

UBV PHOTOMETRY OF M67 MEMBERS

W.L. Sanders¹

Department of Astronomy
New Mexico State University

Received 1988 October 11

RESUMEN

Se presenta fotometría *UBV* de la muestra más amplia de miembros de M67.

ABSTRACT

Complete *UBV* photometry of the most complete membership of M67 is offered.

Key words: CLUSTERS-OPEN – PHOTOMETRY

I. INTRODUCTION

With a new extensive cluster membership (649 probable members, Sanders 1977), photometry for nearly all members were undertaken to improve the color-magnitude (C-M) diagram for M67. As one of the oldest and richest galactic clusters known, good C-M data are essential to the determination of age and, potentially, disk metal abundance history. Age is, of course, critically important to the study of cluster evolution and internal dynamics. The old M67 cluster may also serve as a possible continuity link to the youngest globular clusters when modeling global galactic evolution.

Publication of these data has been delayed while awaiting more modern stellar evolutionary isochrones. It was thought that the more recent isochrones might lead to an improved age estimate, but uncertainties in reddening, distance, abundance, and imperfections in the isochrones themselves leads to severe ambiguities. In this author's opinion, it does not seem possible at this time to confidently choose a unique isochrone for the M67 C-M diagram, although others have done so. These data are offered to others that they may proceed.

II. PHOTOMETRY

UBV magnitudes for those new, mostly faint members were observed at the KPNO 50-inch telescope during the years 1980-82. An S20 extended red cathode and standard KPNO *UBV* filter sets were used throughout. Thirty-four Landolt standards were used each night and mean errors were the usual, i.e., ranging approximately 0.015 – 0.025 in *V*, 0.010 – 0.020 in *B–V*, and 0.020–0.030 in *U–B* for all nights. The standards ran-

ged *V* = 8.1 to 14.2, *B–V* = 0.0 to 1.9, *U–B* = –0.1 to 2.1. The reduction procedure was multivariate least squares for all significant terms. That photometry, combined with existing photometry, is presented in Table 1. The table lists data for all stars with a membership probability greater than 50% and is mostly self-explanatory. The column headed "S" indicates photometry either taken from or combined (weighted) with other sources. The sources and their arbitrarily assigned weights are as follows: JS = Johnson and Sandage 1955 (wt = 1); M = Murray, Corben, and Allchorn 1965; Murray and Clements 1968 (wt = 0 where photographically measured); ES = Eggen and Sandage 1964 (wt = 1); R = Racine 1971 (wt = 0 photographic and wt = 0 when combined with Sanders 1977). The observations reported here are all given wt = 1. Variability was not noted at this level, but neither was it seriously searched for.

TABLE 1
PHOTOMETRY OF M67

Star	<i>V</i>	<i>B–V</i>	<i>U–B</i>	Wt	Ra (1950)	Dec	s
8	14.87	0.71	0.16	4	44 40.6	11 24 24	
15	13.15	0.61	0.11	3	44 37.9	11 31 32	
44	14.97	0.76	0.34	3	44 42.4	12 00 37	
51	14.52	0.83	0.52	2	44 24.4	12 05 45	
60	15.66	0.64	0.00	3	44 24.3	12 16 29	
61	14.85	0.64	0.03	2	44 40.0	12 18 42	
63	15.82	0.78	0.36	3	44 22.7	12 19 30	
80	12.75	0.53	0.01	3	44 32.7	12 40 36	
103	15.69	0.67	0.06	3	44 49.8	11 32 33	
110	14.75	0.72	0.22	2	45 09.6	11 37 48	
135	13.78	0.60	0.01	2	45 03.4	11 57 26	
144	14.17	0.88	0.45	2	44 47.9	12 01 01	
145	12.90	0.44	–0.01	2	44 53.7	12 01 30	
151	14.79	0.82	0.42	2	45 03.5	12 05 07	
157	13.72	0.59	0.07	2	44 55.0	12 15 37	
215	14.38	0.66	0.02	2	45 18.6	11 37 51	
218	13.27	0.73	0.35	2	45 10.2	11 38 31	
225	14.43	0.49	–0.01	2	45 30.5	11 43 29	
243	15.50	0.89	0.46	3	45 33.9	11 56 49	
251	12.57	0.67	0.15	2	45 09.8	12 02 45	

1. Visiting Astronomer, Kitt Peak National Observatory, operated by the Association of Universities for Research in Astronomy, Inc., under contract with the National Science Foundation.

TABLE 1 (CONTINUED)

