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UBVRI photoelectric photometry of high proper motion stars

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Summary. — *UBVRI* photoelectric photometry is presented for 269 late spectral type high proper motion stars belonging to the « Lowell Proper Motion Survey » and included in the present version of the Hipparcos Input Catalogue.

Key words : photoelectric photometry — late spectral type stars — high proper motion stars.

1. Introduction.

Among the red nearby stars proposed by the scientific community for the Hipparcos mission, high proper motion stars constitute the largest sample (Egret and Gómez, 1985). The Hipparcos satellite will provide accurate parallaxes for stars nearer than 100 pc, thus the high proper motion stars contained in the Input Catalogue constitute a very valuable sample. In order to satisfy mission requirements and also to complete photometric data for these stars we have obtained *UBVRI* photometry for a subset of 269 late spectral type stars with apparent magnitude between 10 and 13. All these stars belong to the « Lowell Proper Motion Survey » (Giclas, 1971) and have been selected by Grenon (task leader of the Hipparcos working group 4000 B, Geneva Observatory, Switzerland) among those having no photometric measurements in the Input Catalogue.

2. Observations and data reduction.

The observations were made at Calar Alto (Almería, Spain) with the 1.23 m telescope of the Centro Astronómico Hispano-Alemán (C.A.H.A.) and the 1.52 m telescope of the Observatorio Astronómico Nacional (O.A.N.) and at the Observatorio del Roque de los Muchachos (O.R.M.) using the 1 m Jakobus Kapteyn telescope. Both Calar Alto telescopes are equipped with a one channel photometer with a dry-ice cooled RCA 31034 photomultiplier. The observations with the Jakobus Kapteyn telescope were made using the People's photometer, a two-channel one, which is equipped with EMI 9658AM photomultipliers.

The standard stars were taken from the list of Neckel and Chini (1980). Table I shows the 11 periods devoted to this program with the number of observations of Giclas and standard stars. The observing procedure and the data reduction were performed as described in Rosselló *et al.* (1985) with the exception of the reduction in the $(U\text{-}B)$ color index, where a linear term in $(B\text{-}V)$ was used instead of a second order term in $(U\text{-}B)$. Denoting by *UBV* and *ubv* the data in the standard system and in the instrumental system respectively, and by χ the air mass, the transformation equation for the $(U\text{-}B)$ color index takes the form :

$$(u\text{-}b) = c_1 + c_2\,\chi + c_3(U\text{-}B) + c_4\,\chi\,(U\text{-}B) + c_5(B\text{-}V)\,.$$

As indicated by Neckel and Chini (1980), the necessity of introducing the dependence in $(B\text{-}V)$ is caused by small deviations of the instrumental passbands from those of the standard system. The significance of this term has also been pointed out by Moffat and Vogt (1977), Klare and Neckel (1977) and Haug (1980), among others. The mean values for c_5 obtained in the present observational program are $c_5 = 0.007 \pm 0.007$ for the observations made at Calar Alto and $c_5 = -0.219 \pm 0.006$ for those made at La Palma. These results have pointed out the necessity of considering this dependence, mainly for the reduction of the observations made at La Palma, and it can be attributed to the fact that the *U* filter used there does not match very well the Johnson system (Jones, 1984). As it can be seen in figure 1 the residuals for $(U\text{-}B)$, after including the $c_5(B\text{-}V)$ term, are reasonably small and similar to the residuals for the other colors. All of them are less than 0.02 magnitudes except for the standard stars 4, 25, 48, 51 and 54, which present a higher and systematic deviation, suggesting a revision of their catalogued values.

3. Results.

Table II contains the final results for the sample of 269 stars, the last column being the total number of useful observations of each program star. The quoted error is the standard deviation of the average. The photometry of the stars marked with (*) has been determined only through two quasi-simultaneous measurements with the two-channel People's photometer.

When a program star appeared to be double, the observations were made following the specific conditions necessary for the Hipparcos mission (Dommanget, 1985). The estimated values for their angular separation and the angle θ, as defined in figure 2, are indicated in the remarks of table II. We have marked with « J » the joint photometry (A + B). Some of the fainter stars belonging to multiple system have only an estimated color given in parenthesis in table II.

We have not made an exhaustive literature search to find all the overlaps of our observational program with other observers. However, in table III we present an estimation of the external errors obtained through the comparison of our results with those published by Sandage and Kowal (1986), Carney and Latham (1987) and Weis (1984, 1986 and 1987), hereafter referred to as SK, CL and WE, respectively. By comparing our results with SK and CL it is clear that the zero point differences (in the sense our values minus others) are in all cases small except for the $(U\text{-}B)$ color index, where a systematic difference of 0.039 ± 0.009 magnitudes has been found between our values and those of SK. This difference is in agreement with the external error obtained by CL from 200 stars in common between their catalogue and that of SK. They found a value of $\Delta(U\text{-}B) = 0.020 \pm 0.002$ magnitudes in the sense CL minus SK, which, although smaller, has the same sense that the systematic difference obtained in our observational program. The standard deviations of a single comparison are in the range 0.03-0.04 when our values and those of SK or CL are compared. As can be seen in figure 1, these standard deviations are in agreement with the accuracy of the data given by the internal errors.

Quite large discrepancies arise if we compare our values with those obtained by WE. WE gives V magnitude in the Johnson (1963) system and $(V\text{-}R)$ and $(V\text{-}I)$ in the Kron *et al.* (1957) system. As stated above we used the Neckel and Chini (1980) standard stars, so two transformations have been applied. We have used in a first step Bessell and Weis (1987) cubic relations giving Cousins values as a function of the Kron's ones. Then the relations of Bessell (1983) allow us to obtain the corresponding values in the system defined by Neckel and Chini. Uncertainties in the transformation equations may be responsible for the $(V\text{-}R)$ and $(V\text{-}I)$ discrepancies. The agreement of our V magnitudes with those published by SK and CL seems to indicate a systematic difference in the values quoted by WE.

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TABLE I. — *Observation periods.*

Periods		Nights	Useful nights	Giclas stars observ.	Standard stars observ.
17–28 Jul. 1985	(CAHA)*	12	11	57	161
15–24 Nov. 1985	(OAN)	10	1	7	9
18–23 Dec. 1985	(ORM)*	6	5	333	147
15–26 May 1986	(CAHA)	12	3	43	39
10 Jun. 1986	(ORM)	1	1	86	62
28Ju.–6Jul.1986	(OAN)	10	8	89	100
25Aug–3Sep.1986	(CAHA)	10	5	96	81
29Dec–8Jan.1987	(CAHA)*	11	8	116	111
21–25 Apr. 1987	(OAN)*	5	3	25	31
27May–6Jun.1987	(OAN)*	9	7	14	91
29Jul–4Aug.1987	(ORM)*	7	4	17	138
		93	56	883	970

CAHA : Centro Astronómico Hispano-Alemán
OAN : Observatorio Astronómico Nacional
ORM : Observatorio del Roque de los Muchachos

(*) These periods were not only devoted to this program.

