PHOTOMETRIC *UBV* PERIOD STUDY OF EIGHT Ap STARS

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Eight Ap stars for which periods had been determined by J. E. Winzer were the subject of this independent period determination. All were stars which he found to be short-period variables and which showed the typical small amplitude variation associated with short periods. For six of these, his period was confirmed. For one, HR 9017, a different and better period was determined and for the remaining star, HR 4430, we did not observe periodic variation.

Key words: Ap star period determination

I. Introduction

Eight Ap stars which were included in a sample of Ap stars studied by J. E. Winzer (1974) were the subject of this study. They were selected because he found them to have short periods, all less than 1.5 days. Photoelectric period determination for such stars is difficult because they tend to show small amplitude variation. No one of these stars varied by as much as 0^m05 and most vary by about half that much in any one of the three colors, *UBV*, and several varied in only one color, *U*.

Winzer attempted to analyze a large sample of Ap stars which included all those contained in the Yale Bright Star Catalog which are north of the celestial equator. He actually observed all those for which he concluded reliable period determination had not been made. He found the mean period for this sample of Ap stars to be shorter than the mean period for Ap stars determined by George Preston (1970) using a different sample of stars. Since the period is assumed to be the rotational period of the star and since the stellar radius can be determined from the period, Winzer found the mean radius for Ap stars to be 1.8 $R_\odot$ which is about the average radius for a type-A star. Preston, on the other hand, found the mean radius to be about 3 $R_\odot$. The samples were different and Preston included only those Ap stars for which periods had been determined by two independent observers. Winzer stated that his periods were determined from relatively few points and needed to be confirmed. Sidney Wolff (1975) stated: "most of Winzer's periods are unconfirmed, and since the amplitudes are in many cases only 0.02 mag, the periods need independent confirmation."

II. Observations

Our observations were made in the spring and summer of 1978 during a 25-night period at Kitt Peak National Observatory using the no. 4 41-cm telescope. The telescope was equipped with a dry-ice-cooled 1P21 photomultiplier, a Monsanto pulse counter, and a digital recorder.

Observing techniques were almost identical with those of Winzer. Two comparison stars were selected for each Ap star. The comparison stars used by Winzer were adopted unless he reported a comparison star to be unreliable. Each comparison star is of approximately the same brightness as the Ap star, of similar spectral type, and is located close to the Ap star in the sky. Differential photometry was utilized exclusively. Differences were extinction corrected and transformed to the *UBV* system. The method of Hardie (1962) was used for determination of nightly extinction coefficients and for *UBV* transformation coefficients. An effort was made to establish a constant brightness ratio for the two comparison stars. The brightness difference recorded between one of the comparison stars and the Ap star was plotted to detect variability and period. Usually one observed point was obtained each night on each Ap star, however on at least one night during the run several points were taken to look for possible very short periods.

Each point plotted for each star represents an observation of the first comparison star in three colors (*UBV*), the Ap star, and then the second comparison star. A sky brightness was determined in each color for every star, unless the sky was completely dark in which case sky brightness was observed only for the Ap star. The observation of each star included five 10-sec photon counts in each of the three colors followed by two 10-sec counts in each color with the telescope displaced to observe sky brightness. The average scatter of the five readings was used to evaluate the quality of the night.

III. Results

Variability and periods were sought without reference to Winzer's determination. The period search was done by the method described by Burke, Rolland, and Boy (1970). For six of the eight stars the period was almost identical with that found by Winzer as we see from