Star	<i>V</i>	<i>B-V</i>	<i>U-B</i>	Wt	Ra	(1950)	Dec	s
252	14.39	0.63	0.16	2	45	28.7	12 04 00	
255	14.80	0.64	0.19	2	45	11.2	12 06 11	
272	14.82	0.99	0.77	4	45	09.1	12 18 30	
277	12.28	0.52	0.07	4	45	15.0	12 21 03	
281	13.26	0.65	0.12	5	45	26.3	12 25 40	
299	16.27	0.70	0.14	2	45	13.4	12 37 55	
341	13.20	0.59	0.07	2	45	53.5	11 45 26	
363	13.53	0.53	0.06	2	45	38.5	11 45 53	
362	15.82	0.98	0.98	2	45	40.3	11 57 16	
364	9.93	1.30	1.48	4	45	50.8	11 58 18	
368	12.72	0.57	0.08	2	45	36.9	11 59 53	
395	13.36	0.57	0.07	2	45	41.5	12 15 34	
395	14.46	0.70	0.13	2	45	46.2	12 18 48	
434	12.54	0.63	0.16	5	46	05.9	11 36 27	
445	12.74	0.56	0.08	2	45	54.7	11 42 26	
465	14.19	0.60	0.07	4	46	03.2	11 50 12	
469	14.56	0.62	0.25	1	46	03.7	11 55 28	
471	13.58	0.60	0.12	2	46	15.7	11 57 42	
473	14.22	0.64	0.10	2	45	54.9	11 58 55	
485	13.59	0.57	0.06	2	46	14.1	12 05 58	
488	8.87	1.54	1.96	5	46	06.1	12 08 11	
489	12.88	0.53	0.07	3	46	10.1	12 10 34	
494	9.97	1.09	0.95	2	46	12.1	12 12 08	
499	13.51	0.55	0.09	4	45	53.8	12 13 33	
505	13.99	0.61	0.14	1	46	03.6	12 16 39	
513	15.46	0.63	0.19	1	46	10.1	12 24 16	
520	14.17	0.63	0.06	1	46	04.9	12 31 17	
530	14.21	0.95	0.75	1	46	08.4	12 37 14	
587	13.74	0.59	0.07	1	46	27.9	11 51 09	
591	12.67	0.70	0.27	1	46	36.1	11 53 41	
595	13.79	0.57	0.08	2	46	23.2	11 54 47	
597	13.45	0.56	0.07	2	46	36.6	11 56 38	
598	12.63	0.60	0.13	2	46	28.5	11 56 45	
602	12.95	0.55	0.06	1	46	22.4	11 58 57	
603	14.05	0.61	0.11	2	46	34.6	11 59 00	
606	12.77	0.95	0.69	1	46	30.1	12 00 06	
610	12.89	0.54	0.08	2	46	27.9	12 03 15	
611	15.38	0.83	0.58	3	46	30.4	12 03 26	
615	12.82	0.55	0.03	1	46	34.8	12 04 35	
616	14.64	0.84	0.43	2	46	28.9	12 04 51	
618	13.05	0.60	0.07	1	46	30.6	12 05 43	
621	14.44	0.65	0.10	2	46	27.3	12 05 50	
622	14.48	0.66	0.13	2	46	15.5	12 07 10	
625	14.65	0.83	0.44	2	46	16.7	12 08 45	
626	15.30	0.84	0.37	2	46	17.7	12 09 22	
627	15.20	0.66	0.07	2	46	31.7	12 10 21	
628	14.43	0.77	0.38	2	46	30.8	12 10 51	
630	14.17	0.63	0.08	2	46	21.8	12 11 37	
640	15.05	0.72	0.38	3	46	16.0	12 15 56	
646	15.38	0.47	-0.02	2	46	32.2	12 19 25	
647	13.84	0.58	0.06	1	46	34.1	12 19 26	
648	13.35	0.57	0.03	1	46	36.3	12 19 58	
650	13.88	0.61	0.06	2	46	16.2	12 21 57	
655	13.65	0.58	0.02	1	46	32.0	12 24 07	
656	13.15	0.57	0.07	1	46	32.1	12 24 33	
657	12.60	0.61	0.11	1	46	23.4	12 24 54	
666	14.19	0.62	0.12	2	46	16.3	12 30 23	
674	12.69	0.54	0.03	1	46	17.0	12 36 44	
676	10.54	1.22	1.30	2	46	14.4	12 37 58	
704	13.54	0.56	0.06	1	47	00.3	11 42 37	
711	13.37	0.58	0.02	1	46	47.2	11 48 10	
721	11.24	1.07	0.97	1	46	43.7	11 51 58	
722	14.02	0.58	0.09	2	46	51.9	11 52 04	
723	13.35	0.58	0.03	1	46	49.8	11 52 26	
724	14.54	0.68	0.18	1	47	00.6	11 52 50	
723	14.11	0.61	0.08	2	46	50.7	11 54 59	
740	13.58	0.47	0.02	0	46	55.4	11 58 49	M
744	14.29	0.62	0.07	1	46	41.3	11 59 45	
746	14.47	0.81	0.17	2	46	47.4	12 00 30	ES
747	14.03	0.70	0.17	2	46	59.9	12 00 38	ES
748	14.63	0.82	0.49	2	46	53.8	12 00 59	
750	13.59	0.67	0.10	1	46	47.5	12 01 24	ES
751	12.69	0.51	-0.01	1	46	41.7	12 01 41	
752	11.33	0.29	0.15	7	46	57.6	12 01 53	
754	14.96	0.76	0.33	1	46	55.7	12 02 17	ES
755	13.90	0.59	0.01	1	46	41.6	12 02 13	
756	12.65	0.63	0.10	1	46	57.3	12 02 38	ES
757	13.46	0.59	0.03	1	46	58.8	12 02 48	ES
758	13.44	0.63	0.06	1	46	53.2	12 03 03	ES
760	13.51	0.58	0.07	1	46	47.1	12 04 24	ES

TABLE 1 (CONTINUED)

