

(1)

4th 7/1
646 8 50
June Report
(44)

AD 740858

FOUR-COLOR AND H β PHOTOMETRY
FOR THE BRIGHTER A0 TYPE STARS

Partially Supported by ONR
Under Contract No. 00014-67-C-0176

Produced by
NATIONAL TECHNICAL
INFORMATION SERVICE

PROD
MAY 2 1972
C

FOUR-COLOR AND $H\beta$ PHOTOMETRY
FOR THE BRIGHTER A0 TYPE STARS

D. L. Crawford, J. V. Barnes, J. Gibson*,
J. C. Golson, C. L. Perry**, and M. L. Crawford
Kitt Peak National Observatory†, Tucson, Arizona

*Now at Yale University Observatory

**Now at Louisiana State University

†Operated by the Association of Universities for Research in
Astronomy, Inc., under contract with the National Science
Foundation.

ABSTRACT

Intermediate and narrow-band photoelectric photometry is presented for 572 A0-type stars brighter than $m_v = 6.5$.

I. INTRODUCTION

The problem of spectral or photometric classifications of stars is difficult near the region of maximum hydrogen absorption. The spectrum is rather weak in features except for the hydrogen lines and the Balmer discontinuity, and both of these features pass through a maximum near A0. Hence, it is often difficult to distinguish a late B star from an early A star, especially when interstellar reddening affects the observed color. When no such interstellar reddening is present, the observed color, such as B-V, is a good parameter sensitive to temperature. Spectral type (a temperature parameter) is determined by recognizing the increasing strength of the metal lines in general, and that the helium lines have weakened to indetectability by the early A stars. As the metal lines are so weak, luminosity class is determined primarily by the shape and strength of the hydrogen lines. Peculiarities are evident in about 15% of the stars (Eggen, 1967) and cause classification problems, of course. Even without these peculiarities, it has often proven difficult to detect differences between B9V, A2V, and A0III, for example (Osawa, 1959). We will dwell no longer on the classification problems here, but clearly this region of the HR diagram is and has been important, and needs to be further studied in detail.

For these reasons, we have, over the past years, been engaged in photoelectric photometry of the brighter field stars listed as

A0 in the earlier edition of the Bright Star Catalog (Schlesinger and Jenkins 1940). Not all of these stars are so classified in the new edition (Hoffleit 1964), or in other sources (Jaschek et al. 1964). We have used the earlier edition as the source of our observing list, however. The Strömgren-Perry Catalog of uvby photometry for A2-G0 type stars, and the extension to H β photometry by Crawford et al. (1966) used the same edition as their source list. Separate observing programs on earlier type stars are nearly finished, in two sections: O-B5 and B8-B9, and extensions to the southern hemisphere are under way also. The results for the southern stars brighter than $m_v=5.0$ have been published by Crawford et al. (1970). Material for the southern O-B5 stars is in press.

Much of the current program results from the effort begun by Dr. B. Strömgren, already in 1961, to investigate this region of the HR diagram in depth. Calibrations resulting from the preliminary data have been discussed by Strömgren (1963, 1966). An extension of that calibration, based on material in the present paper, is underway by Crawford and Glaspey.

Photometry for the early A stars, on systems similar to the uvby, 8 system, has been published by Johansen and Gylderkerne (1970) and will be compared to the present data in the next section. They conclude, by comparing their photometry with available uvby, 8 photometry, that their data could be satisfactorily transferred to

β , $b-y$, and c_1 , especially for a limited spectral region. The transformation to m_1 was not so satisfactory. Based on this information, we concentrated more on the four-color work than on the $H\beta$ work for the A0-type stars.

II. THE OBSERVATIONS

The final data resulting from the photometry at Kitt Peak are listed in Table I. The first two columns give the HR number (Bright Star Catalog, Hoffleit 1964) and the HD number. The latter is given to make the table more convenient to the user. An asterisk after the HR number denotes a remark at the end of the table.

The columns headed $(b-y)$, m_1 , c_1 , and n list the uvby photometry: $(b-y)$ is the color index, $m_1 = (v-b) - (b-y)$ is the metallic line index, $c_1 = (u-v) - (v-b)$ is the Balmer discontinuity index, and n is the number of observations. An occasional night was given half-weight; hence, non-integral values of n .

Observations were obtained at both 16-inch telescopes (No. 3 and No. 4) and both 36-inch telescopes (No. 1 and No. 2) at Kitt Peak. Several different filters were used as well as different amplifier and recording systems, including digital read-out on punched paper-tape. The reductions were done with the aid of currently available four-color reduction programs and the observatory's CDC-6400 computer. Details of the system and the reductions have been described by Crawford and Barnes (1970). The standard

stars of that paper were used throughout the A0 star program. Most all of the uvby data was obtained in the period from 1965 to 1970, with the majority in 1967 and 1968.

Mean errors of one observation, as determined from the internal scatter of the observations, are $\pm 0^m.008$ in $(b-y)$, $\pm 0^m.011$ in m_1 , and $\pm 0^m.011$ in c_1 . In all, there are 2570 measures on 572 stars, an average of 4.5 per star.

The $H\beta$ measures are given in the column headed $\beta(KP)$, and $n(KP)$ is the number of measures. The observations were reduced to the standard system of Crawford and Mander (1966). The mean error of one observation was calculated to be $\pm 0^m.013$. There are 1616 measures on 526 stars for an average of 3.1 per star.

Since it appeared early in our program that the Johansen and Gylderkerne (1970) $H\beta$ data could be adequately transferred to the β system (we are most grateful to them for making preliminary lists and preprints of their work available to us), we tailored our $H\beta$ program to complement theirs. As their four-color filters were not well matched to the uvby system, we did not complement their four-color program, even though transformations might well be possible over a limited spectral range. A comparison of our $(b-y)$ and c_1 values with those derived by Johansen and Gyldenkerne from their data indicates that a transformation of their data to our system is possible with a mean error for one star of $\pm 0^m.008$ in

(b-y) and ± 0.011 in c_1 , if we omit values for about 15% of the stars. That confirms, we believe, that over a limited spectral range transformations are possible even if the filter systems differ a great deal. Caution is in order, though, for the range is limited, and measures for non-typical (non-main sequence "normal" A0 type) stars do not transfer well (such as supergiants, Ap stars, stars outside of the usable range, etc.).

The situation for the β index is more straightforward, however. For the stars in common to the two lists, the mean error, for one star, in the difference is ± 0.014 . Only six differences are larger than 0.030 , and the average difference in the β values between the two lists is 0.001 . However, there appears to be a slight trend with right ascension, and for the twelve H β standard stars with data in their table the average difference is 0.009 ± 0.009 (one star). So, even with the β photometry, some caution is in order. Nevertheless, in order to have both more completeness and more weight in the final β values, we have averaged the β values from the two lists. Even in the worst cases, little error will be introduced into the final average, we believe. In taking the average, we have assigned weights of the number of observations, $n(KP)$, to the Kitt Peak data and $n=2$ to the Johnsen-Gyldenkerne data. The weighted average is given in the column headed β (Avg) in Table I. If only one measure is available, we have entered the β value in parenthesis.

We recommend these averaged values be used in further analysis with the data.

In the forthcoming paper by Crawford and Glaspey, we will present the comparison of the uvby data given in Table I to UBV photometry and MK types, and discuss the calibration of the data in terms of absolute magnitude and intrinsic color. A comparison will also be made to previous work on similar stars, such as Cameron's (1966) study of Ap and Am stars, data for some of which are included in Table I. Inspection of Table I will indicate numerous other stars of special interest as well, such as supergiants, reddened stars, and stars whose indices are discordant with their spectral types. As an aid to the user, we show the relation between several of the indices in Figures 1, 2, 3, and 4. The lines drawn in the figure should be indicative of the relation for unreddened stars near the zero-age main sequence.

We wish to express our thanks to Dr. B. Strömgren for his advice and encouragement throughout the program; to Miss Karen Johansen for allowing us to inspect her data in advance of publication; and to the Office of Naval Research, Washington, D.C. and The Carlsberg Foundation, Copenhagen, Denmark, for their financial support of the program.

