered to be stable. We conclude that NGC 5662 is a dynamically stable open cluster.

11 LUMINOSITY FUNCTION OF THE BRIGHT MEMBERS

The luminosity function of NGC 5662 was determined by counting the total numbers of cluster members in intervals of

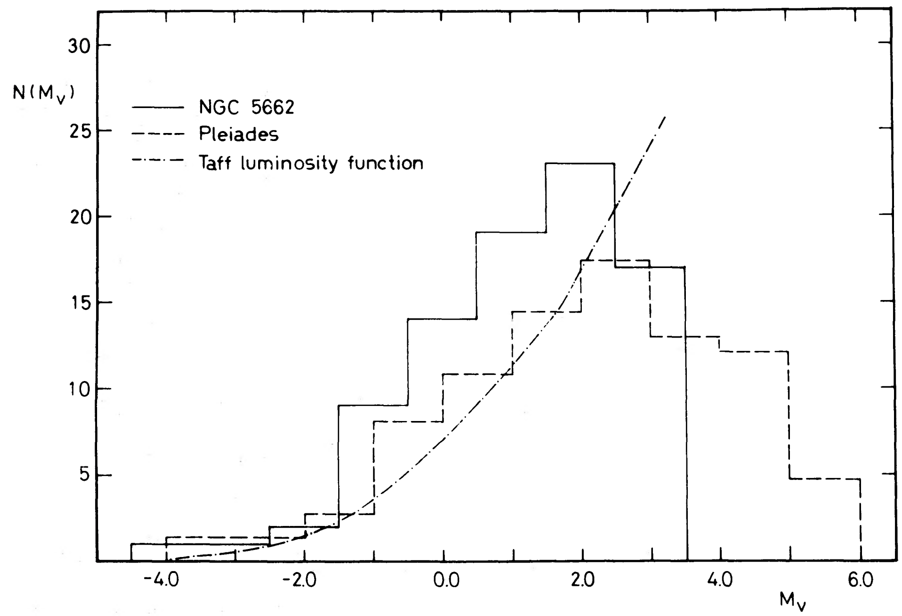

Figure 10. Luminosity function of NGC 5662 (full histogram) compared to the normalized luminosity function of the Pleiades cluster and that averaged over 62 open clusters given by Taff (1974).

1.0 mag in absolute magnitudes M_v. In order to obtain M_v, the mean distance modulus of the cluster (equation 1) was used. The faintest stars considered have $M_v \sim +3.4$, corresponding to a mean visual magnitude of $V \sim 13.8$. The resulting luminosity function is plotted as a full histogram in Fig. 10. Probable members have not been included. For comparison, the normalized luminosity functions of the Pleiades cluster, as taken from Johnson & Morgan (1953), and that obtained by Taff (1974) averaged over 62 open clusters, are also shown in Fig. 10. Two main features should be noticed: (i) the number of stars per unit magnitude interval in NGC 5662 reaches its maximum and begins to decrease near $M_v = 2.0$. This apparent turnover in the distribution for $M_v > 2.0$ probably results from observational selection effects; (ii) the slope of the luminosity function in NGC 5662 appears to be steeper than in the other two functions. This is, perhaps, not what would be expected since NGC 5662 and the Pleiades cluster belong to the same age group.

12 THE CEPHEID V CENTAURI

The probable association of the bright $5^{\mathrm{d}}.5$ Cepheid V Cen with NGC 5662 has been previously noted by Tsarevsky, Ureche & Efremov (1966) and discussed by Turner (1982), who obtained *UBV* photometry of only 10 stars lying within 5 arcmin of the Cepheid. Based essentially on the agreement in interstellar reddening and age for some of these objects with the reddening and age of V Cen, Turner concluded that this Cepheid is an excellent candidate for possible membership in the cluster corona.

V Cen lies at a distance slightly larger than two cluster radii from the centre of NGC 5662. Its $E(B-V)$ colour excess has been determined by different methods yielding values between 0.26 and 0.36 (Dean, Warren & Cousins 1978). Since the absorption across the cluster is not uniform, any $E(B-V)$ value for V Cen within the above interval should be considered consistent with cluster reddening. We have adopted $\langle V \rangle = 6.82$ (Shaltenbrand & Tammann 1971) and $E(B-V)_{\mathrm{V\,Cen}} = 0.30$. The latter value was derived by Pel (1978) from Walraven photometry and transformed to the *UBV* system using the relations of Dean *et al.* (1978). V Cen has been included as a possible cluster member in the unreddened C–M diagram of Fig. 8. The resulting luminosity from this figure, i.e. $M_v = -3.72$, appears to be somewhat high if compared with that of -3.3 predicted by van den Bergh (1977) for Cepheids of this period. However, if we use the mean distance modulus (equation 1), the derived luminosity for V Cen is $M_v = -3.58$, in closer agreement with the expected value.