Star	<i>V</i>	<i>B-V</i>	<i>U-B</i>	Wt	Ra	(1950)	Dec	s
761	13.52	0.60	0.07	1	46	55.6	12 04 40	ES
763	13.59	0.56	0.05	1	46	41.6	12 04 41	
766	13.79	0.57	0.05	1	46	52.9	12 05 10	ES
769	13.43	0.76	0.09	1	46	49.9	12 05 36	
770	14.64	0.70	0.23	1	46	54.9	12 05 43	
771	13.51	0.61	0.06	1	46	53.0	12 05 48	ES
772	15.24	0.82	0.36	0	46	53.0	12 06 19	M
773	13.32	0.58	0.10	0	46	56.1	12 05 52	M
774	12.93	0.86	0.47	2	46	43.8	12 06 02	
775	12.69	0.62	0.09	1	46	55.5	12 06 25	ES
776	13.79	0.58	0.01	1	46	59.2	12 06 25	ES
777	14.52	0.68	0.15	2	46	41.9	12 06 31	
779	14.63	0.73	0.28	1	46	50.5	12 06 43	
781	12.75	0.75	0.26	2	46	55.0	12 07 01	
784	13.60	0.51	0.04	0	46	48.6	12 07 59	M
785	14.81	0.76	0.20	1	46	51.6	12 08 04	
788	14.11	0.59	0.05	1	46	50.2	12 09 19	
789	14.02	0.63	0.10	1	46	58.3	12 08 37	
792	12.00	0.58	0.10	1	46	49.5	12 09 04	
793	15.03	0.72	0.40	1	46	38.8	12 09 07	
796	13.90	0.53	9.99	0	46	58.8	12 09 17	M
800	14.76	0.80	0.20	2	46	40.0	12 09 57	
801	15.05	0.76	0.30	2	46	59.3	12 10 07	
802	14.75	0.80	0.24	1	46	54.2	12 10 09	
803	13.71	0.55	0.00	0	46	49.8	12 10 42	M
804	15.36	0.79	0.60	3	46	40.0	12 10 52	
805	14.09	0.59	0.01	3	46	43.5	12 11 13	
806	12.79	0.81	0.38	1	46	54.0	12 11 22	ES
807	13.62	0.66	0.09	1	46	40.1	12 11 20	
808	14.09	0.65	0.07	2	46	41.9	12 11 37	
810	14.97	0.81	0.39	1	46	47.5	12 12 13	
814	14.88	0.77	0.29	2	46	54.9	12 13 12	
815	12.77	0.55	0.04	1	46	48.1	12 13 19	
816	13.22	0.58	0.02	1	46	53.0	12 13 27	
820	14.91	0.73	0.29	2	46	50.3	12 13 48	
821	12.65	0.47	-0.12	1	46	45.5	12 13 45	
822	14.58	0.63	0.15	2	46	52.1	12 15 05	
827	13.10	0.59	0.04	1	46	50.8	12 16 06	
829	14.37	0.59	0.12	2	46	52.2	12 16 30	
830	12.75	0.56	0.04	1	46	42.4	12 16 58	
833	13.42	0.57	0.05	1	46	45.4	12 17 14	
837	15.03	0.84	0.34	2	46	41.5	12 17 53	
839	13.41	0.56	0.05	1	46	39.9	12 18 46	
844	13.64	0.54	0.03	1	46	42.4	12 20 29	
846	13.55	0.55	0.07	1	46	58.4	12 21 09	
848	13.96	0.62	0.06	3	46	50.9	12 22 25	
853	13.29	0.59	0.10	1	46	58.0	12 25 14	
856	13.34	0.50	0.02	1	46	49.6	12 26 16	
859	12.67	0.66	0.19	1	46	40.5	12 27 00	
868	13.63	0.54	0.04	1	46	47.7	12 32 21	
871	12.62	0.60	0.12	1	46	51.3	12 36 22	
875	16.02	0.73	-0.12	3	46	49.6	12 41 29	
882	14.71	0.80	-0.07	1	47	14.3	11 22 11	
903	13.16	0.55	0.05	1	47	18.7	11 40 11	
905	13.28	0.55	0.00	1	47	18.3	11 41 43	
911	14.05	0.83	0.39	3	47	02.6	11 43 19	
912	13.25	0.55	0.08	1	47	12.3	11 43 22	
913	13.86	0.56	0.05	1	47	05.4	11 43 27	
914	13.16	0.57	0.08	1	47	09.4	11 43 35	
926	12.71	0.55	0.06	1	47	20.1	11 49 54	
927	13.31	0.54	0.03	1	47	08.2	11 50 23	
928	14.79	0.65	0.30	2	47	03.5	11 50 23	
929	14.05	0.66	0.23	1	47	18.1	11 51 44	
937	14.12	0.64	0.04	1	47	01.2	11 52 41	
939	13.43	0.56	-0.01	1	47	01.6	11 53 45	
941	15.15	0.88	0.31	1	47	19.3	11 55 10	
942	14.44	0.65	0.10	2	47	02.2	11 55 18	
943	14.64	0.74	0.30	2	47	22.8	11 55 25	
944	13.68	0.54	0.04	1	47	20.7	11 55 31	
945	14.59	0.65	0.13	3	47	13.0	11 55 46	
947	14.90	0.80	0.32	1	47	17.3	11 56 09	
950	13.77	0.51	0.07	0	47	14.9	11 56 32	M
951	14.53	0.72	0.17	2	47	04.8	11 56 42	
954	13.74	0.55	0.09	2	47	13.3	11 57 10	ES
955	14.72	0.75	0.23	1	47	09.8	11 57 22	
958	14.46	0.67	0.10	1	47	08.4	11 58 02	ES
961	12.00	0.79	0.27	1	47	03.5	11 58 37	ES
963	14.46	0.73	0.19	1	47	11.1	11 59 29	
964	13.23	0.58	0.09	1	47	12.1	11 59 47	ES
965	14.59	0.78	0.24	1	47	18.6	11 59 48	

TABLE 1 (CONTINUED)