TABLE II. — *Photometry for program stars.*

Giclas number	R.A. (1950)	DEC (1950)	V	error	B-V	error	U-B	error	V-R	error	V-I	error	Obs.
G217-29	0 0 28	+56 27.3	9.756	0.008	0.951	0.026	0.724	0.000	0.705	0.005	1.212	0.009	2*
G217-30A	0 1 50	+57 47.4	10.476	0.009	0.785	0.009	0.221	0.003	0.640	0.004	1.151	0.006	4
G217-30B			13.134	0.039	1.656	0.019	(1.8)		1.230	0.009	2.288	0.012	3
G130-46	0 6 27	+27 22.3	11.669	0.005	1.259	0.000	1.118	0.009	1.031	0.013	1.852	0.003	2*
G243-16	0 8 42	+58 4.4	9.500	0.010	1.254	0.023	1.067	0.036	1.022	0.000	1.869	0.002	3
G131-35	0 9 58	+21 26.3	11.681	0.003	1.459	0.011	1.242	0.022	1.210	0.014	2.311	0.000	3
G241-76	0 10 27	+69 3.0	12.448	0.024	1.587	0.016	1.269	0.036	1.534	0.031	3.345	0.004	3
G217-41	0 12 35	+52 47.8	10.407	0.015	0.896	0.004	0.520	0.007	0.692	0.014	1.189	0.008	2*
G217-40	0 12 35	+52 48.0	14.372	0.029	(1.5)		(1.5)		1.466	0.039	3.077	0.040	3
G243-19	0 12 44	+64 .0	10.661	0.013	1.088	0.008	0.871	0.009	0.840	0.030	1.502	0.012	2*
G171-46	0 15 20	+39 57.2	9.969	0.003	0.820	0.010	0.288	0.000	0.638	0.015	1.167	0.010	2*
G217-46	0 20 34	+60 56.2	11.068	0.015	1.312	0.015	1.270	0.002	1.079	0.006	1.995	0.001	2*
G242-56	0 25 49	+80 38.1	11.374	0.025	1.153	0.012	0.998	0.038	1.040	0.012	1.739	0.023	2*
G242-59	0 27 51	+73 5.6	10.628	0.001	1.359	0.003	1.298	0.008	1.132	0.000	2.043	0.007	3
G171-62	0 30 18	+44 27.3	10.288	0.014	0.793	0.007	0.399	0.011	0.617	0.003	1.069	0.015	2*
G218- 5	0 35 28	+52 3.5	10.484	0.018	1.424	0.039	1.267	0.009	1.171	0.012	2.184	0.009	2*
G 69-21	0 43 57	+33 33.2	10.348	0.010	0.661	0.005	0.133	0.012	0.536	0.000	0.919	0.011	2*
G172-23	0 44 11	+43 22.6	9.757	0.011	0.879	0.008	0.511	0.019	0.717	0.003	1.268	0.005	2*
G243-41	0 46 26	+67 40.8	10.422	0.006	1.030	0.003	0.910	0.009	0.792	0.010	1.324	0.005	2*
G172-28	0 51 3	+45 40.4	11.105	0.011	1.435	0.037	1.246	0.036	1.183	0.008	2.243	0.000	2*
G243-61	1 3 57	+69 36.7	10.580	0.001	1.009	0.017	0.823	0.023	0.877	0.012	1.495	0.006	2*
G172-45	1 11 56	+42 53.3	9.982	0.005	0.623	0.003	0.074	0.014	0.529	0.006	0.922	0.005	2*
G245-21	1 16 29	+73 55.2	9.958	0.007	0.628	0.019	0.076	0.001	0.560	0.023	0.963	0.037	2*
G034-22	1 18 44	+24 4.1	10.696	0.006	1.420	0.021	1.271	0.004	1.197	0.005	2.232	0.008	2*
G244-26	1 21 20	+64 20.4	10.756	0.009	0.973	0.001	0.790	0.021	0.822	0.003	1.444	0.002	2*
G 72-15A	1 31 5	+26 59.0	11.035	0.000	1.197	0.006	1.104	0.006	1.036	0.004	1.894	0.003	2*
G219-14	1 32 35	+56 26.8	9.405	0.004	0.920	0.002	0.710	0.016	0.696	0.003	1.183	0.003	2*
G133-20	1 32 40	+41 47.2	10.974	0.020	1.283	0.010	1.189	0.007	1.070	0.006	1.889	0.005	2*
G219-15J	1 35 6	+56 58.9	11.238	0.005	1.406	0.006	1.139	0.003	1.216	0.006	2.576	0.001	3
G133-28	1 37 43	+41 40.9	11.039	0.003	1.169	0.004	1.128	0.004	0.974	0.003	1.611	0.029	2*
G173-16	1 41 14	+50 8.7	10.616	0.013	0.469	0.003	-0.136	0.007	0.494	0.001	0.842	0.018	4
G219-20	1 42 24	+57 35.9	9.520	0.007	0.601	0.016	0.025	0.011	0.541	0.010	0.923	0.000	2*
G245-34	1 49 4	+73 43.2	10.345	0.000	1.131	0.011	1.052	0.014	0.995	0.000	1.647	0.001	3
G 72-39	1 49 39	+36 5.9	10.086	0.009	0.936	0.025	0.630	0.031	0.802	0.011	1.330	0.010	2*
G219-28J	1 50 55	+57 9.0	10.332	0.002	0.790	0.003	0.424	0.003	0.676	0.004	1.176	0.023	2
G244-43	1 51 33	+65 23.2	12.204	0.005	1.420	0.018	1.326	0.009	1.178	0.004	2.210	0.002	3
G245-44	2 3 25	+73 46.1	9.879	0.007	0.727	0.021	0.261	0.009	0.605	0.003	0.976	0.006	2*
G134- 1	2 3 48	+44 57.2	10.233	0.005	1.490	0.019	1.235	0.040	1.339	0.005	2.407	0.005	3
G134-14	2 10 0	+46 2.8	10.250	0.009	1.192	0.021	1.146	0.013	1.040	0.022	1.645	0.002	3
G134-20	2 12 42	+46 13.6	11.154	0.016	1.290	0.024	1.074	0.035	1.031	0.001	1.825	0.017	5
G 94-52	2 14 24	+26 3.3	10.999	0.018	1.104	0.032	1.048	0.036	0.948	0.033	1.566	0.016	5
G 74-16J	2 17 30	+34 .9	12.319	0.010	1.423	0.033	1.343	0.004	1.122	0.002	2.125	0.000	2
G173-52A	2 17 48	+53 19.9	10.375	0.007	1.243	0.008	1.244	0.017	1.062	0.001	1.913	0.019	2
G173-52B			14.696	0.015	0.679	0.001	(0.2)		(0.5)				3
G173-52C			14.528	0.026	0.471	0.002	(0.3)		(0.6)				3
G173-52D			14.946	0.005	0.736	0.013	0.141	0.020	(0.6)		(1.2)		2
G173-52E			14.858	0.022	0.703	0.006	0.227	0.030	(0.9)		(1.5)		2
G134-40	2 34 26	+43 46.7	10.156	0.014	0.530	0.001	-0.031	0.001	0.515	0.005	0.874	0.014	3
G 74-42	2 41 17	+36 40.7	11.127	0.032	1.363	0.040	1.321	0.002	1.087	0.018	1.823	0.016	3
G 37- 3	2 41 55	+24 37.8	10.780	0.008	0.995	0.008	0.737	0.008	0.870	0.005	1.516	0.011	3
G 78- 4	2 42 21	+44 44.4	10.812	0.007	1.398	0.027	1.268	0.032	1.257	0.004	2.424	0.005	2
G246-10	2 43 43	+64 4.7	10.764	0.001	0.997	0.000	0.828	0.004	0.798	0.003	1.346	0.001	2*
G 36-45	2 52 42	+27 55.8	11.055	0.018	1.399	0.020	1.300	0.015	1.180	0.011	2.128	0.029	2
G 78-12A	2 58 50	+42 32.7	10.149	0.004	0.721	0.001	0.156	0.011	0.634	0.005	1.111	0.012	2*
G 78-12B			13.662	0.005	1.190	0.013	1.093	0.025	0.908	0.018	1.603	0.020	4