TABLE I

STAR	PERIOD (days)		ΔM (magnitude of variation)		$\sigma_{\Delta M comp.}$
	Winzer	Burke	Winzer	Burke	
1. HD 96707 (HR 4330)	0.8183	Constant	0.02 V	0.015 V	HD 97138–HD 93427 variable (HD 97138 variable)
2. HD 120198 (HR 5187)	1.3799	1.37996 ±.00008	0.03 U	0.03 U	HD 121409–HD 119024 0.012 U (HD 121409 slightly variable)
3. HD 149822 (HR 6176)	1.4590	1.45876 ±.00008	0.03 U	0.02 U	HD 149632–HD 150012 0.0077 U
4. HD 151525 (HR 6234)	1.3116	1.31159 ± .0001	0.03 U	0.04 U	HD 149121–HD 151956 0.006 U
5. HD 164429 (HR 6718)	0.51747	0.517468 ± .00001	0.03 U	0.044 U	HD 162132–HD 165358 0.0091 U
6. HD 170973 (HR 6958)	0.9451	0.945099 ± .00008	0.03 U	0.025 U	HD 170200–HD 171802 0.0094 U
7. HD 179527 (HR 7283)	1.1608	1.160898 ± .0001	0.04 U	0.03 U	HD 178947–HD 180613 0.0074 U
8. HD 223358 (HR 9017)	0.9135	1.092	0.02 U	0.03 U	HD 224893–HD 225180 0.0087 U

Table I. That table is self-explanatory except possibly the last column, which shows the standard deviation of the brightness ratio of the comparison stars from the average value. For the seventh star, HR 9017, we find a period of 1^d092 whereas Winzer found it to be 0^d9135. We believe ours to be a better period. For the eighth star, HR 4330, our data do not indicate periodic variation. On all of the light curves our data are plotted with circles and Winzer's data are shown by solid triangles, usually only in U. All the data plotted are listed in Table II. All observations listed for days prior to JD2443670 were taken by J. E. Winzer and have been shifted up or down on any one light curve by the same magnitude difference so that his curves can be compared with ours. Usually we used the comparison star which Winzer did not use for the analysis. When only his U magnitude differences are plotted, the V and B differences are indicated in the table by zeros.

An evaluation of the period for each of the eight stars follows:

1. HR 4330 = HD 96707

This peculiar star of spectral type F0p(Sr) shows very slight indication of variability in U, less than 0^m03. In both V and B we find a variation of less than 0^m015 is indicated, which is close enough to our limit of detection as to make period determination from these data useless. Winzer found a variation of about 0^m03 in V and B and almost zero variation in U. We attempted to find a peri-

TABLE II
Photoelectric Observations

UBV DIFFS.(HD120198-HD119024) P=1.37996

HJD 2440000+	PHASE	VISUAL	BLUE	UV
1096.796	0.816	0.000	0.000	-0.159
1097.669	0.448	0.000	0.000	-0.155
1110.703	0.894	0.000	0.000	-0.168
1111.757	0.657	0.000	0.000	-0.142
1114.723	0.807	0.000	0.000	-0.115
1117.782	0.024	0.000	0.000	-0.173
1120.692	0.132	0.000	0.000	-0.159
1444.734	0.952	0.000	0.000	-0.157
1440.800	0.000	0.000	0.000	-0.177
1445.724	0.650	0.000	0.000	-0.146
1447.721	0.117	0.000	0.000	-0.164
1450.745	0.308	0.000	0.000	-0.160
1452.703	0.734	0.000	0.000	-0.152
1453.787	0.513	0.000	0.000	-0.155
1457.762	0.393	0.000	0.000	-0.154
1459.699	0.797	0.000	0.000	-0.153
1461.694	0.242	0.000	0.000	-0.161
3670.781	0.077	0.218	0.057	-0.174
3671.781	0.801	0.223	0.052	-0.163
3672.751	0.503	0.231	0.069	-0.136
3674.756	0.958	0.219	0.070	-0.172
3675.737	0.668	0.227	0.062	-0.167
3677.735	0.116	0.224	0.054	-0.169
3678.736	0.841	0.219	0.056	-0.167
3680.701	0.265	0.231	0.063	-0.153
3681.717	0.250	0.224	0.066	-0.176
3683.684	0.427	0.231	0.072	-0.146
3684.701	0.164	0.222	0.064	-0.164
3685.706	0.892	0.215	0.058	-0.160
3686.703	0.616	0.225	0.070	-0.147
3690.778	0.568	0.224	0.065	-0.139
3691.720	0.250	0.231	0.063	-0.152
3694.709	0.416	0.233	0.075	-0.148
3695.726	0.153	0.226	0.065	-0.162