The age of V Cen, according to the results of Kipenhahn & Smith (1969) and Meyer-Hofmeister (1972), is about 6×10^7 yr (Turner 1982). The good agreement with the cluster age, however, is taken as an argument of lower weight due to the well-known discrepancy between 'evolution' and 'pulsation' ages in cluster Cepheids (Cox 1980; Romeo *et al.* 1989). We conclude that, although situated nearly two radii far from the cluster centre, V Cen is very likely a cluster member. It would be interesting to confirm this result from radial velocity data.

13 CONCLUSIONS

Photoelectric *UBV* photometry performed for a total of 237 stars in the vicinity of NGC 5662, together with existing proper motions, allowed us to identify 86 cluster members, mostly main-sequence B- and A-type stars, and 19 probable members. In general, the kinematic and photometric membership criteria yield results in good agreement. The cluster contains two red giants and two photometric variable stars. Among the cluster non-members, three stars are found to be suspected variables. The mean cluster distance here derived is (790 ± 55) pc, a value somewhat larger than those previously found by other authors from the observation of smaller samples of stars. The interstellar reddening is found to

Table 9. Summary of results obtained for NGC 5662.

Distance	V-Mv	apparent distance modulus	= 10.49
	E(B-V)	selective absorption	= 0.31 ± 0.04 (s.d.)
	Av	visual absorption (variable)	= 0.93
	V_o-Mv	true distance modulus	= 9.50 ± 0.15
	d	distance from the sun	= (790 ± 55)pc
	z	distance below the galactic plane	= 48 pc
Dimensions	D	angular diameter	= 30′
	δ	linear diameter	= 6.9 pc
Membership	N(m)	number of members	> 87
	N(pm)	number of probable members[a]	= 20
	N(RG)	number of red giants[a]	= 2
	N(v)	number of variables[a]	= 3
Chemical composition	[Fe/H]	metallicity	= -0.03 ± 0.13
Structure of main sequence	$(B-V)_o$	bluest $(B-V)_o$ colour index	= -0.17
	$(U-B)_o$	bluest $(U-B)_o$ colour index	= -0.52
	MK	earliest spectral type	= B7V
	τ	age	= 7.9×10^7 yr
Luminosity function		slope somewhat steeper than that of the Pleiades cluster	
Integrated parameters	Mv	integrated visual absolute magnitude	= -5.03
	$(B-V)_o$	integrated intrinsic (B-V) colour	= 0.294
	$(U-B)_o$	integrated intrinsic (U-B) colour	= -0.206
	V_o	integrated visual magnitude	= 4.552
	$M/M_\odot$	total mass	> 256 $M_\odot$
	$\bar{n}$	stellar density (stars/pc³)	= 0.50
	ρ	mean space density ($M_\odot$/pc³)	= 1.5

a: the Cepheid V Cen has been included

increase across the cluster field from north to south, the mean value being $\langle E(B-V)\rangle = 0.31 \pm 0.04$. The linear diameter of NGC 5662 obtained from star counts is about 6.9 pc, so that the stellar density is 0.50 stars pc^{-3}. NGC 5662 appears to be dynamically stable since the computed total mass ($>256\ M_\odot$) implies a lower limit of the space density of 1.5 $M_\odot$ pc^{-3} and this value greatly exceeds the limit beyond which a cluster is generally considered to be stable. An age of 7.9×10^7 yr has been derived, which places NGC 5662 within the Pleiades age group (Mermilliod 1981a). From DDO and Washington photometry of the two red giants, the cluster metal content turned out to be nearly solar. The slope of the luminosity function appears to be steeper than both the Pleiades cluster luminosity function and that obtained by Taff (1974) averaged over 62 open clusters. On the basis of the improved cluster parameters here derived, the possible membership of the $5^d\!.5$ Cepheid V Cen is re-examined. It is concluded that, although lying about two radii from the (poorly determined) cluster centre, V Cen is a likely member of NGC 5662. Table 9 summarizes the results obtained in the present study.

A more extensive photometric study of NGC 5662 would evidently be of interest for a better understanding of its nature. In particular, *UBV* photometry of additional main-sequence stars and a better definition of the lower main sequence is needed. Radial velocity data of some cluster members as well as for V Cen would also be very useful to confirm their membership status as well as to provide information about the kinematic properties. Finally, an independent measure of the cluster metal content would be valuable to confirm or improve the present preliminary result.

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