REFERENCES

- Cameron, R. C. 1966, An Investigation of the Magnetic and Related Stars Through Photoelectric Narrow-Band Photometry, Georgetown Observatory Monograph No. 21.
- Crawford, D. L., and Barnes, J. V. 1970, Astron. J., 75, 978.
- Crawford, D. L., Barnes, J. V., Faure, B. Q., Golson, J. C., and Perry, C. L. 1966, Astron. J., 71, 709.
- Crawford, D. L., Barnes, J. V., and Golson, J. C. 1970, Astron. J., 75, 624.
- Crawford, D. L., and Mander, J. 1966, Astron. J., 71, 114.
- Eggen, O. J. 1967, The Magnetic and Related Stars, R. C. Cameron, Ed. (Mono Book Corp., Baltimore), p. 141.
- Hoffleit, D. 1964, Catalogue of Bright Stars (Yale Univ. Obs., New Haven, Conn.), 3rd rev. ed.
- Jaschek, C., Conde, H., and Sierra, A. 1964, Catalogue of Stellar Spectra Classified in the Morgan-Keenan System (La Plata Obs.)
- Johansen, K. T., and Gyldenkerne, K. 1970, Astronomy and Astrophysics Supplement Series, Vol. 1, 165.
- Osawa, K. 1959, Astrophys. J., 130, 159.
- Schlesinger, F., and Jenkins, L. F. 1940, Catalogue of Bright Stars (Yale University Observatory, New Haven, Conn.), 2nd ed.
- Strömgren, B. 1963, Basic Astronomical Data, K. Aa. Strand, Ed. (University of Chicago Press, Chicago), p. 123.
- 1966, Annual Review of Astronomy and Astrophysics, L. Goldberg, Ed. (Annual Reviews, Inc.), Vol. 4.

TABLE I. Photometry of A0 stars.

HR	HD	b-y	m_1	c_1	n	β (KP)	n(KP)	β (Avg)
1	3	0 ^m .042	0 ^m .155	1 ^m .120	3	2 ^m .860	3	2 ^m .860
44	952	.001	.160	0.989	3	2.881	1	2.885
49	1048	.001	.149	1.070	3	2.868	1	2.890
53	1083	- .005	.149	1.034	3	2.866	2	2.863
56	1185	.013	.186	1.047	3	2.899	2	2.896
62	1279	- .020	.092	0.588	5	2.675	5	2.675
70	1438	- .033	.118	0.677	4	2.751	6	2.751
71	1439	- .004	.137	1.069	5			2.842
76	1561	.027	.135	1.182	3	2.845	2	2.845
93	2011	.039	.090	0.923	7	2.761	4	2.761
96	2054	- .022	.123	0.693	5	2.775	5	2.775
128	2888	.003	.139	0.784	4	2.822	3	2.822
129	2904	- .011	.148	1.037	3	2.846	3	2.846
132	2913	.001	.137	0.827	3			2.834
133	2924	.046	.161	1.193	3	2.886	2	2.885
149	3322	- .024	.109	0.577	3	2.734	3	2.734
196	4222	.007	.164	1.121	4			2.873
234	4778	- .021	.243	0.873	4	2.862	3	2.862
241	4881	.048	.108	1.083	3	2.796	3	2.796
246	5066	.025	.145	1.165	3	2.870	3	2.870
250	5128	.071	.266	0.941	3	2.861	3	2.861
278	5715	.055	.203	1.028	3	2.880	3	2.880
310	6456	.000	.165	0.938	3	2.870	3	2.866
311	6457	- .021	.145	0.869	4	2.855	3	2.851
317	6530	- .004	.159	1.104	3	2.872	1	(2.872)
333	6798	- .010	.189	1.059	3	2.908	3	2.909
336	6829	- .022	.149	1.056	3	2.846	3	2.846
384	8003	.045	.195	0.997	2	2.886	3	2.886
395	8374	.164	.232	0.746	3			2.809
398	8424	- .007	.135	1.012	4	2.818	3	2.818
428	9030	.025	.193	0.991	3	2.895	3	2.895
444	9484	- .025	.151	0.940	3	2.863	1	(2.863)
465	9996	- .055	.213	0.915	4	2.855	3	2.855
478	10221	- .055	.181	0.773	4	2.782	3	2.772
480	10250	- .018	.151	1.021	4			2.876
502	10587	.033	.163	1.137	4	2.862	3	2.862
522	10982	- .019	.149	0.880	3	2.887	1	2.876
538	11335	.026	.164	1.145	3	2.876	2	2.890
545/6	11502/3	- .046	.200	0.882	3	2.849	3	2.849
567	11946	- .008	.148	1.054	5			2.851
597	12467	.061	.181	0.979	3			2.868
598	12468	- .022	.184	0.970	3	2.905	3	2.905
613	12869	.055	.228	0.944	4	2.906	2	2.902
641	13476	.477	- .066	1.201	4	2.638	3	2.638
655	13869	- .002	.143	1.005	4	2.857	2	2.849

TABLE I (continued)

HR	HD	b-y	m ₁	c ₁	n	$\beta'(\text{KP})$	n(KP)	$\beta(\text{Avg})$
658	13936	0. ^m 007	0. ^m 125	1. ^m 113	3	2. ^m 798	3	2. ^m 798
664	14055	.005	.166	1.048	3	2.889	2	2.890
668	14171	- .012	.157	0.989	3	2.884	3	2.884
669	14191	.015	.143	1.114	4	2.859	2	2.860
670	14212	- .009	.167	1.044	6	2.895	2	2.894
682	14392	- .037	.133	0.571	3	2.770	2	2.764
704	15004	.001	.123	1.061	3	2.785	3	2.795
718	15318	- .030	.148	0.971	3	2.862	5	2.858
769	16350	- .009	.138	1.052	3	2.839	4	2.839
793	16811	- .007	.142	0.986	4	2.866	2	2.864
797	16861	.031	.185	1.023	3	2.918	3	2.918
815	17138	.072	.196	0.929	5	2.882	4	2.882
830	17471	- .014	.135	0.957	4	2.831	2	2.826
839	17581	.056	.206	0.959	3	2.899	4	2.899
873	18296	- .025	.192	0.678	5	2.769	3	2.767
891	18538	- .007	.150	0.857	3	2.843	3	2.843
933	19279	.063	.182	1.028	4	2.848	3	2.848
945	19600	.017	.145	1.051	3	2.879	3	2.879
954	19832	- .054	.132	0.552	3	2.760	2	2.752
964	20041	.596	- .149	0.741	4	2.584	3	2.585
971	20149	.014	.150	1.071	4	2.894	2	2.877
972	20150	- .014	.158	1.105	4	2.888	3	2.882
979	20283	- .011	.145	0.846	3	2.825	3	2.825
986	20346	.012	.181	1.171	3	2.877	2	2.875
1019	20995	- .014	.152	0.849	3	2.846	4	2.846
1026	21038	.024	.140	1.064	3	2.849	3	2.849
1033	21203	.041	.104	0.696	5	2.791	4	2.791
1039	21379	- .019	.160	0.935	4	2.878	5	2.878
1040	21389	.468	- .092	0.548	4	2.568	2	2.557
1041	21402	.009	.184	1.088	3	2.883	1	2.889
1055	21610	.001	.168	1.019	3	2.862	2	2.862
1056	21620	.047	.142	1.109	4	2.853	2	2.853
1061	21686	- .019	.138	1.004	7	2.855	1	2.836
1078	21912	.056	.228	0.936	4	2.876	1	2.882
1091	22243	.001	.168	1.069	3	2.890	3	2.890
1103	22615	.080	.197	1.093	3	2.880	3	2.880
1118	22805	.062	.153	1.139	5	2.887	3	2.887
1148	23401	.028	.156	1.220	4	2.836	2	2.830
1192	24141	.077	.256	0.875	4			2.890
1224	24817	.023	.189	1.021	5	2.882	2	2.884
1229	24982	.078	.122	1.143	2	2.848	3	2.848
1251	25490	.004	.184	1.086	5	2.900	6	2.894
1261	25642	.010	.116	1.152	6	2.796	4	2.791
1268	25823	- .068	.131	0.487	4	2.726	2	2.715
1341	27309	- .090	.192	0.566	3	2.769	Std	2.769

TABLE I (continued)