Star	V	B-V	U-B	Wt	Ra (1950)	Dec	s
966	14.51	0.69	0.16	0	47 15.9	12 00 11	M
967	13.44	0.57	0.06	1	47 12.3	12 00 18	ES
969	14.11	0.67	0.13	1	47 15.8	12 00 57	
973	13.43	0.53	0.05	2	47 10.3	12 01 25	
975	10.89	0.43	0.11	5	47 08.3	12 01 53	
976	13.11	0.16	0.05	0	47 14.8	12 01 55	R
977	13.04	-0.10	-0.33	10	47 05.8	12 02 14	
979	9.69	1.33	1.63	5	47 11.5	12 02 15	
981	14.00	0.73	0.19	1	47 10.7	12 02 36	
982	14.12	0.59	0.08	2	47 19.0	12 02 36	R
984	12.19	0.52	0.11	1	47 15.2	12 02 45	
985	14.97	0.92	0.59	0	47 05.4	12 02 49	R
986	12.72	0.56	0.03	2	47 11.9	12 02 43	R
987	13.90	0.60	0.04	2	47 11.3	12 02 55	R
988	13.18	0.56	0.10	1	47 14.5	12 02 56	R
989	11.45	1.05	0.96	1	47 15.6	12 02 58	
990	13.43	0.58	-0.02	1	47 02.6	12 03 03	R
991	14.54	0.70	-0.17	2	47 04.0	12 03 09	R
992	13.24	0.61	-0.01	0	47 05.3	12 02 51	R
993	15.37	0.92	0.37	2	47 01.0	12 03 24	
994	13.21	0.57	0.04	1	47 16.0	12 03 33	R
995	12.78	0.55	0.07	6	47 14.1	12 03 34	
996	15.01	0.92	0.51	2	47 22.4	12 03 42	R
997	12.11	0.46	0.05	3	47 13.8	12 03 52	
998	13.09	0.56	9.99	1	47 11.3	12 03 53	R
999	12.62	0.77	0.28	0	47 12.6	12 03 55	R
1001	12.40	0.99	0.74	4	47 02.3	12 04 03	
1002	15.09	0.83	0.22	2	47 06.0	12 04 11	R
1003	12.84	0.55	0.07	0	47 08.7	12 04 16	R
1004	14.88	0.78	0.26	2	47 18.3	12 04 21	R
1005	12.68	0.50	0.06	3	47 09.3	12 04 23	
1007	12.56	0.60	0.03	0	47 19.3	12 04 27	R
1009	13.69	0.58	-0.01	2	47 13.1	12 04 47	R
1010	10.46	1.12	1.02	1	47 16.7	12 04 54	
1012	14.49	0.69	0.27	1	47 18.7	12 04 56	R
1014	14.15	0.74	0.20	1	47 19.4	12 05 06	R
1016	10.30	1.28	1.32	2	47 11.0	12 05 08	
1017	13.39	0.57	0.04	1	47 03.2	12 05 12	R
1018	12.81	0.56	0.10	1	47 18.0	12 05 15	R
1019	14.41	0.83	0.35	0	47 17.2	12 05 20	R
1021	13.91	0.59	0.04	1	47 06.2	12 05 26	R
1024	12.72	0.58	0.02	1	47 16.8	12 05 42	R
1025	13.84	0.58	0.04	1	47 05.6	12 05 42	R
1027	13.27	0.59	0.04	0	47 18.9	12 05 44	R
1029	15.23	0.82	0.41	1	47 15.5	12 05 56	R
1030	13.23	0.59	-0.01	1	47 19.9	12 06 02	R
1031	13.29	0.47	-0.01	1	47 16.9	12 06 05	R
1032	13.46	0.58	-0.05	1	47 20.4	12 06 13	R
1033	14.19	0.61	0.06	1	47 08.9	12 06 13	R
1034	12.65	0.61	0.08	0	47 12.4	12 06 14	R
1035	13.90	0.51	0.07	0	47 13.1	12 06 17	R
1036	12.84	0.47	-0.06	1	47 22.1	12 06 21	R
1040	11.49	0.91	0.48	2	47 17.7	12 06 41	
1041	14.76	0.74	0.23	1	47 20.1	12 06 46	R
1044	15.42	1.00	0.80	0	47 05.4	12 06 57	R
1045	12.58	0.58	0.08	0	47 12.9	12 06 58	R
1046	13.54	0.58	0.06	1	47 11.6	12 06 58	R
1047	13.62	0.57	0.01	1	47 02.3	12 06 57	R
1048	14.41	0.68	0.21	1	47 21.9	12 07 06	R
1049	12.84	0.56	0.08	0	47 09.2	12 07 06	R
1050	14.40	0.66	0.11	0	47 12.0	12 07 11	R
1051	13.99	0.58	0.05	1	47 14.1	12 07 14	R
1053	12.09	0.51	0.29	1	47 07.5	12 07 29	
1054	10.98	1.00	0.72	1	47 10.9	12 07 38	
1055	13.84	0.57	0.03	1	47 02.4	12 07 45	R
1056	13.03	0.92	0.44	0	47 09.5	12 07 48	R
1060	13.07	0.88	0.45	1	47 12.6	12 08 11	R
1061	13.86	0.54	0.01	1	47 07.5	12 08 10	R
1062	13.33	0.57	0.04	1	47 16.3	12 08 21	R
1063	13.63	1.03	0.71	1	47 07.2	12 08 31	R
1064	14.06	0.64	0.15	1	47 15.6	12 08 34	R
1065	14.58	0.82	0.32	1	47 21.7	12 08 39	R
1066	10.93	0.11	0.09	3	47 20.9	12 08 45	
1067	14.98	0.74	9.99	0	47 01.6	12 08 45	M
1069	12.66	0.69	0.18	0	47 22.7	12 08 53	R
1070	13.95	0.62	0.06	1	47 13.5	12 09 03	R
1071	12.84	0.57	0.08	0	47 22.2	12 09 10	R
1072	11.28	0.61	0.16	2	47 15.6	12 09 30	
1073	13.31	0.58	0.09	1	47 19.4	12 09 32	R
1074	10.51	1.11	1.00	3	47 06.5	12 09 34	

TABLE 1 (CONTINUED)