TABLE II (*continued*).

Giclas number	R.A. (1950)	DEC (1950)	V	error	B-V	error	U-B	error	V-R	error	V-I	error	Obs.
G 78-14	3 2 24	+44 53.9	9.719	0.004	0.784	0.006	0.298	0.004	0.649	0.002	1.135	0.007	2*
G 78-19	3 6 9	+45 32.8	10.151	0.008	1.507	0.006	1.227	0.037	1.449	0.032	2.449	0.041	3
G 78-20	3 7 22	+37 11.5	10.888	0.007	0.912	0.011	0.528	0.006	0.763	0.012	1.340	0.005	2*
G 5-21	3 9 18	+20 23.9	12.115	0.005	0.953	0.017	0.646	0.038	0.802	0.016	1.364	0.003	2*
G174-38	3 10 57	+52 10.0	10.210	0.007	1.311	0.008	1.310	0.034	1.058	0.008	1.800	0.015	2*
G245-71A	3 13 57	+79 47.0	11.228	0.009	1.599	0.007	1.175	0.029	1.477	0.032	3.018	0.016	5
G 5-41	3 25 7	+21 51.3	11.392	0.012	1.432	0.022	1.160	0.003	1.187	0.031	2.208	0.005	2
G 37-40	3 27 34	+33 51.9	12.743	0.016	1.438	0.030	1.260	0.019	1.264	0.025	2.389	0.018	4
G 37-43	3 31 49	+34 26.8	10.870	0.004	1.225	0.019	1.253	0.023	1.108	0.002	2.048	0.029	2
G246-48A	3 42 41	+60 18.6	10.006	0.010	0.737	0.003	0.402	0.002	0.639	0.010	1.151	0.027	3
G246-48B			13.497	0.009	0.944	0.021	0.527	0.037	0.812	0.014	(1.5)		2
G248- 6	3 43 59	+79 33.5	10.794	0.005	0.672	0.010	0.207	0.016	0.615	0.007	0.995	0.010	2
G222- 1	4 3 26	+82 47.4	10.798	0.008	1.424	0.003	1.249	0.020	1.217	0.001	2.292	0.001	2
G247-14	4 7 35	+62 26.9	12.062	0.013	1.420	0.009	1.195	0.001	1.293	0.004	2.606	0.010	2
G 81-15	4 17 22	+45 42.3	9.886	0.009	0.621	0.006	0.039	0.011	0.560	0.003	1.023	0.035	3
G175-43	4 34 16	+51 4.4	10.363	0.011	0.770	0.000	0.388	0.007	0.693	0.003	1.202	0.001	2
G247-30	4 35 6	+67 29.6	10.744	0.016	1.254	0.004	1.299	0.041	1.062	0.000	1.873	0.000	2
G247-31J	4 36 7	+60 56.9	12.251	0.003	1.393	0.002	1.251	0.024	1.201	0.009	2.121	0.026	4
G247-38J	4 48 34	+69 9.5	9.781	0.000	0.714	0.010	0.206	0.012	0.595	0.000	1.014	0.001	3
G 96-13	4 55 45	+48 42.6	10.894	0.002	1.310	0.003	1.273	0.021	1.130	0.040	1.866	0.009	2*
G247-44	4 56 21	+61 3.2	10.148	0.004	1.036	0.018	0.899	0.010	0.871	0.010	1.553	0.012	5
G191-40	5 24 32	+52 10.5	11.138	0.006	0.862	0.020	0.588	0.003	0.729	0.002	1.231	0.003	2
G191-45	5 30 13	+51 11.0	11.073	0.020	1.449	0.018	1.200	0.021	1.257	0.039	2.385	0.040	3
G191-47	5 33 3	+52 29.7	10.140	0.036	1.132	0.004	0.960	0.010	0.952	0.020	1.638	0.029	2
G249-17	5 40 14	+67 46.6	10.957	0.007	1.077	0.003	1.063	0.008	0.864	0.015	1.404	0.010	4
G191-55	5 53 4	+58 40.4	10.487	0.005	0.516	0.009	-0.163	0.012	0.506	0.021	0.911	0.011	2*
G192-11	5 55 14	+58 35.5	10.269	0.009	1.516	0.020	1.247	0.008	1.323	0.012	2.462	0.030	2
G249-33	5 59 23	+64 45.1	10.931	0.026	0.546	0.000	0.001	0.005	0.530	0.003	0.941	0.008	3
G101-38	6 21 40	+48 45.5	10.852	0.010	1.079	0.038	0.884	0.006	0.879	0.021	1.507	0.012	3
G104-38	6 24 42	+24 21.3	9.361	0.004	0.815	0.013	0.417	0.007	0.623	0.003	1.057	0.009	2*
G101-42	6 26 18	+35 55.7	9.946	0.002	0.999	0.001	0.726	0.008	0.833	0.006	1.443	0.000	2*
G101-45A	6 31 43	+44 41.5	10.339	0.021	1.007	0.002	0.905	0.033	0.822	0.020	1.387	0.003	3
G101-45B			12.638	0.024	1.089	0.013	0.872	0.010	(0.7)		(1.6)		2
G101-47	6 34 36	+48 50.8	10.131	0.012	0.721	0.038	0.187	0.015	0.596	0.004	1.042	0.007	4
G107-19	6 43 48	+40 4.4	10.791	0.015	0.802	0.009	0.318	0.006	0.652	0.013	1.118	0.008	2*