HR	HD	b-y	m ₁	c ₁	n	R(KP)	n(KP)	R(Avg)
1352	27402	0.049	0.187	1.099	3	2.862	3	2.862
1382	27855	.061	.108	1.153	4	2.818	3	2.818
1440	28780	-.015	.154	1.111	3	2.878	1	2.867
1448	28978	.035	.156	1.175	3	2.888	2	2.884
1460*	29173	.048	.216	0.970	3	2.867	2	2.867
1482	29526	-.020	.172	1.024	3	2.882	1	2.892
1490	29646	-.011	.175	1.038	3	2.909	2	2.906
1494	29722	.000	.175	1.058	5	2.868	1	2.889
1519	30210	.091	.251	0.953	3	2.847	9	2.848
1544	30739	.010	.152	1.108	4	2.841	5	2.840
1550	30823	.087	.125	1.299	3	2.850	1	2.825
1555	30958	.028	.120	1.031	3	2.824	1	2.817
1570	31295	.042	.184	1.001	4	2.909	5	2.907
1578	31411	.019	.169	0.934	3	2.867	3	2.867
1592	31647	.008	.182	0.953	4	2.902	2	2.904
1596	31739	.048	.194	1.083	3	2.864	3	2.864
1609	32039	-.011	.122	0.816	3	2.778	2	2.778
1610	32040	-.017	.110	0.702	3	2.762	3	2.762
1615	32188	.170	.061	1.496	3	2.757	3	2.757
1643	32650	-.076	.150	0.689	3	2.753	4	2.761
1650	32781	-.006	.149	0.965	4	2.861	3	2.861
1675	33266	-.002	.175	1.124	3	2.821	1	2.861:
1683	33541	-.029	.171	0.891	3	2.887	1	2.879
1692	33654	.094	.086	1.311	3	2.794	3	2.794
1704	33948	-.061	.117	0.400	3	2.718	3	2.718
1711	34053	.051	.160	1.159	3	2.883	3	2.883
1714	34109	-.005	.161	1.109	3	2.880	3	2.880
1718	34203	.004	.145	1.090	6	2.879	3	2.873
1732	34452	-.126	.178	0.348	5	2.707	1	2.703
1751	34787	-.006	.134	1.081	4	2.814	1	2.806
1752	34790	.019	.194	1.015	3	2.904	3	2.902
1777	35242	.063	.183	0.991	3	2.869	3	2.869
1778	35281	-.023	.134	0.576	3	2.759	3	2.759
1795	35520	.144	.076	1.320	3	2.758	1	2.760
1814	35770	.039	.099	1.009	3	2.781	3	2.777
1821	35943	-.015	.148	0.808	3	2.833	3	2.833
1850	36484	.037	.222	1.010	3	2.886	3	2.886
1945A	37646	-.043	.124	0.598	3	2.764	3	2.764
1945B	37647	-.015	.151	0.889	2	2.891	2	2.891
1971	38104	.010	.176	1.121	3			2.872
2027	39220	.003	.158	1.168	4	2.848	2	2.850
2034	39357	.060	.136	1.153	Std	2.854	0	2.854
2039	39421	.054	.167	1.045	3	2.855	3	2.855
2071	39927	.012	.191	1.049	3	2.885	3	2.885
2088	40183	.017	.174	1.091	7	2.892	3	2.889

TABLE I (continued)

HR	HD	b-y	m ₁	c ₁	n	β (KP)	n(KP)	R(Avg)
2095	40312	-0. ^m 040	0. ^m 144	0. ^m 965	4	2. ^m 769	2	2. ^m 770
2101	40394	.018	.114	1.006	3			2.738
2103	40446	.001	.165	1.053	4			2.884
2110	40588	.053	.178	1.011	3			2.913
2112	40626	- .026	.153	0.989	3			2.860
2127	40964	- .012	.130	0.720	3	2.770	3	2.770
2133	41076	- .013	.156	1.025	3	2.968	2	2.867
2174	42111	.052	.140	1.228	3	2.804	2	2.810
2195	42536	- .008	.174	1.097	3	2.870	3	2.870
2209	42818	.008	.158	1.060	2	2.885	4	2.881
2210	42824	.016	.176	1.065	3	2.904	3	2.904
2224	43157	- .072	.107	0.279	3	2.668	2	2.667
2238	43378	.012	.173	1.060	3	2.914	4	2.913
2253	43683	.027	.134	1.268	3	2.814	2	2.822
2272	44092	.016	.154	0.958	3	2.866	3	2.866
2300	44783	- .020	.096	0.834	3	2.667	3	2.667
2304	44927	.018	.136	1.103	3	2.831	2	2.836
2312	45050	- .008	.136	0.760	3	2.791	3	2.791
2324	45320	.032	.186	1.025	3	2.884	2	2.884
2327	45357	.018	.162	0.993	3	2.871	3	2.871
2328	45380	- .028	.161	0.917	3	2.849	3	2.849
2330	45394	.027	.158	1.195	3	2.867	3	2.867
2346	45560	.031	.171	1.027	3	2.893	3	2.893
2362	45827	.139	.051	1.248	3	2.704	3	2.704
2372	46052	.081	.231	0.944	6	2.862	3	2.868
2383	46251	.027	.174	1.093	3	2.899	3	2.899
2385	46300	.052	.069	0.992	2	2.647	3	2.642
2398	46553	.005	.131	1.084	5	2.811	1	2.803
2402	46590	.002	.165	1.101	3	2.881	1	2.891
2404	46642	- .013	.153	1.071	2	2.863	3	2.863
2407	47152	- .005	.183	0.926	3	2.865	1	2.864
2407	47863	- .006	.133	1.127	3	2.819	3	2.819
2466	48097	.022	.200	0.995	5	2.914	1	2.924
2471	48272	.057	.132	1.193	3	2.858	3	2.858
2499	49059	.018	.200	1.008	1	2.898	3	2.898
2502	49147	- .015	.130	1.058	2	2.817	3	2.817
2521	49643	- .043	.111	0.501	3	2.716	2	2.714
2529	49908	.001	.150	1.162	5	2.846	2	2.856
2534	49976	- .003	.202	0.991	2	2.884	3	2.884
2543	50062	.011	.198	1.042	3	2.898	2	2.898
2584	50931	.014	.183	1.036	3	2.896	3	2.896
2624	52312	- .016	.098	0.783	3	2.712	3	2.712
2629	52479	.057	.110	1.454	3	2.797	3	2.797
2659	53257	- .008	.140	1.038	2	2.831	2	2.821
2710	55111	- .002	.144	1.078	3	2.834	2	2.840

TABLE 1 (continued)

HR	HD	b-y	m ₁	c ₁	n	R(KP)	n(KP)	R(Λvg)
2714	55185	0 ^m .011	0 ^m .129	1 ^m .219	3	2 ^m .834	4	2 ^m .829
2780	57049	.015	.136	1.224	3	2.804	3	2.804
2810	57744	- .006	.165	1.023	3	2.894	2	2.895
2818	58142	.000	.143	1.117	4	2.878	5	2.878
2836	58552	.032	.194	1.003	4	2.899	3	2.899
2858	59059	- .009	.121	1.027	3	2.778	3	2.778
2872	59507	.026	.196	0.997	3	2.898	4	2.898
2893	60275	.004	.164	0.933	4	2.879	3	2.879
2901	60357	.005	.122	1.065	3	2.782	2	2.787
2931	61219	.022	.156	1.066	3	2.897	3	2.901
2966	61887	- .016	.137	1.072	2	2.816	2	2.822
2969	61931	.014	.122	1.087	4	2.814	1	2.818
2991	62510	.003	.162	1.057	4	2.889	3	2.889
3008	62832	.008	.156	1.015	3	2.835	1	2.843
3039	63586	- .004	.146	1.044	3	2.862	9	2.862
3040	63589	.081	.236	0.940	3	2.883	3	2.883
3077	64347	.030	.152	1.130	4	2.856	3	2.856
3082	64486	- .032	.152	0.969	2	2.831	2	2.834
3083	64491	.196	.132	0.668	4	2.736	3	2.736
3086	64648	- .012	.129	1.059	2	2.837	3	2.834
3132	65856	.008	.158	1.076	4	2.875	3	2.875
3134	65873	- .014	.145	1.056	3	2.844	2	2.845
3136	65900	- .013	.179	1.056	3	2.885	2	2.887
3158	66552	- .014	.138	0.956	3	2.861	4	2.861
3163	66664	- .003	.173	1.025	6	2.907	4	2.906
3167	66824	- .010	.144	0.947	3	2.856	3	2.856
3174	67159	.000	.120	0.976	2	2.804	3	2.804
3198	67959	.006	.156	1.122	5	2.866	13	2.866
3215	68351	- .036	.157	0.990	3	2.773	3	2.769
3268	70011	- .006	.118	1.002	3	2.808	2	2.804
3314	71155	- .005	.158	1.024	Std	2.897	Std	2.897
3354	72037	.106	.233	0.872	5			2.850
3361	72208	- .017	.131	0.890	5	2.805	3	2.805
3372	72359	- .003	.156	1.038	3	2.810	1	(2.810)
3383	72660	- .004	.168	1.044	5	2.892	3	2.891
3401	73029	.010	.167	1.056	5	2.903	2	2.903
3406	73143	.049	.172	1.147	3	2.872	3	2.876
3410	73262	.008	.153	1.091	Std	2.851	Std	2.851
3412	73316	- .010	.163	1.006	3	2.909	3	2.909
3437	73997	- .004	.163	1.030	4	2.895	3	2.895
3449	74198	.000	.174	1.054	6	2.912	5	2.910
3465	74521	- .076	.216	0.734	3	2.756	2	2.759
3481	74873	.064	.188	0.934	4	2.890	2	2.889
3486	74983	.029	.154	1.191	6	2.868	2	2.865
3492	75137	- .004	.138	1.056	5	2.890	4	2.885