Star	V	B-V	U-B	Wt	Ra (1950)	Dec	s
1075	13.86	0.60	-0.02	2	47 14.0	12 09 40	R
1076	12.85	0.57	0.02	1	47 09.6	12 09 51	R
1077	12.47	0.66	9.99	0	47 01.0	12 09 53	M
1078	14.20	0.64	0.10	2	47 21.3	12 09 55	R
1079	15.30	0.83	0.39	2	47 15.8	12 10 01	R
1082	11.21	0.40	0.10	6	47 14.6	12 10 18	
1084	10.48	1.10	0.96	3	47 20.1	12 10 44	
1087	14.18	0.66	0.10	4	47 16.9	12 10 57	
1088	13.60	0.61	0.16	1	47 10.3	12 11 07	ES
1089	14.26	0.63	0.05	2	47 06.1	12 11 15	
1090	15.36	0.84	9.99	0	47 05.7	12 11 35	M
1092	13.33	0.63	0.03	1	47 21.7	12 12 34	ES
1093	13.32	0.60	0.10	1	47 12.5	12 12 42	
1095	14.59	0.66	0.16	2	47 02.9	12 13 51	
1096	14.49	0.67	0.13	2	47 06.7	12 13 53	
1100	15.28	0.77	0.29	3	47 07.5	12 14 29	
1102	14.26	0.61	0.05	2	47 02.5	12 14 45	
1106	14.78	0.72	0.19	2	47 01.8	12 15 44	
1107	14.13	0.60	0.09	1	47 15.2	12 15 57	
1111	13.67	0.57	0.03	2	47 01.9	12 17 57	
1112	15.05	0.74	0.24	2	47 17.7	12 18 23	
1113	13.63	0.99	0.59	2	47 19.0	12 19 48	
1115	13.70	0.56	0.04	1	47 02.8	12 19 52	
1120	15.78	0.63	0.12	2	47 14.3	12 22 24	
1130	14.38	0.66	0.16	1	47 06.0	12 28 08	
1155	14.62	0.64	0.18	1	47 42.2	11 35 05	
1165	12.80	0.51	0.03	1	47 28.2	11 39 45	
1168	13.11	0.56	0.05	1	47 42.9	11 42 34	
1172	14.63	0.65	0.25	1	47 24.4	11 44 26	
1176	15.66	0.85	0.34	1	47 45.1	11 47 11	
1181	13.19	0.57	0.08	1	47 36.5	11 49 02	
1182	12.00	0.99	0.79	1	47 42.6	11 50 12	
1183	12.83	0.41	0.10	1	47 44.1	11 50 15	
1186	12.72	0.57	0.08	1	47 24.0	11 52 05	
1189	13.29	0.56	0.06	1	47 26.3	11 53 07	
1191	14.15	0.69	0.29	1	47 37.2	11 53 24	
1193	14.83	0.78	0.38	1	47 31.2	11 53 50	
1195	12.34	0.42	0.12	1	47 31.9	11 53 59	
1197	13.18	0.56	0.05	1	47 28.6	11 54 52	
1201	13.93	0.57	0.08	1	47 30.4	11 55 51	
1202	13.54	0.55	0.05	1	47 39.2	11 55 55	
1203	14.43	0.72	0.25	0	47 29.6	11 55 41	M
1207	13.24	0.57	0.07	1	47 38.8	11 58 46	ES
1208	14.60	0.84	0.38	0	47 26.7	11 59 00	M
1209	15.82	0.48	-0.13	0	47 33.7	11 59 07	M
1211	14.08	0.59	0.09	0	47 42.6	11 59 18	M
1212	15.24	0.90	0.40	0	47 41.2	11 59 25	M
1216	12.73	0.57	0.08	1	47 36.0	12 00 32	ES
1217	15.30	0.93	0.40	0	47 43.1	12 00 34	M
1218	14.62	0.71	0.14	0	47 28.6	12 00 44	M
1219	13.15	0.59	0.01	1	47 24.2	12 00 43	R
1220	13.42	0.55	0.06	1	47 40.0	12 01 04	ES
1221	10.78	1.14	1.11	4	47 37.6	12 01 21	
1226	13.40	0.54	0.06	1	47 38.8	12 01 56	ES
1229	15.53	0.88	0.51	1	47 26.0	12 02 00	R
1230	13.10	0.54	0.02	1	47 37.8	12 03 09	JS
1231	12.92	0.93	0.62	1	47 23.4	12 02 21	R
1234	12.65	0.57	0.00	5	47 25.2	12 02 47	ES
1236	15.20	0.87	0.30	1	47 27.6	12 02 49	R
1237	10.75	0.95	0.67	5	47 44.3	12 03 02	
1239	12.78	0.71	0.30	3	47 38.0	12 03 19	
1240	13.41	0.58	0.04	1	47 40.5	12 03 21	ES
1242	12.70	0.70	0.15	1	47 30.0	12 03 27	R
1244	13.79	0.60	0.09	1	47 34.5	12 03 31	R
1245	12.96	0.92	0.56	0	47 38.7	12 03 40	R
1246	14.61	0.74	0.15	0	47 26.3	12 03 38	R
1247	14.02	0.63	0.14	1	47 31.3	12 03 49	R
1248	14.19	0.62	0.13	1	47 28.2	12 03 50	R
1249	14.33	0.79	0.28	0	47 41.5	12 04 05	M
1250	9.67	1.36	1.54	2	47 23.9	12 04 10	
1251	14.78	0.82	0.21	0	47 42.7	12 04 30	M
1252	14.10	0.64	0.12	1	47 35.5	12 04 31	R
1254	11.51	1.06	0.90	6	47 39.2	12 04 40	
1255	14.47	0.71	0.17	1	47 30.1	12 04 41	R
1256	13.72	0.67	0.12	1	47 33.0	12 04 49	R

TABLE 1 (CONTINUED)