G192-47	6 45 40	+55 56.5	10.388	0.013	1.277	0.003	1.191	0.038	1.050	0.017	1.815	0.001	3
G192-50	6 46 19	+53 11.7	9.834	0.016	0.955	0.012	0.781	0.009	0.766	0.001	1.103	0.018	3
G107-25	6 47 18	+48 6.9	9.789	0.016	0.858	0.005	0.637	0.014	0.665	0.004	1.116	0.007	3
G250-29	6 49 31	+60 56.5	11.015	0.039	1.522	0.011	1.210	0.024	1.487	0.005	3.209	0.016	2
G250-33	6 59 8	+68 21.6	11.953	0.014	1.527	0.012	1.247	0.022	1.489	0.011	3.167	0.022	2*
G250-34	7 2 45	+67 16.8	11.169	0.007	1.499	0.000	1.209	0.012	1.417	0.017	2.765	0.015	3
G193-37J	7 8 16	+52 21.6	11.282	0.011	1.492	0.013	1.210	0.019	1.333	0.020	2.735	0.003	3
G107-61	7 14 44	+39 22.0	10.298	0.000	1.508	0.009	1.198	0.001	1.299	0.011	2.556	0.025	2*
G250-44	7 18 38	+61 1.6	10.418	0.013	0.888	0.008	0.595	0.036	0.744	0.018	1.302	0.005	2
G193-49A	7 23 29	+52 32.3	11.365	0.018	0.896	0.020	0.458	0.043	0.672	0.005	1.153	0.007	2*
G193-49B			12.983	0.004	(1.2)		(1.4)		0.839	0.011	1.605	0.018	2
G251-36	7 26 1	+77 1.5	10.313	0.006	0.722	0.005	0.184	0.005	0.602	0.007	1.060	0.010	3
G193-52	7 29 38	+49 50.9	11.349	0.000	1.415	0.005	1.254	0.022	1.188	0.006	2.195	0.024	2*
G193-53	7 31 17	+52 55.5	11.061	0.001	1.110	0.002	0.972	0.007	0.927	0.005	1.559	0.005	2*
G193-54	7 31 48	+56 14.7	10.844	0.002	1.142	0.001	1.041	0.005	0.914	0.008	1.540	0.001	2*
G193-57	7 34 41	+54 32.9	9.934	0.005	0.871	0.036	0.545	0.007	0.726	0.014	1.233	0.041	2
G111-25	7 35 11	+41 4.0	10.714	0.001	1.123	0.002	0.995	0.005	0.923	0.030	1.534	0.000	2*
G193-58	7 36 39	+53 59.9	11.825	0.002	1.177	0.002	1.051	0.030	0.974	0.007	1.756	0.014	4
G234- 7	7 37 34	+60 41.1	9.694	0.001	0.704	0.003	0.187	0.010	0.569	0.005	0.974	0.002	2*
G111-28	7 38 55	+43 3.5	10.255	0.002	1.061	0.002	0.889	0.012	0.886	0.001	1.508	0.005	2*
G193-66	7 43 27	+50 57.8	11.359	0.002	0.965	0.000	0.748	0.037	0.822	0.005	1.432	0.005	3
G193-77	7 51 16	+51 59.7	10.186	0.001	0.941	0.001	0.648	0.018	0.731	0.002	1.244	0.010	2*
G111-45	7 54 10	+40 10.5	11.308	0.002	1.129	0.003	0.974	0.020	0.974	0.009	1.679	0.016	2*
G111-48	7 55 47	+45 33.2	10.082	0.000	0.868	0.004	0.485	0.004	0.689	0.005	1.181	0.002	2*
G 51- 8	8 18 28	+35 39.1	10.703	0.001	0.982	0.002	0.734	0.007	0.768	0.009	1.288	0.008	2*
G194-31	8 25 36	+55 17.6	11.972	0.003	1.237	0.013	1.035	0.029	1.058	0.007	1.880	0.016	3
G115-11	8 33 22	+39 13.0	11.795	0.003	1.294	0.009	1.069	0.011	1.082	0.009	1.930	0.029	3
G234-49	8 50 23	+63 57.0	11.059	0.012	1.423	0.014	1.249	0.005	1.196	0.023	2.183	0.024	2
G252-26	8 55 40	+70 52.2	10.651	0.015	0.931	0.001	0.599	0.031	0.782	0.003	1.351	0.003	3
G253-18	8 55 44	+78 42.0	12.332	0.017	0.838	0.012	0.325	0.016	0.745	0.002	1.285	0.000	3
G115-39	8 55 58	+36 38.4	11.849	0.001	1.447	0.012	1.195	0.017	1.210	0.024	2.352	0.001	3
G194-54	9 0 46	+51 30.6	10.977	0.006	0.827	0.008	0.325	0.007	0.672	0.009	1.202	0.000	2
G253-21	9 6 39	+84 23.2	12.163	0.028	1.466	0.012	1.145	0.000	1.316	0.011	2.683	0.022	3
G235-20	9 15 28	+62 16.1	11.416	0.001	1.586	0.027	1.145	0.024	1.526	0.026	2.548	0.003	2
G116-24	9 20 17	+36 56.9	11.354	0.011	1.236	0.000	1.210	0.011	1.043	0.007	1.733	0.006	2*
G116-27A	9 21 4	+40 17.4	10.543	0.016	1.149	0.001	1.089	0.015	0.957	0.001	1.607	0.005	3