TABLE I (continued)

HR	HD	b-y	m ₁	c ₁	n	β (KP)	n(KP)	β (Avo ¹)
3504	75469	0 ^m .004	0 ^m .143	1 ^m .164	8	2 ^m .859	4	2 ^m .859
3566	76595	.008	.159	1.090	7	2.874	3	2.874
3573	76757	.018	.190	1.012	4	2.915	3	2.915
3594	77327	.012	.130	1.188	3	2.825	2	2.816
3595	77350	- .018	.131	1.009	8	2.814	5	2.816
3601	77557	.018	.156	1.078	5	2.868	4	2.868
3608	77692	.026	.150	1.194	5	2.865	3	2.865
3651	79108	- .003	.154	1.036	5	2.879	4	2.879
3657	79248	.017	.164	1.094	10	2.885	3	2.885
3665	79469	- .028	.145	0.944	11	2.866	4	2.864
3676	79763	.029	.186	1.006	6	2.874	1	2.896
3689	80064	.048	.162	1.198	8	2.861	3	2.861
3711	80613	.002	.146	1.098	6	2.862	4	2.862
3744	81728	.041	.150	1.098	4	2.859	3	2.859
3799	82621	.022	.172	1.104	9	2.877	3	2.881
3818	83023	.024	.148	0.980	7	2.858	4	2.858
3832	83373	- .019	.145	0.976	3	2.862	4	2.862
3854	83869	.004	.164	1.044	7	2.877	4	2.877
3906	85504	- .014	.136	1.040	14	2.817	5	2.827
3937	86360	- .010	.118	1.010	8	2.812	2	2.810
3975	87737	.030	.068	0.966	13	2.652	7	2.650
3981	87887	- .004	.126	1.080	8	2.833	7	2.830
3985	88024	.016	.148	1.078	6	2.882	4	2.882
3989	88195	.040	.108	1.152	7	2.788	3	2.788
4000	88372	.020	.142	1.141	6	2.859	3	2.859
4024	88960	.010	.156	1.085	9	2.882	3	2.878
4101	90569	- .036	.180	0.956	11	2.846	2	2.844
4109	90763	.020	.188	1.014	8	2.888	3	2.888
4131	91311	- .004	.152	1.078	9	2.852	3	2.852
4148	91636	.034	.161	1.070	5	2.890	2	2.880
4227	93702	.027	.147	1.130	8	2.869	3	2.869
4248	94334	- .016	.146	1.048	9	2.869	7	2.865
4286	95256	.082	.246	0.958	8	2.845	4	2.845
4295	95418	- .007	.164	1.082	6	2.880	9	2.881
4300	95608	.022	.194	1.019	10	2.919	6	2.919
4356	97585	- .001	.134	1.102	7	2.832	4	2.831
4359	97633	.006	.150	1.156	6	2.874	5 ₂	2.872
4378	98280	.024	.190	1.052	11	2.914	2	2.909
4386	98664	- .020	.127	1.014	13	2.828	4	2.826
4391	98772	.046	.182	1.058	7	2.862	2	2.867
4493	101391	- .048	.122	0.672	9	2.765	4	2.765
4528	102510	.010	.176	1.014	9	2.920	3	2.918
4554	103287	.006	.153	1.113	Std	2.885	Std	2.885
4585	104181	.004	.150	1.076	8	2.888	7	2.889
4632	105778	.042	.154	1.144	9	2.846	3	2.846

TABLE I (continued)

HR	HD	b-y	m ₁	c ₁	n	β (KP)	n(KP)	β (Avg)
4673	106887	0 ^m .087	0 ^m .222	0 ^m .932	6	2 ^m .877	2	2 ^m .874
4689	107259	.017	.163	1.130	10	2.862	5	2.867
4705	107655	- .002	.169	1.034	11	2.885	4	2.891
4752	108662	- .052	.214	0.884	6	2.850	8	2.851
4781	109309	- .020	.145	0.956	6	2.874	3	2.860:
4789	109485	.008	.144	1.090	10	2.867	7	2.866
4799	109704	.032	.194	1.011	7	2.909	3	2.909
4805	109860	.011	.140	1.154	9	2.855	3	2.855
4816	110066	.008	.256	0.890	9	2.864	3	2.864
4828	110411	.040	.180	0.992	9	2.908	6	2.910
4829	110423	.000	.156	1.010	7	2.885	2	2.885
4833	110462	.010	.181	1.173	6	2.874	2	2.875
4861	111308	.012	.167	1.052	11	2.884	3	2.884
4865	111397	.020	.156	1.130	10	2.885	3	2.879
4869	111469	.025	.169	1.074	10	2.898	3	2.900
4905	112185	- .014	.168	1.064	7	2.867	5	2.868
4914*	112412	.230	.152	0.578	10	2.723	3½	2.723
4915*	112413	- .058	.188	0.630	8	2.777	6½	2.777
4921	112846	.106	.173	0.956	4	2.818	2	2.830
4936	113436	.036	.150	1.166	8	2.820	5	2.820
4963	114330	.007	.141	1.147	6	2.837	3	2.835
4974	114504	- .008	.156	1.082	6	2.870	5	2.870
5021	115709	.035	.166	1.012	9	2.870	4	2.870
5023	115735	- .029	.136	0.944	7	2.812	2	2.843
5037	116160	.022	.174	0.992	6	2.887	3	2.891
5040	116235	.054	.214	0.972	8	2.891	3	2.903
5085	117376	.000	.164	1.019	5	2.894	1	2.906
5109	118214	- .010	.150	1.006	8	2.890	2	2.885
5162	119476	.040	.180	1.022	7	2.903	3	2.913
5163	119537	.030	.172	0.978	10	2.885	4	2.885
5169	119765	.000	.168	1.010	8	2.895	3	2.899
5187	120198	- .058	.202	0.886	5	2.832	3	2.840
5216	120874	.036	.210	0.976	7	2.901	4	2.901
5238	121409	- .012	.138	1.045	5	2.828	3	2.828
5255	121950	.004	.144	1.120	7	2.862	3	2.863
5280	122866	.020	.181	1.016	10	2.904	3	2.910
5291	123299	- .010	.128	1.072	7	2.844	4½	2.844
5313	124224	- .054	.134	0.590	8	2.763	3	2.760
5342	124931	.000	.153	1.046	9	2.872	4	2.872
5351	125162	.051	.184	0.998	7	2.894	4	2.894
5360	125349	.020	.186	0.990	5	2.888	4	2.888
5414	127043	.014	.168	1.018	10	2.900	3	2.900
5415	127067	.008	.146	1.020	10	2.889	5	2.889
5467	128998	- .006	.162	1.078	4	2.872	2	2.878
5468	129002	.000	.190	0.968	4	2.910	3	2.898

TABLE I (continued)

HR	HD	b-y	m ₁	c ₁	n	β (KP)	n(KP)	β (Avg)
5511	130109	0 ^m .007	0 ^m .134	1 ^m .081	Std	2 ^m .846	Std	2 ^m .846
5522	130557	- .007	.134	0.992	11	2.831	4	2.831
5567	131951	- .012	.128	1.040	6	2.826	3	2.824
5574	132145	.010	.164	1.019	9	2.907	4	2.907
5578	132230	.017	.142	0.993	3	2.901	3	2.901
5536	132742	.020	.118	0.972	5	2.816	4	2.816
5597	133029	- .092	.206	0.778	7	2.804	4	2.804
5627	133962	- .005	.156	0.992	5½	2.904	3	2.900
5633	134064	.032	.190	1.017	10½	2.904	3	2.910
5665	135263	.039	.173	1.050	8½	2.910	4	2.910
5676	135502	.028	.172	1.081	6½	2.888	2	2.896
5717	136831	.008	.136	1.044	10	2.869	4	2.869
5752	138213	.046	.194	1.142	10	2.860	2	2.869
5754	138245	.062	.210	0.982	10	2.872	4	2.872
5793	139006	.000	.144	1.060	10	2.871	5	2.869
5818	139493	.018	.174	1.038	9	2.898	2	2.900
5843	140160	.006	.206	1.048	5	2.902	3	2.914
5857	140728	- .052	.182	0.894	6	2.825	3	2.829
5858	140729	.000	.158	1.022	6	2.881	3	2.886
5859	140775	.028	.148	1.100	6	2.873	3	2.879
5870	141187	.056	.172	1.004	5	2.886	2	2.890
5881	141513	- .008	.142	0.960	6	2.846	4	2.840
5959	143459	.048	.111	1.092	5	2.835	4	2.835
5971	143807	- .020	.132	0.872	7	2.817	5	2.819
6013	145122	.006	.134	1.048	4	2.827	4	2.827
6035	145647	.013	.150	1.055	3½	2.876	2	2.882
6036	145674	.032	.140	1.004	9	2.857	3	2.857
6041	145788	.103	.114	1.110	7½	2.854	3	2.854
6074	146738	.034	.156	1.232	7	2.852	2	2.858
6111	147869	.008	.150	1.082	6	2.868	2	2.872
6117	148112	.010	.156	1.044	7	2.837	5	2.841
6156	149081	.003	.186	0.998	9½	2.898	3	2.898
6162A	149303	.064	.180	1.028	8	2.848	4	2.849
6162B		.388	.179	0.310	3	2.616	3	2.616
6168	149630	.006	.122	1.040	9	2.791	7	2.789
6169	149632	.037	.168	0.986	9½	2.890	3	2.890
6170	149650	.024	.158	1.114	7	2.878	2	2.885
6176	149822	- .077	.207	0.824	9½	2.796	3	2.796
6179	149911	.096	.181	1.071	7½	2.868	3	2.868
6184	150100	- .016	.138	0.910	5	2.801	2	2.807
6194	150379	.069	.209	0.977	7½	2.881	3	2.881
6195	150378	- .002	.141	1.014	5	2.873	2	2.872
6234	151525	.010	.134	1.098	4	2.824	2	2.843
6246	151862	.018	.159	1.021	3	2.888	3	2.885
6250	151956	.056	.202	1.009	6	2.890	2	2.887