Star	V	B-V	U-B	Wt	Ra (1950)	Dec	s
1257	10.99	0.22	0.20	3	47 42.6	12 06 11	
1263	12.62	0.60	0.09	1	47 43.9	12 06 26	JS
1269	14.90	0.77	0.36	0	47 34.5	12 03 32	R
1270	12.63	0.58	0.12	4	47 43.1	12 06 38	
1271	12.37	0.53	0.04	1	47 28.2	12 06 37	R
1272	11.39	0.63	0.13	1	47 36.3	12 06 46	
1273	12.27	0.55	0.10	2	47 33.1	12 06 53	
1274	12.63	0.60	0.06	1	47 26.1	12 06 57	R
1275	12.60	0.60	0.10	1	47 31.3	12 06 59	R
1277	11.62	1.06	0.89	3	47 36.3	12 07 02	
1278	14.31	0.83	0.36	1	47 23.8	12 07 18	R
1279	10.52	1.11	1.01	3	47 22.9	12 07 26	
1280	12.22	0.26	0.11	3	47 26.5	12 07 34	
1281	13.68	0.55	0.06	1	47 28.3	12 07 45	R
1282	13.62	0.53	0.30	0	47 31.8	12 07 51	R
1283	14.09	0.67	0.15	1	47 23.8	12 08 02	R
1284	10.92	0.24	0.17	3	47 28.2	12 08 04	
1285	12.55	0.64	0.16	3	47 42.3	12 08 07	
1286	15.23	0.86	0.42	1	47 27.1	12 08 06	R
1287	14.02	0.59	0.12	1	47 25.8	12 08 10	R
1288	11.27	1.08	0.94	3	47 36.2	12 08 07	
1289	14.89	0.78	0.32	1	47 24.3	12 08 14	R
1291	15.34	0.88	0.42	1	47 29.3	12 08 29	RR
1292	13.22	0.63	0.10	1	47 27.5	12 08 38	R
1293	12.14	1.04	0.81	3	47 33.3	12 08 40	
1300	13.80	0.61	0.06	1	47 33.9	12 09 37	ES
1302	13.09	0.57	0.04	1	47 25.8	12 10 05	R
1303	13.72	0.60	0.08	0	47 25.0	12 10 11	RR
1304	15.48	0.89	0.47	1	47 25.9	12 10 24	M
1307	15.27	0.88	0.27	0	47 26.9	12 10 36	
1308	12.86	0.60	0.11	1	47 23.2	12 11 07	ES
1309	15.31	0.89	0.37	0	47 30.6	12 11 16	M
1310	12.79	0.60	0.09	1	47 35.0	12 11 23	ES
1313	13.22	0.60	0.06	1	47 30.9	12 11 53	ES
1314	13.67	0.65	0.10	1	47 25.8	12 12 02	ES
1316	10.61	1.13	0.93	1	47 37.6	12 13 37	
1318	14.00	0.56	0.06	1	47 30.1	12 13 44	
1319	12.90	0.92	0.64	1	47 42.6	12 13 47	
1320	14.44	0.62	0.18	1	47 31.4	12 13 39	
1321	13.54	0.56	0.05	1	47 39.0	12 13 50	
1323	12.80	0.75	0.29	2	47 29.1	12 14 50	
1330	14.04	0.60	0.05	1	47 36.4	12 16 24	
1331	13.85	0.58	0.10	1	47 26.9	12 16 34	
1333	13.59	0.58	0.05	1	47 37.3	12 17 49	
1337	13.00	0.59	0.10	1	47 31.8	12 18 07	
1340	13.69	0.56	0.04	1	47 31.1	12 20 12	
1341	14.68	0.67	0.16	1	47 24.4	12 21 07	
1344	13.93	0.34	2.00	1	47 31.9	12 22 00	
1348	13.70	0.56	0.04	1	47 28.5	12 25 04	
1356	12.94	0.91	0.61	1	47 31.9	12 37 06	
1359	10.49	1.09	0.96	1	47 20.0	12 10 45	
1388	14.61	0.65	0.18	1	48 08.0	11 40 35	
1389	13.24	0.56	0.02	1	47 49.9	11 41 07	
1394	13.20	0.58	0.03	1	48 03.4	11 45 00	
1397	13.21	0.54	0.04	1	47 47.2	11 46 53	
1400	13.74	0.56	0.03	1	47 46.9	11 47 43	
1402	11.39	1.16	1.25	1	48 05.3	11 48 48	
1406	14.02	0.60	0.10	1	47 49.4	11 52 30	
1415	12.68	0.57	0.07	1	47 47.6	11 55 29	
1416	13.43	0.56	0.03	1	48 00.5	11 55 39	
1418	15.13	0.69	0.55	1	48 03.6	11 55 43	
1420	14.15	0.61	0.15	1	47 50.3	11 56 01	
1421	14.50	0.63	0.11	1	47 48.1	11 56 02	
1426	14.25	0.62	0.09	1	48 05.6	11 57 31	
1431	13.74	0.60	0.02	2	47 59.9	11 57 22	
1434	10.66	0.12	0.14	3	48 04.9	12 01 03	
1440	13.43	0.46	0.05	1	48 07.5	12 02 59	
1441	13.20	0.58	0.00	0	47 56.8	12 03 00	M
1442	14.81	0.83	0.20	0	47 59.1	12 03 18	M
1443	15.47	0.96	0.99	0	47 47.9	12 03 30	M
1446	14.03	0.61	0.06	2	48 03.7	12 03 45	
1449	14.39	0.68	0.11	2	47 50.5	12 04 22	
1452	14.60	0.76	0.04	0	48 01.1	12 04 22	M
1453	13.98	0.61	0.07	3	47 50.5	12 05 09	ES
1455	15.53	0.92	0.52	1	47 52.8	12 05 11	
1456	12.72	0.56	0.04	1	47 47.3	12 05 16	JS
1457	13.91	0.69	0.18	3	47 49.5	12 05 35	ES
1458	13.38	0.59	0.08	1	47 56.1	12 06 05	ES
1462	14.37	0.68	0.12	3	47 52.8	12 06 59	ES
1463	12.94	1.01	0.73	1	47 50.0	12 07 10	ES