G116-27B			14.588	0.000	0.647	0.019	0.020	0.007	0.543	0.000	0.850	0.013	3
G195-26	9 22 41	+51 51.9	10.270	0.016	0.930	0.004	0.740	0.022	0.760	0.000	1.278	0.004	3
G116-35	9 27 48	+32 55.5	10.185	0.007	0.769	0.001	0.241	0.011	0.620	0.000	1.061	0.002	3
G116-41	9 33 38	+35 2.5	10.507	0.018	0.606	0.003	0.002	0.011	0.524	0.004	0.907	0.004	3
G117-36J	9 40 39	+36 38.8	10.778	0.002	1.323	0.014	1.251	0.023	1.077	0.021	1.988	0.022	3
G 49-23	9 41 4	+27 12.1	12.073	0.015	1.523	0.023	1.237	0.025	1.496	0.023	3.225	0.023	4
G195-38	9 42 9	+52 26.1	10.365	0.001	0.753	0.002	0.295	0.010	0.581	0.005	0.996	0.005	2*
G235-40	9 44 28	+60 29.5	12.732	0.016	1.639	0.025	1.387	0.024	1.386	0.020	2.841	0.025	2*
G195-47	9 50 18	+50 59.1	12.031	0.009	1.511	0.001	1.250	0.035	1.312	0.011	2.674	0.001	3
G116-63	9 51 58	+40 37.1	11.393	0.004	1.373	0.021	1.254	0.004	1.119	0.007	2.084	0.009	2*
G 49-29	9 52 59	+26 55.6	12.063	0.010	1.136	0.009	1.118	0.032	0.964	0.008	1.704	0.009	4
G195-49	9 53 33	+52 15.1	9.908	0.004	0.818	0.000	0.473	0.010	0.620	0.003	1.081	0.001	2*
G236-12	10 0 15	+64 19.7	10.858	0.000	0.497	0.013	-0.085	0.006	0.462	0.010	0.822	0.006	2*
G116-77	10 3 43	+41 57.7	11.315	0.002	1.492	0.019	1.224	0.025	1.259	0.026	2.513	0.035	3
G196-10	10 9 13	+60 13.7	10.093	0.002	1.076	0.001	1.010	0.009	0.848	0.001	1.458	0.012	2*
G118-38	10 11 2	+34 24.8	10.667	0.008	0.970	0.009	0.752	0.021	0.770	0.003	1.337	0.014	2*
G118-54J	10 19 20	+37 4.4	10.914	0.005	0.890	0.001	0.603	0.011	0.698	0.001	1.227	0.015	2*
G146-41	10 30 21	+47 40.1	11.203	0.006	1.148	0.017	0.712	0.017	0.970	0.001	1.721	0.004	2*
G253-37	10 34 9	+76 26.1	10.730	0.002	1.235	0.008	1.203	0.020	1.048	0.004	1.802	0.001	2*
G254- 6	10 40 52	+72 48.2	10.995	0.007	1.365	0.012	1.301	0.018	1.159	0.011	2.089	0.002	2*
G236-44	10 51 32	+64 54.2	11.385	0.001	0.906	0.006	0.526	0.020	0.771	0.004	1.361	0.004	2*
G196-51	10 52 51	+56 18.1	12.731	0.003	1.539	0.015	1.094	0.000	1.357	0.011	2.845	0.035	3
G119-44	10 54 31	+27 29.2	11.131	0.005	0.669	0.006	0.046	0.013	0.547	0.000	0.982	0.012	2*
G254-10	10 55 0	+74 55.9	11.340	0.005	1.154	0.009	1.110	0.013	0.955	0.002	1.624	0.000	2*
G119-46	10 56 2	+35 19.6	11.131	0.012	1.119	0.015	0.992	0.011	0.966	0.010	1.751	0.013	5
G253-41	10 58 25	+79 30.2	11.772	0.002	0.463	0.034	-0.197	0.001	0.478	0.010	0.854	0.007	3
G176- 8	11 2 43	+45 16.9	11.096	0.025	1.483	0.011	1.293	0.004	1.300	0.010	2.423	0.005	3
G122- 2J	11 8 36	+43 41.7	10.940	0.003	1.504	0.008	1.240	0.008	1.476	0.010	2.817	0.002	2
G122- 7	11 12 36	+43 33.3	13.553	0.004	0.796	0.023	0.360	0.015	0.621	0.017	1.153	0.008	3
G176-25	11 18 12	+37 55.2	11.446	0.036	1.139	0.030	1.084	0.033	0.905	0.005	1.613	0.041	2
G122-22	11 21 15	+45 49.1	11.926	0.002	1.174	0.000	0.925	0.038	0.988	0.010	1.692	0.006	3
G197-14	11 24 26	+59 50.0	11.404	0.008	0.663	0.002	-0.063	0.005	0.523	0.019	0.814	0.008	2*
G197-18	11 28 33	+59 28.2	13.065	0.007	1.000	0.004	0.763	0.011	0.855	0.012	1.532	0.028	3
G122-30	11 31 56	+40 26.2	11.239	0.039	0.782	0.001	0.212	0.026	0.594	0.005	1.149	0.015	4
G237-25	11 37 10	+59 58.4	11.589	0.007	1.360	0.013	1.339	0.014	1.152	0.009	2.004	0.030	2*
G197-27	11 39 8	+59 6.4	11.691	0.022	1.391	0.005	1.138	0.018	1.162	0.000	2.022	0.007	2*