TABLE I (continued)

HR	HD	b-y	m ₁	c ₁	n	β (KP)	n (KP)	β (Avg)
6255	152127	0. ^m 033	0. ^m 171	0. ^m 996	6	2. ^m 913	2	2. ^m 913
6268	152308	- .023	.172	0.962	6	2.867	3	2.867
6324	153808	- .002	.154	0.924	7	2.861	9	2.860
6326	153882	.012	.184	1.052	4	2.866	4	2.866
6329	153914	.046	.182	1.000	4	2.890	3	2.890
6341	154228	- .006	.176	0.986	4	2.888	2	2.889
6352	154441	.035	.108	0.928	3	2.841	3	2.841
6362	154713	.048	.180	1.122	7	2.876	3	2.876
6367	154895	.049	.156	0.984	4	2.890	2	2.877
6385	155375	.047	.198	1.024	8	2.884	4	2.884
6412	156208	.167	.090	1.195	5	2.850	4	2.850
6432	156653	.014	.146	1.104	5	2.856	3	2.862
6457	157198	.006	.141	1.167	4	2.848	2	2.855
6484	157778	.000	.123	1.129	4	2.841	7	2.841
6521	158716	.011	.187	0.997	4½	2.922	3	2.922
6533	159139	.000	.162	1.028	4	2.892	3	2.884
6571	160181	.076	.164	0.978	4	2.866	6	2.858
6589	160765	.012	.169	1.005	6½	2.906	4	2.906
6609	161270	.069	.129	0.912	8	2.866	5	2.866
6610	161289	.047	.138	0.996	7½	2.872	3	2.872
6618	161693	.016	.148	1.150	6	2.877	3	2.874
6627	161833	.023	.155	1.041	4	2.897	3	2.891
6629	161868	.026	.165	1.054	Std	2.908	Std	2.908
6641	162132	.044	.184	1.022	4	2.880	3	2.880
6642	162161	.020	.142	0.932	7	2.845	4	2.861:
6690	163641	.032	.089	0.793	5	2.774	4	2.774
6696	163772	.088	.133	1.082	5	2.888	4	2.888
6732	164716	.146	.044	0.886	4	2.798	3	2.798
6744	165029	.028	.131	1.057	4½	2.870	3	2.870
6753	165358	.016	.164	1.126	4	2.897	4	2.897
6758	165475	.183	.169	0.948	4	2.799	5	2.799
6776	165910	.062	.119	1.175	5½	2.808	5	2.808
6779	166014	.010	.110	1.134	6	2.795	11	2.794
6789	166205	.014	.146	1.102	3	2.896	5	2.896
6826	167370	- .026	.130	0.804	4	2.783	4	2.779
6827	167387	- .003	.139	1.062	4	2.836	4	2.836
6852	168270	.032	.100	1.020	5	2.811	4	2.812
6878	169009	.125	.092	0.992	4	2.850	4	2.850
6883	169111	.037	.146	1.147	4	2.883	4	2.882
6920	170000	- .040	.138	0.667	4	2.797	5	2.795
6955	170878	.051	.127	1.193	4	2.833	4	2.829
6963	171149	.049	.114	1.012	4	2.846	3	2.846
6976	171505	.037	.129	1.100	3½	2.857	5	2.857
6977	171623	.022	.126	1.018	4	2.819	4	2.815
6992	171975	.024	.105	0.807	3½	2.798	3	2.798

TABLE I (continued)

HR	HD	b-y	m_1	c_1	n	$\beta(KP)$	n(KP)	$\beta(Avg)$
6993	171978	0.048 ^m	0.148 ^m	1.143 ^m	4	2.864 ^m	2	2.871 ^m
7001	172167	.004	.157	1.089	7	2.903	9	2.904
7017	172671	- .021	.125	0.939	4	2.800	4	2.800
7018	172728	- .017	.131	0.923	5	2.832	4	2.832
7030	172958	- .002	.102	0.877	5	2.782	3	2.782
7048	173495	.030	.158	1.049	5	2.908	4	2.906
7049	173524	- .035	.122	0.802	4	2.788	3	2.788
7058	173650	.037	.126	0.940	6	2.788	3	2.788
7080	174177	.042	.155	1.201	4	2.827	3	2.827
7085	174240	.037	.132	1.111	5	2.870	3	2.870
7086	174262	.007	.168	1.029	4	2.902	5	2.905
7090	174366	.041	.152	0.989	3	2.886	3	2.886
7091	174369	.038	.191	0.988	4	2.906	5	2.906
7143	175640	.002	.110	0.740	4	2.790	3	2.790
7178	176437	.001	.093	1.219	Std	2.754	Std	2.754
7199	176795	.004	.156	1.056	3	2.865	3	2.865
7209	176984	.025	.110	1.138	4	2.827	3	2.821
7235	177724	.012	.147	1.080	Std	2.878	Std	2.873
7251	178207	- .008	.149	0.987	3	2.861	3	2.861
7283	179527	- .010	.110	0.764	5	2.711	4	2.712
7284	179583	.049	.166	1.106	5	2.864	3	2.864
7286	179648	.059	.139	1.194	3	2.849	3	2.849
7313	180782	.012	.160	1.004	5	2.883	3	2.883
7324	181119	.073	.126	1.197	3	2.833	4	2.833
7338	181470	.012	.143	0.971	4	2.833	3	2.833
7351	181960	.015	.151	1.127	5	2.865	3	2.865
7364	182422	.050	.094	1.090	4	2.799	4	2.799
7369	182490	.034	.184	0.995	4	2.880	2	2.880
7384	182761	- .003	.142	0.982	4	2.869	3	2.869
7390	182919	- .003	.157	0.985	4	2.906	2	2.895
7395	183056	- .058	.119	0.603	3	2.712	2	2.710
7400	183324	.051	.167	0.994	3	2.885	2	2.891
7408	183534	- .003	.157	1.023	3	2.905	2	2.894
7415	183656	.049	.037	0.814	3	2.643	3	2.643
7419	183986	.002	.126	0.958	4	2.790	2	2.802
7436	184603	.063	.186	1.024	4	2.875	3	2.875
7480	185762	.059	.163	1.052	3	2.850	2	2.864
7512	186568	- .005	.089	0.813	4	2.725	2	2.727
7528	186882	- .001	.114	1.037	5	2.822	3	2.812
7529A	186901	- .021	.104	1.000	2	2.774	3	2.774
7529B	186902	.018	.111	1.018	3	2.768	5	2.768
7545	187340	.040	.163	1.157	3	2.886	3	2.886
7562	187753	.052	.202	1.018	3	2.879	3	2.879
7580	188107	.051	.088	1.036	3	2.772	3	2.772
7592	188260	- .003	.126	0.951	6	2.823	4	2.814

TABLE I (continued)