TABLE 1 (CONTINUED)

Star	V	B-V	U-B	Wt	Ra (1950)	Dec	s
1463	15.36	0.86	0.27	1	47 52.5	12 09 10	
1469	15.40	0.85	0.36	1	47 54.4	12 09 25	
1471	12.83	0.59	0.09	1	47 53.5	12 09 53	ES
1473	15.05	0.96	0.29	0	47 50.1	12 10 31	M
1477	14.60	0.80	0.16	0	47 47.1	12 11 15	M
1479	10.48	1.11	0.97	2	47 53.3	12 12 01	
1483	14.34	0.61	0.19	1	47 54.1	12 13 04	
1484	14.50	0.77	0.49	1	47 47.4	12 13 15	
1485	12.73	0.56	0.07	1	47 45.2	12 14 45	
1486	13.94	0.63	0.09	1	47 57.0	12 15 03	
1487	12.63	0.64	0.14	1	47 58.5	12 15 25	
1488	15.72	0.92	0.63	2	47 53.3	12 15 46	
1491	13.78	0.57	0.06	1	47 51.8	12 17 55	
1492	14.51	0.91	0.52	1	47 55.2	12 17 60	
1501	14.66	0.69	0.07	1	48 06.3	12 19 57	
1503	12.96	0.54	0.05	1	47 57.1	12 20 26	
1504	13.89	0.61	0.08	1	47 46.9	12 20 26	
1505	14.19	0.65	0.11	1	47 55.3	12 20 49	
1506	12.68	0.58	0.06	1	47 46.5	12 21 13	
1507	13.48	0.55	0.10	1	47 45.4	12 21 41	
1508	12.78	0.57	0.08	1	47 53.3	12 21 53	
1515	14.15	0.63	0.09	1	48 03.5	12 27 26	
1516	13.71	0.56	0.03	1	47 54.9	12 28 05	
1519	14.19	0.62	0.09	1	48 01.5	12 33 44	
1524	13.00	0.81	0.45	1	47 49.0	12 34 51	
1533	10.14	1.27	1.20	2	47 55.8	12 42 48	
1547	15.49	0.72	0.24	2	48 15.2	11 27 46	
1553	8.80	1.65	1.94	1	48 25.0	11 32 34	
1554	13.27	0.57	0.06	1	48 20.8	11 33 36	
1557	10.19	1.29	1.42	1	48 11.2	11 36 38	
1560	14.47	0.69	0.22	2	48 21.3	11 39 30	
1564	15.10	0.75	0.36	2	48 13.2	11 40 49	
1573	14.46	0.63	0.17	2	48 25.1	11 46 06	
1575	12.81	0.52	0.00	1	48 09.1	11 48 07	
1583	13.21	0.56	0.05	1	48 15.2	11 56 07	
1585	12.50	0.94	0.72	1	48 20.6	11 58 27	
1586	13.49	0.54	0.00	1	48 10.8	11 59 28	
1587	14.12	0.59	0.06	2	48 24.5	11 59 51	
1589	12.76	0.54	0.08	1	48 12.8	12 00 23	
1592	12.75	0.53	0.03	1	48 12.7	12 01 24	
1595	13.69	0.58	0.04	2	48 27.2	12 02 24	
1597	14.94	0.79	0.26	2	48 10.0	12 03 25	
1598	13.73	0.55	0.04	1	48 15.9	12 03 45	
1601	14.56	0.92	0.47	2	48 10.9	12 05 30	
1604	14.88	0.72	0.31	2	48 16.1	12 06 01	
1607	12.62	0.56	0.09	1	48 15.3	12 07 40	
1608	14.20	0.72	0.28	2	48 08.3	12 07 51	
1612	13.69	0.56	0.06	1	48 25.3	12 08 51	
1616	14.48	0.64	0.19	2	48 09.4	12 10 01	
1620	15.84	0.65	0.15	2	48 10.7	12 13 12	
1634	13.19	0.58	0.06	1	48 24.5	12 21 15	
1635	13.25	0.57	0.05	2	48 27.8	12 21 23	
1639	12.66	0.53	0.07	2	48 26.4	12 23 24	
1648	13.72	0.53	0.03	2	48 07.5	12 29 40	
1676	14.95	0.89	0.52	3	48 34.6	11 31 22	
1687	13.04	0.54	0.03	2	48 51.0	11 42 27	
1688	13.89	0.57	0.04	3	48 39.2	11 42 53	
1698	15.23	0.76	0.41	4	48 37.7	11 53 33	
1713	12.53	0.97	0.80	2	48 50.3	12 05 59	
1714	14.66	0.79	0.46	2	48 40.4	12 05 59	
1720	13.48	0.56	0.03	1	48 43.2	12 09 11	
1735	15.99	0.67	0.07	3	48 32.1	12 18 47	
1736	14.87	0.75	0.23	3	48 42.4	12 19 50	
1792	12.63	0.60	0.12	2	48 59.6	11 51 53	
1808	12.60	0.58	0.10	1	48 53.9	11 57 46	
1816	15.28	1.51	1.18	3	49 12.5	12 05 10	
1817	13.68	0.55	0.00	2	49 01.9	12 05 18	
1832	12.76	0.54	0.07	1	49 05.7	12 16 37	
1872	15.43	0.62	-0.02	1	49 35.8	11 23 57	
1910	15.59	0.58	-0.01	2	49 27.6	11 51 20	
1912	13.02	0.54	0.04	1	49 26.5	11 51 55	
1933	13.84	0.62	0.04	1	49 20.6	12 17 26	
1947	13.46	0.43	-0.09	1	49 18.8	12 24 11	
1958	14.42	0.50	-0.06	1	49 15.0	12 28 47	
1962	13.01	0.55	0.05	1	49 16.6	12 29 15	