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TABLE II *(continued)*.

Giclas number	R.A. (1950)	DEC (1950)	V	error	B-V	error	U-B	error	V-R	error	V-I	error	Obs.
G122-44	11 42 51	+44 57.6	11.174	0.006	1.323	0.011	1.178	0.020	1.098	0.005	2.008	0.020	4
G236-82	11 45 17	+71 8.3	10.955	0.016	0.630	0.010	0.045	0.024	0.580	0.013	1.026	0.025	2‡
G237-32	11 45 18	+71 38.1	11.383	0.012	1.369	0.021	1.337	0.005	1.173	0.004	2.208	0.041	5
G254-31	11 46 20	+76 39.4	11.944	0.002	0.843	0.041	0.465	0.018	0.746	0.001	1.299	0.039	2‡
G197-38J	11 56 3	+59 50.0	11.028	0.007	1.338	0.018	1.148	0.020	1.158	0.019	2.208	0.027	3
G168-36	16 12 10	+20 49.0	11.396	0.010	1.319	0.005	1.270	0.039	1.177	0.012	2.237	0.009	2
G180-45	16 14 5	+35 56.5	9.617	0.008	1.227	0.011	1.356	0.019	1.004	0.003	1.622	0.025	2
G169-15A	16 28 48	+27 25.5	12.001	0.007	1.485	0.001	1.240	0.027	1.201	0.000	2.157	0.022	8
G169-15B			13.859	0.010	0.904	0.004	0.801	0.014	0.761	0.001	1.360	0.035	4
G138-44	16 33 59	+10 6.5	12.888	0.026	1.394	0.008	1.048	0.013	1.245	0.002	2.463	0.015	3
G138-54	16 39 16	+11 45.3	11.151	0.002	1.374	0.005	1.295	0.027	1.174	0.001	2.148	0.018	3
G169-24	16 40 47	+19 27.7	10.884	0.010	0.601	0.001	-0.040	0.005	0.590	0.002	1.012	0.005	3
G170-10A	17 0 53	+17 48.2	10.514	0.030	0.992	0.000	0.764	0.032	0.861	0.004	1.489	0.002	4
G170-10B			12.769	0.002	0.418	0.012	-0.111	0.007	0.359	0.017	0.732	0.007	2
G169-45A	17 3 19	+27 .1	10.004	0.006	0.567	0.001	0.022	0.043	0.466	0.013	0.763	0.004	3
G169-45B			13.342	0.017	0.778	0.014	(0.4)		0.711	0.002	1.209	0.001	3
G226-50	17 12 1	+59 7.3	9.952	0.007	1.116	0.000	0.965	0.023	0.940	0.010	1.636	0.000	3
G139-23	17 13 40	+11 7.0	10.819	0.009	1.378	0.002	1.271	0.010	1.321	0.003	2.628	0.011	2
G181-36	17 16 53	+34 47.6	10.695	0.003	0.759	0.002	0.237	0.034	0.579	0.000	0.868	0.044	3
G181-40	17 18 48	+28 27.8	11.217	0.004	1.052	0.002	0.997	0.018	0.860	0.006	1.351	0.011	3
G226-55	17 19 1	+53 52.8	11.243	0.000	1.145	0.003	1.151	0.035	1.042	0.026	1.913	0.012	4
G181-41	17 20 56	+28 51.4	9.631	0.011	0.804	0.001	0.620	0.020	0.675	0.002	1.129	0.001	2
G182-15	17 30 48	+33 36.1	10.207	0.003	0.956	0.002	0.934	0.032	0.821	0.002	1.413	0.000	2
G170-59	17 38 51	+26 27.9	9.741	0.009	0.862	0.001	0.720	0.020	0.743	0.002	1.269	0.000	2
G204-30	17 48 17	+37 32.2	10.215	0.011	0.565	0.001	0.014	0.003	0.520	0.004	0.923	0.016	2
G227-18	17 50 58	+54 37.4	10.587	0.002	0.945	0.015	0.993	0.017	0.803	0.014	1.335	0.002	3
G227-20	17 52 0	+64 46.9	11.149	0.001	1.370	0.026	1.293	0.027	1.237	0.002	2.367	0.023	2
G182-33A	17 54 0	+33 25.7	10.164	0.009	1.185	0.008	1.268	0.030	0.992	0.001	1.800	0.009	2
G182-33B			13.312	0.027	1.435	0.008	0.997	0.022	1.432	0.023	2.942	0.030	2
G204-40	17 58 1	+49 2.0	11.570	0.037	1.495	0.034	1.195	0.032	1.268	0.032	2.408	0.014	3
G258-26J	17 58 56	+71 59.4	10.805	0.008	1.073	0.001	1.110	0.001	0.973	0.013	1.613	0.020	2
G206- 9	18 6 3	+32 7.0	9.581	0.009	0.730	0.002	0.406	0.012	0.626	0.004	1.061	0.008	2
G183-28	18 7 50	+16 1.4	11.421	0.026	0.628	0.005	0.030	0.013	0.573	0.008	1.034	0.013	2
G182-42	18 9 16	+32 40.1	10.479	0.008	1.000	0.014	0.903	0.007	0.856	0.011	1.483	0.001	2
G228-20	18 9 42	+49 57.7	9.914	0.004	1.282	0.022	1.246	0.038	1.073	0.012	1.821	0.011	2
G205-20	18 23 51	+38 19.9	11.278	0.006	1.442	0.011	1.186	0.003	1.265	0.003	2.427	0.004	4
G206-35	18 35 51	+34 38.8	10.784	0.002	1.336	0.030	1.218	0.008	1.123	0.013	2.115	0.002	2
G184-20	18 41 38	+15 57.7	12.582	0.005	0.671	0.014	0.008	0.002	0.643	0.007	1.166	0.009	2
G229-18	18 55 13	+54 28.0	10.409	0.005	1.341	0.005	1.388	0.006	1.153	0.011	2.109	0.005	2
G141-52	18 57 13	+ 7 55.1	10.860	0.008	1.431	0.001	1.262	0.003	1.212	0.002	2.353	0.010	2
G205-53	18 58 59	+45 37.4	11.219	0.004	0.902	0.000	0.532	0.015	0.705	0.004	1.159	0.000	2
G185-10	19 10 3	+24 2.8	11.223	0.012	1.410	0.000	1.308	0.031	1.179	0.005	2.158	0.002	6
G142-17	19 11 46	+11 43.5	10.840	0.003	0.694	0.002	0.200	0.013	0.616	0.000	1.041	0.018	3
G207-23	19 14 28	+36 58.8	11.086	0.001	0.664	0.001	0.020	0.003	0.576	0.012	1.073	0.018	5
G142-32	19 26 23	+18 9.6	9.920	0.004	0.757	0.001	0.387	0.019	0.676	0.003	1.186	0.002	2
G260-27	19 35 28	+69 49.1	9.793	0.007	0.595	0.006	0.079	0.008	0.556	0.002	0.937	0.009	2
G208-32	19 36 22	+44 52.3	9.603	0.009	0.488	0.008	-0.073	0.004	0.500	0.011	0.871	0.001	2
G260-28	19 37 34	+70 37.6	9.984	0.002	0.881	0.004	0.494	0.027	0.722	0.004	1.199	0.030	3
G260-29	19 38 9	+62 30.7	10.399	0.010	0.767	0.024	0.527	0.028	0.686	0.023	1.127	0.040	2
G260-30	19 40 5	+71 45.4	10.920	0.005	1.542	0.013	1.254	0.000	1.257	0.000	2.423	0.009	2
G260-40	20 1 6	+63 24.2	10.035	0.002	0.895	0.009	0.804	0.029	0.743	0.000	1.236	0.001	2
G230-35	20 18 56	+52 4.1	9.960	0.003	1.081	0.002	1.205	0.009	0.937	0.019	1.653	0.000	2