HR	HD	b-y	m_1	c_1	n	β (KP)	n(KP)	β (Avg)
7596	188350	0.091^m	0.077^m	1.133^m	3	2.820^m	2	2.818^m
7598	188385	.013	.181	0.989	3	2.924	2	2.914
7601	188485	- .005	.135	0.931	6	2.842	2	2.842
7611	188793	.010	.163	1.055	3	2.907	1	2.900
7616	188971	.036	.157	1.139	3	2.885	3	2.885
7632	189253	- .009	.157	0.969	3	2.902	3	2.902
7654	189900	.020	.155	1.117	4	2.868	2	2.872
7664	190229	- .041	.101	0.597	5	2.695	2	2.703
7684	190781	.020	.160	1.076	3	2.861	3	2.868
7694	191110	.069	.071	0.739	3	2.768	3	2.768
7710	191692	- .026	.123	1.009	4	2.820	3	2.815
7717	191984	.025	.159	1.011	3	2.863	3	2.863
7723	192342	.186	.227	0.722	3	2.790	4	2.790
7724	192425	.028	.188	1.022	6	2.919	3	2.912
7736	192640	.098	.159	0.929	7	2.832	5	2.831
7752	192934	- .004	.153	1.036	3	2.880	3	2.880
7755	192983	.052	.155	1.051	4	2.853	3	2.853
7769	193369	.013	.182	0.980	3	2.906	3	2.910
7781	193592	.066	.177	0.934	3	2.868	3	2.866
7782	193621	.013	.100	1.104	3	2.779	3	2.779
7784	193702	.035	.155	1.076	3	2.861	3	2.861
7803	194244	.002	.104	1.005	3	2.771	3	2.771
7818	194882	.046	.174	1.155	3	2.869	3	2.869
7826	195050	.030	.175	1.062	3	2.864	1	2.880
7827	195066	.012	.138	1.065	3	2.860	4	2.860
7835	195324	.377	- .044	1.201	4			2.642
7836	195325	.028	.098	1.072	3	2.764	2	2.757
7840A	195483	.055	.094	0.548	3	2.750	3	2.750
7840B	195482	.173	.175	0.793	3	2.760	3	2.760
7857	195922	.059	.149	1.092	3	2.843	2	2.843
7835	196606	- .040	.119	0.625	5	2.729	3	2.729
7891	196724	- .024	.153	0.973	4	2.876	4	2.874
7903	196821	- .017	.117	1.017	3	2.806	1	2.798
7917	197120	.097	.171	0.968	3	2.858	3	2.858
7938	197734	.016	.156	1.133	3	2.887	3	2.887
7950	198001	.002	.144	1.192	3	2.882	4	2.882
7954	198070	.007	.128	0.973	3	2.857	3	2.857
7974	198391	.006	.156	1.071	3	2.888	3	2.888
7981	198552	.015	.175	1.042	3	2.914	3	2.914
8002	199095	- .014	.161	1.036	2	2.883	3	2.883
8004	199099	.001	.138	0.986	3	2.880	3	2.880
8028	199629	.024	.120	1.171	4	2.805	3	2.798
8094	201433	- .026	.134	0.708	2	2.791	3	2.793
8101A	201671	.014	.155	0.952	3	2.882	2	2.882
8101B	201670	.091	.224	0.885	3	2.860	2	2.860

TABLE I (continued)

HR	HD	b-y	m_1	c_1	n	β (KP)	n(KP)	β (Avg)
8143	202850	0 ^m .138	0 ^m .027	0 ^m .571	Std	2 ^m .584	Std	2 ^m .584
8147	202923	.019	.176	1.107	3	2.896	1	2.890
8169	203439	.047	.150	1.171	3	2.865	1	2.865
8178	203562	.030	.168	1.151	3	2.889	2	2.884
8186	203696	.012	.159	1.068	3	2.890	1	(2.890)
8194	203858	.017	.156	1.060	3	2.886	1	(2.886)
8203	204041	.089	.176	0.936	3	2.850	2	2.850
8206	204131	- .009	.163	1.080	3	2.859	2	2.859
8217	204414	.012	.192	1.002	3			2.915
8231	204862	- .023	.140	0.928	3			2.825
8237	204965	.051	.153	1.213	3			2.867
8246	205314	- .021	.155	0.947	3			2.820
8265	205811	.008	.186	0.995	3	2.921	1	(2.921)
8291	206538	.040	.157	1.150	3			2.873
8300	206644	.030	.170	0.982	3	2.911	1	2.891
8328	207203	.011	.143	1.137	3			2.849
8329	207218	.197	.119	1.099	3	2.788	1	(2.788)
8342	207636	- .004	.155	1.035	3	2.882	1	(2.882)
8343	207650	- .011	.178	0.970	3	2.901	6	2.897
8345	207673	.347	- .006	1.048	3	2.637	1	(2.637)
8358	208108	.000	.184	1.001	3			2.907
8377	208727	- .030	.121	0.609	4	2.762	1	(2.762)
8389	209124	.025	.125	1.141	3	2.817	1	(2.817)
8404	209459	- .013	.114	1.022	3	2.796	1	2.794
8407	209515	- .011	.141	1.026	4	2.834	1	2.811
8419	209833	- .019	.127	0.863	3			2.814
8422	209932	- .004	.127	0.922	4	2.846	2	2.846
8438	210129	- .025	.102	0.476	5	2.643	3	2.643
8451	210419	.003	.146	1.051	3	2.856	1	2.835
8473	210873	- .025	.134	0.922	5	2.823	3	2.823
8487	211096	- .006	.171	1.031	3			2.888
8489	211211	.005	.151	0.992	3			2.875
8490	211242	- .027	.098	0.585	3	2.691	3	2.691
8491	211287	.015	.143	1.065	3	2.875	1	2.860
8512	211838	- .002	.094	0.680	4	2.724	3	2.724
8518	212061	- .034	.151	0.998	3	2.850	4	2.850
8522	212097	.017	.096	0.873	5	2.740	4	2.740
8525	212150	.033	.107	1.087	4			2.835
8537	212495	.030	.124	1.175	4			2.854
8546	212710	- .019	.149	0.991	3	2.868	1	
8569	213272	.018	.178	1.029	3	2.888	2	2.888
8573	213320	- .025	.145	1.006	2	2.862	2	2.962
8574	213323	- .010	.134	0.986	3	2.866	1	2.848
8585	213558	.001	.173	1.030	Std	2.908	Std	2.908
8599	214035	.009	.144	1.193	3	2.843	1	2.839

TABLE I (continued)

HR	HD	b-y	m_1	c_1	n	β (KP)	n(KP)	β (Avg)
8605	214203	0. ^m 010	0. ^m 177	1. ^m 077	3	2. ^m 892	2	2. ^m 892
8624	214698	.014	.155	1.144	3	2.872	2	2.872
8641	214994	- .004	.151	1.108	4 $\frac{1}{2}$	2.852	3	2.852
8677	215907	.030	.112	1.110	2 $\frac{1}{2}$	2.807	1	2.780:
8717	216735	- .006	.161	1.079	4	2.865	4	2.869
8738	217186	.022	.171	1.022	3	2.878	2	2.878
8781	218045	- .012	.130	1.128	Std	2.841	Std	2.841
8806	218525	.116	.133	1.219	3	2.880	2	2.880
8821	218700	- .024	.105	0.861	4	2.752	3	2.752
8837	219290	- .008	.159	1.004	3	2.894	2	2.891
8844	219485	- .008	.143	1.090	3			2.868
8865	219832	- .015	.154	1.001	3	2.875	3	2.875
8873	219927	- .008	.095	0.637	5	2.719	2	2.719
8887	220222	- .042	.103	0.561	5	2.707	2	2.707
8891	220318	- .017	.141	1.059	3	2.844	2	2.844
8902	220575	.052	.073	0.752	3	2.717	2	2.717
8903	220599	- .031	.123	0.837	3			2.788
8915	220933	- .033	.142	0.901	3			2.824
8933	221394	- .002	.195	1.063	3	2.896	1	(2.896)
8936	221491	- .017	.125	0.850	3	2.809	2	2.809
8947	221756	.056	.166	1.072	3			2.883
8960	222098	.008	.179	1.048	3	2.872	2	2.872
8963	222133	- .002	.165	1.032	3			2.880
8976	222439	- .035	.131	0.831	Std	2.834	Std	2.834
8983	222602	.059	.167	1.086	3			2.886
9013	223274	- .007	.150	1.116	3			2.853
9019	223386	- .011	.154	0.990	3	2.886	1	(2.886)
9042	223855	.000	.153	1.027	3	2.885	2	2.885
9048	224103	- .029	.138	0.854	5	2.836	4	2.836
9056	224309	.015	.196	1.000	3	2.920	1	(2.920)
9080	224801	- .031	.151	0.629	3	2.930	1	2.936
9100	225180	.246	.036	1.518	4			2.777

Notes to Table I

1460AB Component A: $\beta=2.900$ (3 measures);
 Component B: $\beta=2.801$ (1 measure).

4914 F0V Faint component of 4915.

4915 α^2 CVn See 4914.

Captions to Figures

Figure 1. The $(u-b)$ vs $(b-y)$ relation for the data in Table I.