1989RMxAA...17...31S

Star	<i>V</i>	<i>B</i> − <i>V</i>	<i>U</i> − <i>B</i>	Wt	<i>R</i> _a	(1950)	Dec	<i>s</i>
1982	14.27	0.66	0.19	1	49	56.2	11 27 01	
1983	14.39	0.64	0.16	1	49	46.8	11 28 11	
1973	15.65	0.60	−0.02	2	49	38.0	11 35 48	
1996	15.64	0.60	0.10	3	49	53.3	11 37 56	
2015	12.56	0.61	0.03	1	49	44.5	12 00 17	
2021	12.29	1.17	1.08	1	49	59.0	12 17 29	
2202	15.23	0.77	0.38	1	47	08.3	12 01 32	R
2204	12.88	0.47	0.07	1	47	14.6	12 03 10	R
2205	13.16	0.56	0.06	1	47	14.3	12 02 45	R
2206	12.33	0.75	0.30	1	47	10.7	12 02 21	R

Star	<i>V</i>	<i>B</i> − <i>V</i>	<i>U</i> − <i>B</i>	Wt	<i>R</i> _a	(1950)	Dec	<i>s</i>
2207	12.59	0.59	0.15	1	47	26.5	12 04 46	R
2208	12.76	0.80	0.39	1	47	26.4	12 04 54	R
2212	12.68	0.61	0.10	1	47	24.5	12 06 06	R
2213	14.89	0.72	0.22	1	47	06.1	12 05 16	R
2216	15.05	0.76	0.36	1	47	18.3	12 06 44	R
2219	13.16	0.57	0.05	1	47	10.8	12 07 01	R
2221	13.38	0.58	0.06	1	47	08.3	12 07 32	R
2222	14.89	0.77	0.31	1	47	05.9	12 07 29	R
2223	13.30	0.51	0.03	1	47	23.7	12 08 23	M
2224	13.62	0.61	9.99	0	47	01.3	12 09 47	M

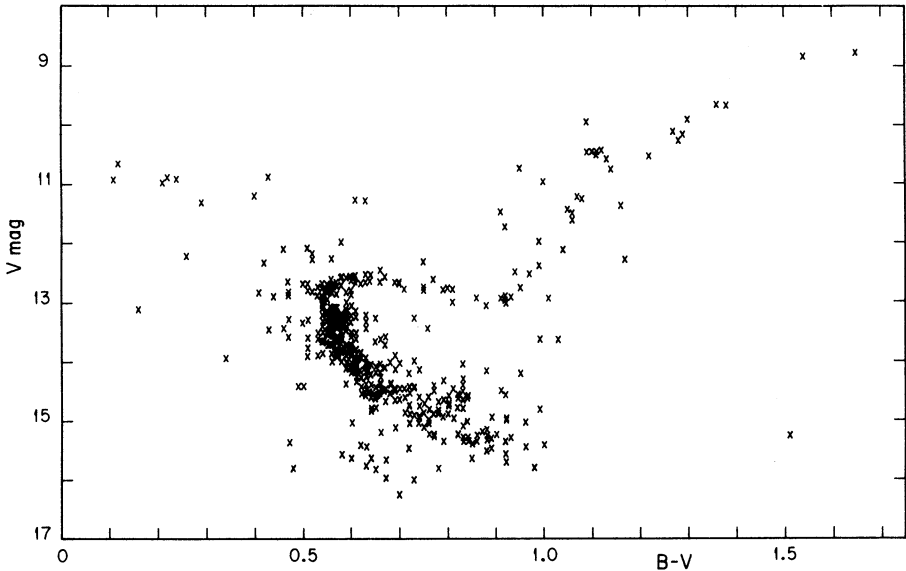


Fig. 1. C-M magnitude of M67.

The color-magnitude diagram of the stars listed in Table 1 is shown in Figure 1. This diagram consists of all stars whose membership probability is greater than or equal to 50%. The plotted points are the observed values of *V* and *B*−*V* uncorrected for reddening. A well defined cluster main sequence, giant, and horizontal branch are present. The “gap” located at *V* = 13.1 and *B*−*V* = 0.55 is also evident. Presumably this feature results from a rapid stage of stellar evolution.

The cluster main sequence is well defined for stars having *V* less than about 15. At an approximate distance modulus of 9.5, this corresponds to an absolute visual magnitude near 5.5. Fainter than this value the cluster’s main sequence becomes less well defined.

I wish to thank Dr. B. McNamara for contributing a few of the *UBV* observations.

REFERENCES

Eggen, O.J. and Sandage, A.R. 1964, *Ap. J.*, **140**, 130.
Johnson, H. and Sandage, A.R. 1955, *Ap. J.*, **121**, 616.
Murray, C.A. and Clements, E.D. 1968, *Royal Obs. Bull.*, No. 139.
Murray, C.A., Corben, P.M., and Allchorn, M.R. 1965, *Royal Obs. Bull.*, No. 91.
Racine, R. 1971, *Ap. J.*, **168**, 393.
Sanders, W.L. 1977, *Astr. and Ap. Suppl.*, **27**, 89.

W.L. Sanders: Department of Astronomy, New Mexico State University, Las Cruces, NM 88003 USA.