G210-18	20 21 27	+33 19.7	11.543	0.005	0.948	0.006	0.811	0.002	0.805	0.021	1.394	0.005	2
G187- 2	20 40 52	+26 37.8	10.795	0.018	1.083	0.002	0.793	0.030	0.929	0.003	1.699	0.003	3
G262-27	20 47 28	+70 44.6	10.760	0.028	1.365	0.032	1.272	0.007	1.150	0.007	2.163	0.004	5
G187- 7	20 47 32	+26 45.0	10.526	0.000	1.027	0.003	0.818	0.035	0.871	0.000	1.528	0.021	3
G212- 7	20 53 27	+42 6.8	10.274	0.017	0.606	0.011	-0.103	0.023	0.561	0.002	0.983	0.013	2
G210-40	20 54 8	+38 39.4	11.595	0.007	1.274	0.005	1.289	0.037	1.128	0.034	2.152	0.033	2
G210-42	20 54 38	+34 47.4	10.793	0.016	1.042	0.035	1.015	0.028	0.923	0.007	1.632	0.001	4
G144-61	21 2 52	+19 24.5	11.610	0.000	1.244	0.004	1.097	0.033	1.091	0.015	2.030	0.004	3
G261-37	21 8 39	+80 35.3	10.841	0.021	1.260	0.005	1.270	0.031	1.098	0.020	1.980	0.026	3
G187-29	21 8 47	+29 13.3	11.072	0.010	1.337	0.001	1.224	0.041	1.313	0.011	2.595	0.012	3
G187-30A	21 9 12	+33 19.1	11.619	0.016	0.923	0.012	0.625	0.003	0.845	0.003	1.513	0.011	2
G187-30B			13.876	0.008	(1.3)		(1.6)		1.020	0.001	1.695	0.000	3
G187-30C			13.417	0.008	1.174	0.002	1.426	0.003	0.906	0.004	1.594	0.009	2
G187-30D			14.875	0.003	0.588	0.037	(0.1)		0.619	0.006	(1.0)		2
G187-30E			14.870	0.023	0.721	0.001	0.180	0.035	0.642	0.010	1.069	0.025	3
G187-30F			14.235	0.017	1.051	0.023	0.832	0.034	0.825	0.005	1.442	0.035	3
G187-30G			15.630	0.006	0.773	0.000	0.195	0.038	0.731	0.025	(1.2)		2
G145-26	21 11 44	+14 44.6	10.333	0.002	0.942	0.007	0.873	0.004	0.798	0.004	1.356	0.005	2
G187-41	21 19 52	+30 53.2	10.670	0.002	1.210	0.001	1.243	0.010	1.041	0.005	1.873	0.004	2
G212-35	21 23 43	+42 47.2	12.193	0.034	1.320	0.002	1.353	0.034	1.127	0.004	2.002	0.043	2
G126- 3	21 26 48	+19 16.0	10.869	0.003	1.323	0.037	1.389	0.020	1.091	0.007	1.965	0.009	2
G213- 3	21 28 47	+36 40.0	10.658	0.005	1.034	0.004	1.105	0.031	0.934	0.006	1.588	0.029	2
G126-17	21 36 11	+18 48.6	10.299	0.007	0.732	0.016	0.353	0.021	0.631	0.000	1.078	0.002	2
G213- 9	21 38 9	+36 50.0	11.436	0.025	1.365	0.006	1.247	0.017	1.233	0.036	2.326	0.014	2
G126-26	21 40 11	+17 36.9	10.934	0.004	1.169	0.014	1.204	0.001	0.989	0.002	1.710	0.009	3
G232-58A	22 8 0	+52 20.7	9.557	0.012	0.881	0.000	0.745	0.008	0.752	0.000	1.309	0.002	4
G232-58B			14.129	0.007	0.399	0.004	(0.2)		(0.3)		0.858	0.020	2
G127-29	22 22 32	+17 2.2	10.357	0.002	0.954	0.007	0.894	0.015	0.833	0.005	1.400	0.006	2
G127-31	22 23 51	+21 16.8	9.942	0.016	0.744	0.044	0.183	0.021	0.616	0.012	1.031	0.010	2‡
G241- 8	22 24 53	+63 37.4	9.496	0.031	1.102	0.011	1.166	0.015	0.965	0.020	1.656	0.003	2
G232-74	22 26 7	+59 29.5	10.651	0.028	1.076	0.012	1.214	0.012	0.945	0.023	1.605	0.008	2
G127-35	22 26 21	+18 40.6	10.727	0.006	1.359	0.002	1.312	0.000	1.233	0.017	2.354	0.008	2
G242- 3	22 34 13	+74 25.7	12.002	0.003	1.448	0.019	1.364	0.039	1.244	0.003	2.242	0.036	2‡
G233-25	22 37 29	+57 3.9	10.736	0.007	1.281	0.004	1.283	0.008	1.085	0.002	1.958	0.002	2
G127-62	22 51 36	+26 41.4	11.410	0.012	1.141	0.007	1.113	0.029	1.058	0.018	1.943	0.003	2
G128-21	22 54 19	+29 14.2	10.390	0.006	1.232	0.006	1.226	0.038	0.977	0.006	1.653	0.005	2‡
G190- 5	22 57 21	+40 47.2	10.992	0.020	1.195	0.002	1.264	0.010	1.011	0.010	1.775	0.018	2
G189-55	22 57 28	+35 42.0	11.316	0.021	1.233	0.002	1.320	0.004	1.055	0.006	1.903	0.010	2
G233-40	23 2 18	+56 58.1	11.140	0.006	1.194	0.018	1.161	0.014	0.988	0.001	1.793	0.035	2
G128-31	23 3 13	+28 39.4	10.099	0.021	0.689	0.003	0.254	0.004	0.603	0.003	1.043	0.013	2
G190- 9	23 3 43	+42 3.7	11.166	0.008	1.385	0.000	1.345	0.005	1.112	0.014	1.920	0.017	2‡
G128-38A	23 9 39	+26 39.5	9.552	0.009	1.048	0.005	0.762	0.032	0.868	0.028	1.601	0.017	2‡
G128-38B			12.837	0.060	0.650	0.001	0.243	0.020	0.588	0.008	1.022	0.008	2
G216-32	23 10 5	+51 49.2	9.486	0.007	0.802	0.027	0.604	0.012	0.673	0.001	1.217	0.005	2
G242-33	23 21 46	+72 31.8	11.472	0.006	1.204	0.021	1.099	0.001	0.937	0.002	1.584	0.001	2‡
G128-61	23 23 26	+28 55.4	11.043	0.002	0.975	0.005	0.731	0.021	0.819	0.000	1.402	0.001	2
G242-35	23 29 49	+81 8.1	10.192	0.028	0.768	0.009	0.460	0.008	0.715	0.005	1.189	0.025	3
G171- 5	23 33 15	+41 41.3	11.169	0.010	1.372	0.014	1.273	0.013	1.299	0.003	2.572	0.023	2
G128-84	23 33 57	+32 45.7	10.117	0.002	0.930	0.007	0.621	0.011	0.741	0.005	1.268	0.014	2‡
G217-13	23 34 0	+55 13.2	11.718	0.003	1.461	0.005	1.189	0.013	1.321	0.005	2.717	0.024	3
G131- 6A	23 55 57	+23 55.5	11.680	0.005	1.332	0.009	1.261	0.038	1.107	0.011	2.015	0.031	3
G131- 6B			14.655	0.026	(1.6)		(0.9)		(1.5)		(3.3)		2
G171-34	23 57 41	+38 46.1	10.738	0.008	0.819	0.009	0.353	0.014	0.678	0.014	1.183	0.014	2‡
G130-34	23 58 49	+34 .3	11.278	0.019	1.308	0.004	1.326	0.022	1.167	0.010	2.177	0.011	2
G129-57	23 59 15	+21 11.0	10.345	0.013	1.019	0.009	0.772	0.040	0.833	0.011	1.443	0.000	2‡