Figure 2. The c_1 vs $(b-y)$ relation for the data in Table I.

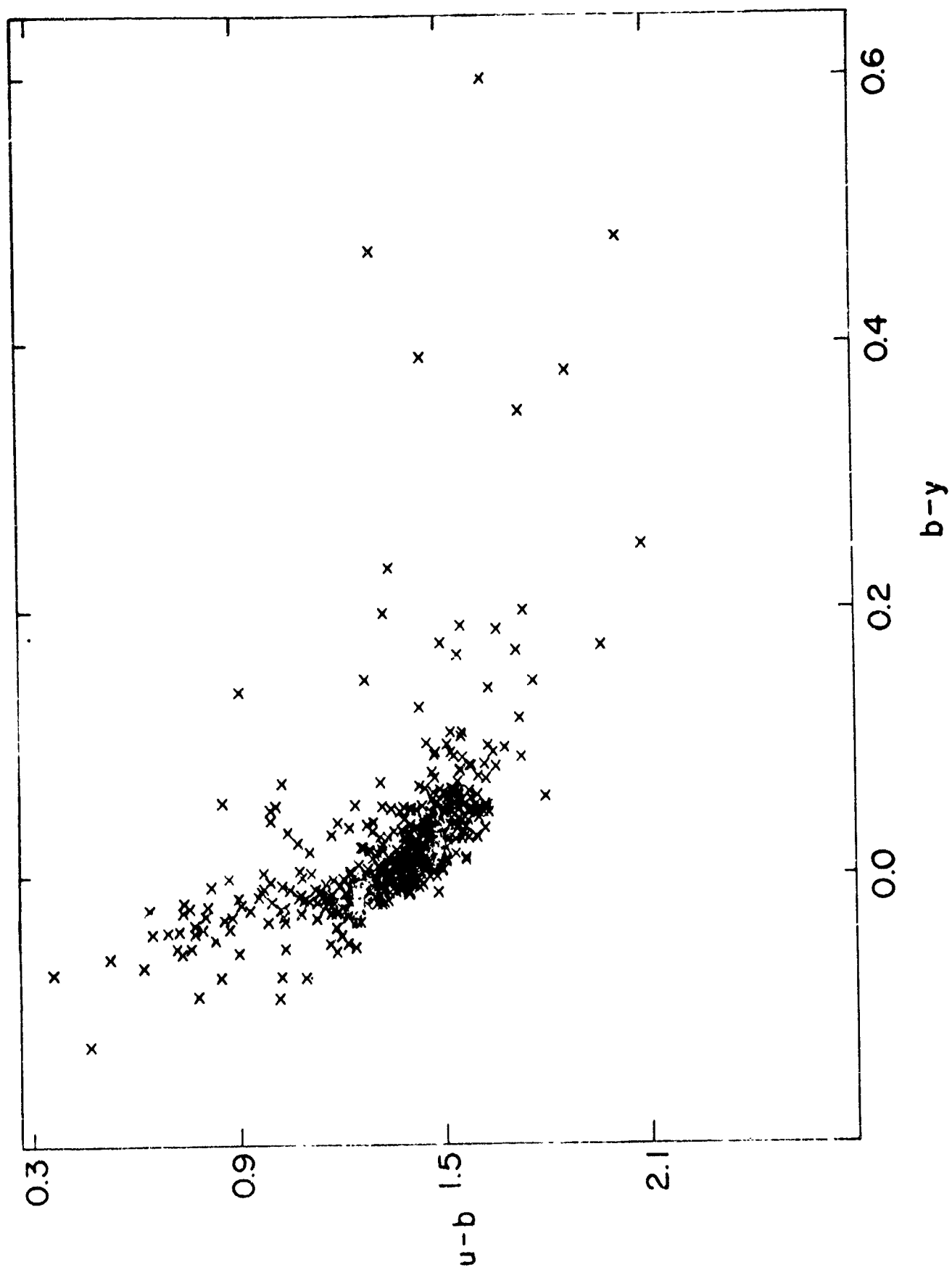
The lines drawn are the relations for unreddened zero-age main sequence B-, A-, and F-type stars.

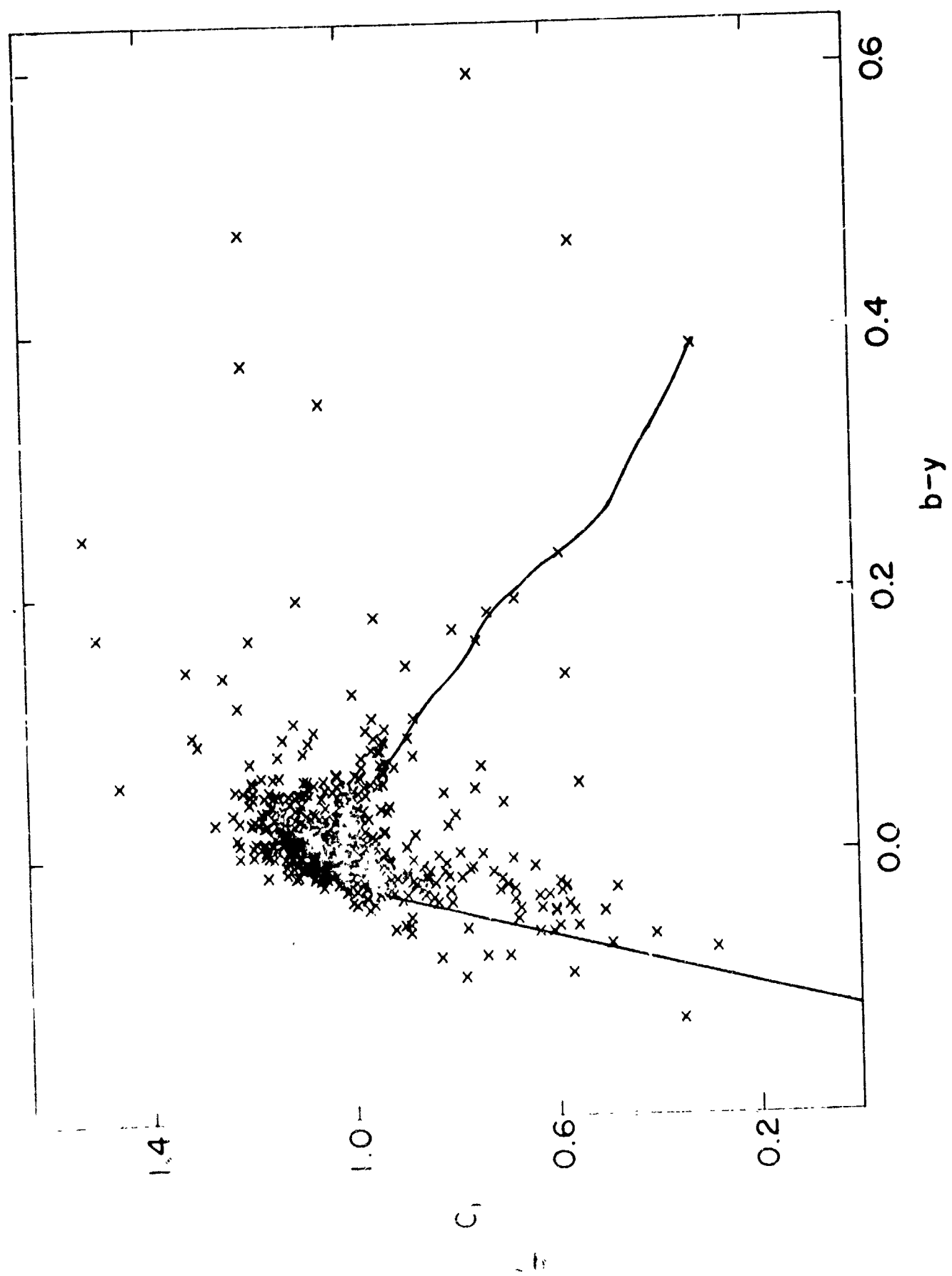
Figure 3. The m_1 vs β relation for the data in Table I. The