TABLE II (continued).

REMARKS:

G072-15	ρ = 25", θ = 160°
G078-12	ρ = 13", θ = 200°
G101-45	ρ = 15", θ = 90°
G116-27	ρ = 23", θ = 225°
G117-36	θ = 170°
G118-54	Multiple system: Photometry of (A+B) being: ρ = 8", θ = 110° Separation between A and C: ρ = 12", θ = 280°
G122-02	ρ = 8"
G128-38	ρ = 12", θ = 80°
G131-06	ρ = 12", θ = 260°
G169-15	ρ = 17", θ = 0°
G169-45	ρ = 20"
G170-10	ρ = 26"
G173-52	The five components of this multiple system are inside a radius of 63"
G187-30	All the components of this multiple system are inside a radius of 44"
G193-37	ρ < 3", θ = 180°
G193-49	ρ = 15", θ = 85°
G197-38	ρ = 5", θ = 300°
G217-30	ρ = 15", θ = 320°
G217-40,41	ρ = 15", θ = 350°
G219-15	ρ = 7", θ = 130°
G219-28	ρ = 8", θ = 220°
G232-58	ρ = 21", θ = 270°
G245-71	ρ = 10", θ = 150°
G246-48	ρ = 40", θ = 0°
G247-31	ρ = 5", θ = 210°
G247-38	ρ = 8", θ = 280°

TABLE III. — *Accuracies from external comparisons with other observers, in the sense our values minus other values. σ is the standard deviation of a single comparison.*

	Mean	σ	Number of stars
Sandage and Kowal (1986)			
ΔV	0.000 ± 0.009	0.042	21
$\Delta (B-V)$	0.008 ± 0.009	0.041	21
$\Delta (U-B)$	0.039 ± 0.009	0.041	21
Carney and Latham (1987)			
ΔV	0.002 ± 0.009	0.043	21
$\Delta (B-V)$	−0.003 ± 0.006	0.029	21
$\Delta (U-B)$	0.009 ± 0.008	0.036	21
Weis (1984,1986 and 1987)			
ΔV	−0.022 ± 0.006	0.031	32
$\Delta (V-R)$	−0.019 ± 0.006	0.032	32
$\Delta (V-I)$	0.011 ± 0.009	0.050	32

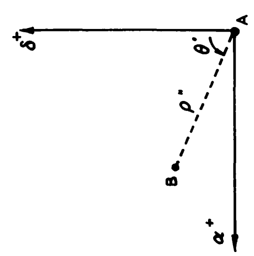

FIGURE 2. — Adopted parameters to define a double system.

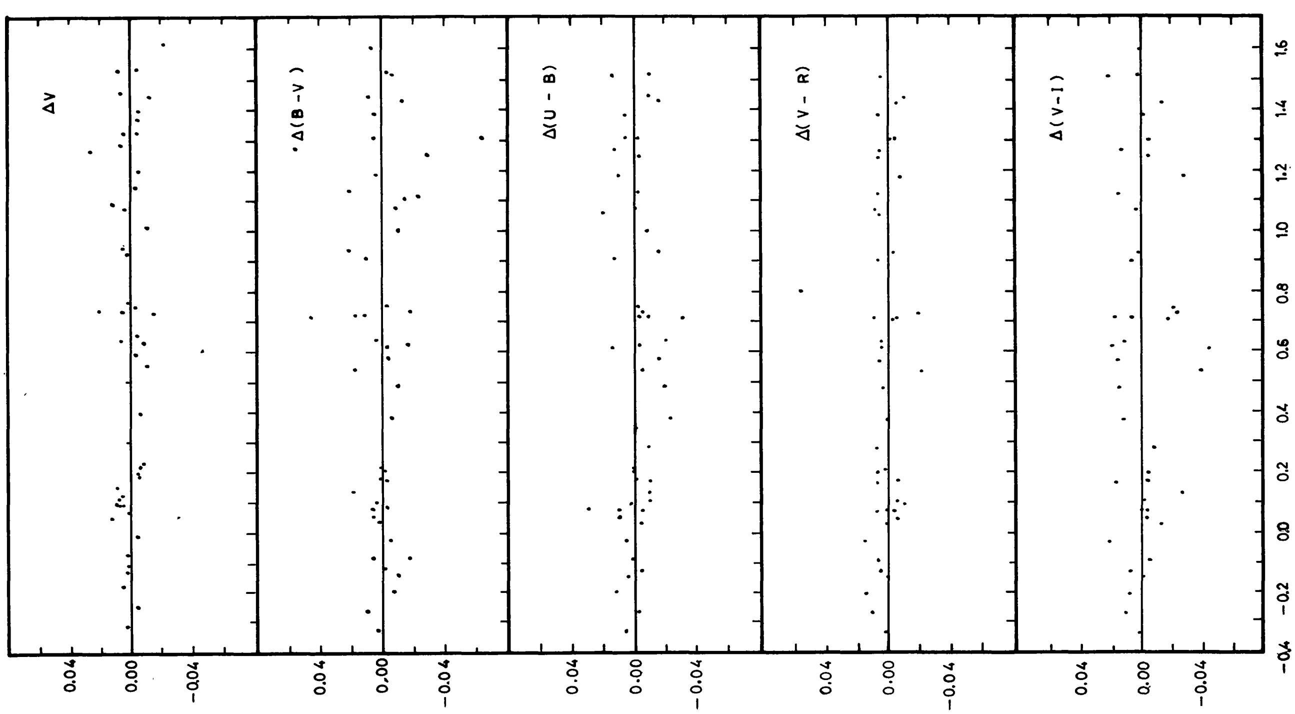

FIGURE 1. — Mean residuals (observed-catalogued) for standard stars as a function of $(B-V)$.