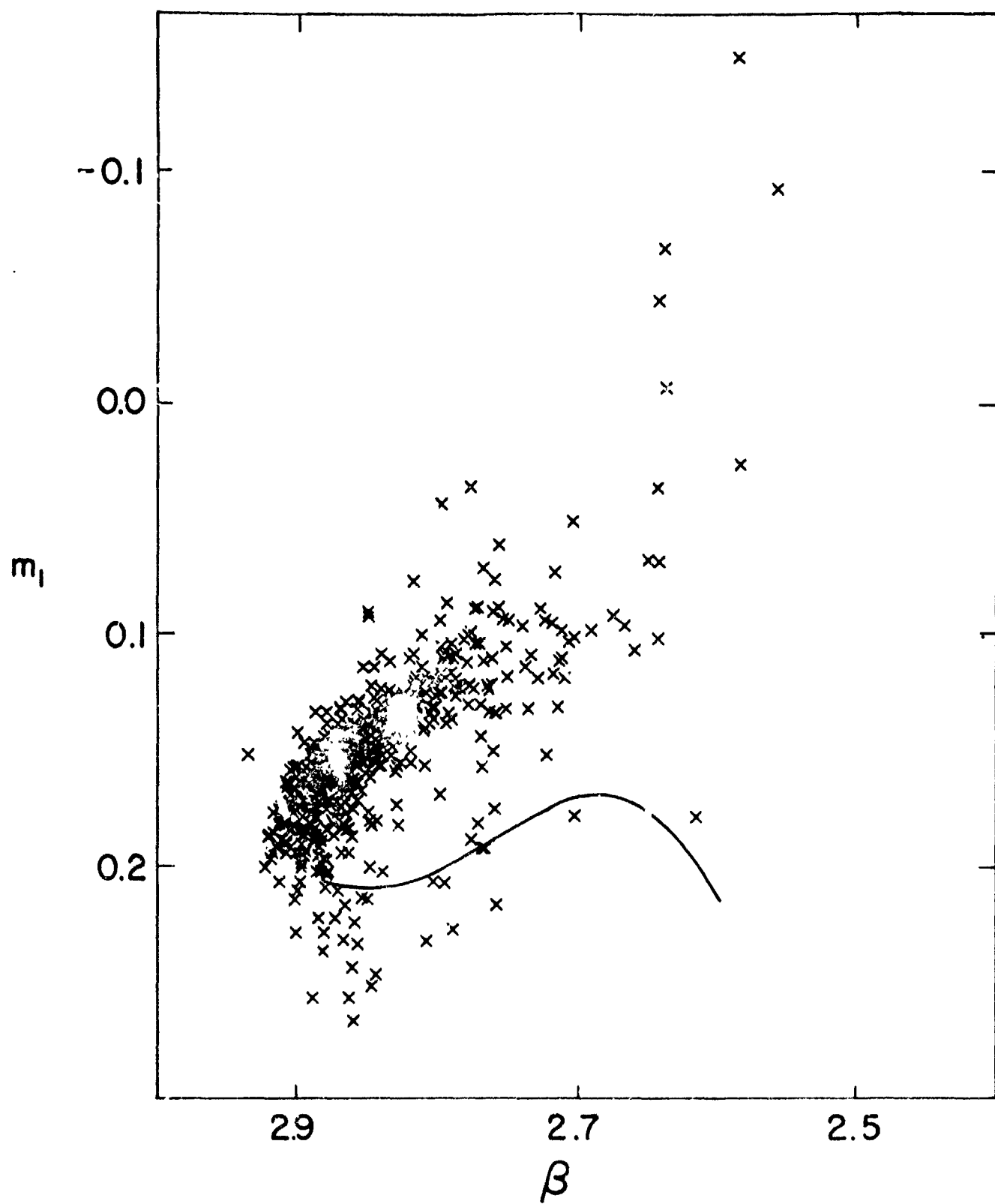
β is from the $\beta(\text{Avg})$ column. The line drawn is the relation for unreddened zero-age main sequence A- and F-type stars.

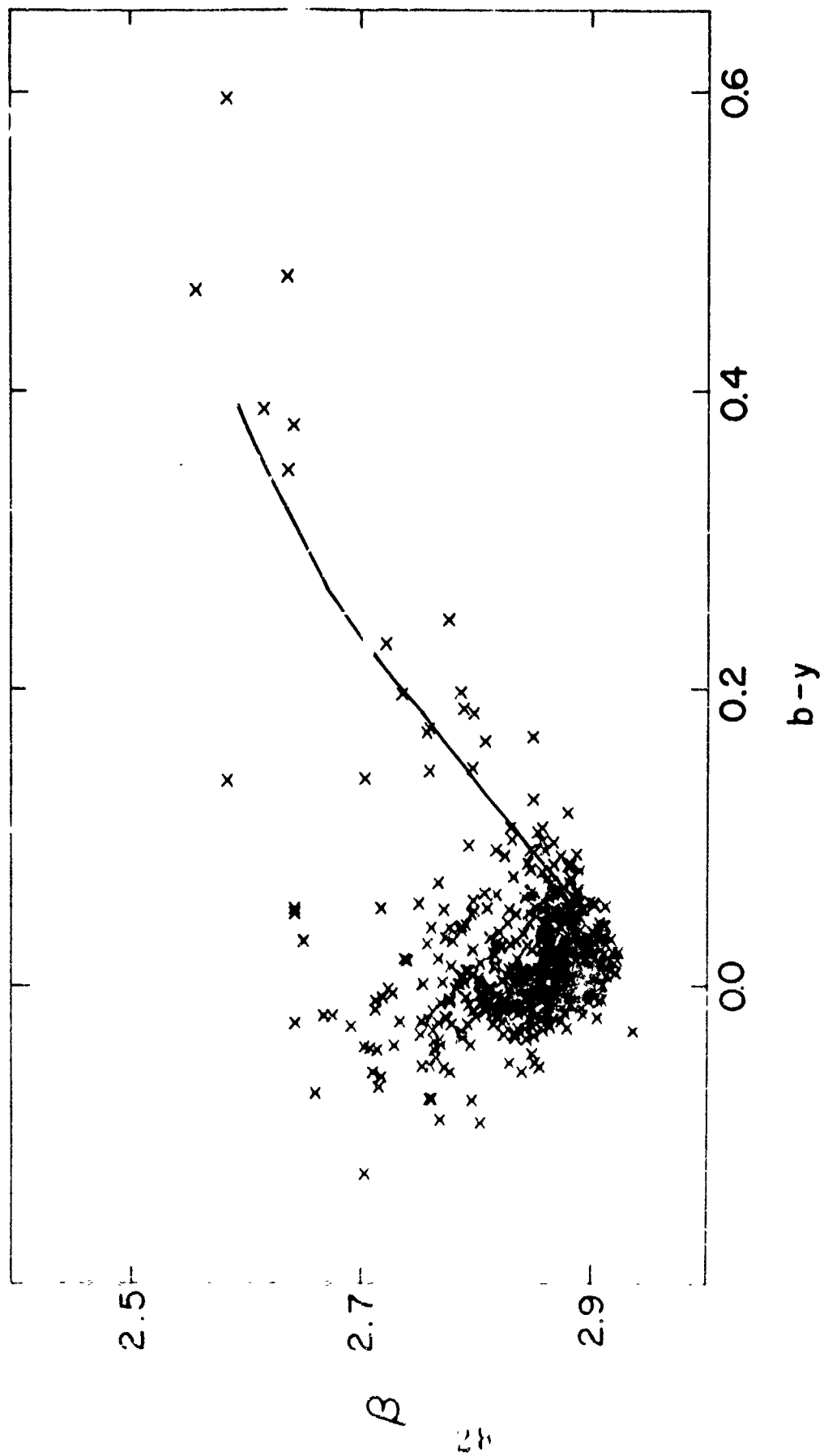
Figure 4. The β vs $(b-y)$ relation for the data in Table I.

The β is from the $\beta(\text{Avg})$ column. The line drawn is the relation for unreddened zero-age main sequence A- and F-type stars.









Final Report on ONR Contract N00014-67-C-0173, Project No. NR 046-824:
A Search for Highly Luminous Stars in the Southern Milky Way.

This project was terminated by ONR before it was completed, hence this report is being given less complete distribution than would otherwise be the case.

As indicated in one of the quarterly reports, the necessary objective prism plates have all been taken. About 2/3 of them have now been searched and nearly this many have been measured astrometrically. We will try to complete the work without ONR support, and possibly will publish in two years.

Some of the most interesting new peculiar stars found on these plates have already been published; in most cases this has involved further observations made at higher spectral resolution plus more accurate photometry. Publications that have so far resulted from our work are:

- 1) A New Bright Probable White Dwarf (by C. B. Stephenson, H. Sanduleak, and R. Hoffleit). Publications of the Astronomical Society of the Pacific, 80, 92, 1968.
- 2) A New Hot, Rapid Variable Star (by C. B. Stephenson, H. Sanduleak, and R. Schild). Astrophysical Letters, 1, 247, 1968., *CTIO Contribution # 35*
- 3) Spectroscopic and Photometric Observations of Peculiar Stars Listed on Southern Objective Prism Plates (by H. A. Hiltner, C. B. Stephenson, and H. Sanduleak). Astrophysical Letters, 2, 153, 1968. *CTIO #44*

Best Available Copy

C. B. Stephenson

C. B. Stephenson
Principal Investigator
December 17, 1968