UBV DIFFS. (HD149822-HD149632) P=1.45876

HJD 2440000+	PHASE	VISUAL	BLUE	UV
1097.795	0.348	0.000	0.000	-1.273
1106.786	0.518	0.000	0.000	-1.269
1108.833	0.920	0.000	0.000	-1.295
1115.793	0.692	0.000	0.000	-1.285
1119.846	0.470	0.000	0.000	-1.268
1120.795	0.121	0.000	0.000	-1.289
1443.896	0.611	0.000	0.000	-1.269
1444.847	0.263	0.000	0.000	-1.271
1447.806	0.291	0.000	0.000	-1.270
1449.821	0.673	0.000	0.000	-1.271
1452.800	0.715	0.000	0.000	-1.276
1458.831	0.850	0.000	0.000	-1.290
1459.050	0.000	0.000	0.000	-1.298
1459.753	0.482	0.000	0.000	-1.275
1460.750	0.165	0.000	0.000	-1.286
1463.738	0.213	0.000	0.000	-1.278
3672.873	0.607	-0.895	-1.033	-1.282
3673.771	0.223	-0.901	-1.042	0.000
3674.799	0.928	-0.901	-1.038	-1.292
3675.785	0.604	-0.901	-1.038	-1.281
3676.743	0.260	-0.897	-1.038	0.000
3677.835	0.009	-0.892	-1.042	-1.290
3678.775	0.653	-0.898	0.000	0.000
3679.738	0.313	-0.886	-1.019	-1.276
3680.739	0.999	-0.904	-1.035	-1.297
3683.740	0.057	-0.899	-1.030	-1.286
3684.777	0.767	-0.891	-1.030	-1.282
3685.743	0.430	-0.898	0.000	-1.271
3686.764	0.130	-0.894	-1.034	-1.275
3689.734	0.166	-0.888	-1.037	-1.279
3690.793	0.892	-0.904	0.000	0.000
3691.738	0.540	-0.900	-1.029	-1.276
3692.742	0.228	-0.898	-1.028	-1.280
3693.752	0.920	-0.891	0.000	0.000
3694.729	0.590	-0.899	-1.034	-1.274
3695.764	0.300	-0.896	-1.027	-1.273

UBV DIFFS.(HD151525-HD151956) P=1.31159

HJD 2440000+	PHASE	VISUAL	BLUE	UV
1096.915	0.413	0.000	0.000	-0.488
1097.777	0.064	0.000	0.000	-0.514
1115.740	0.765	0.000	0.000	-0.488
1116.722	0.514	0.000	0.000	-0.486
1118.719	0.037	0.000	0.000	-0.521
1122.770	0.125	0.000	0.000	-0.499
1443.876	0.946	0.000	0.000	-0.506
1445.795	0.409	0.000	0.000	-0.485
1449.801	0.464	0.000	0.000	-0.490
1450.815	0.237	0.000	0.000	-0.488
1452.783	0.737	0.000	0.000	-0.491
1457.865	0.612	0.000	0.000	-0.480
1458.810	0.332	0.000	0.000	-0.484
1461.734	0.562	0.000	0.000	-0.480
1463.620	0.000	0.000	0.000	-0.526
1463.719	0.075	0.000	0.000	-0.511
3670.821	0.837	-0.251	-0.380	-0.514
3672.787	0.335	-0.250	-0.384	-0.487
3673.788	0.099	-0.252	-0.369	-0.502
3676.759	0.364	-0.257	-0.378	-0.480
3677.851	0.196	-0.257	-0.359	-0.492
3678.791	0.913	-0.261	-0.382	-0.523
3679.752	0.646	-0.255	-0.363	-0.476
3680.750	0.407	-0.248	-0.364	-0.490
3683.764	0.705	-0.255	-0.367	-0.485
3684.816	0.507	-0.249	-0.379	-0.483
3685.769	0.233	-0.265	-0.375	-0.494
3686.774	0.000	-0.274	-0.391	-0.519
3689.772	0.285	-0.256	-0.387	-0.491
3690.826	0.089	-0.275	-0.398	-0.525
3691.773	0.811	-0.259	-0.373	-0.498
3692.753	0.558	-0.254	-0.375	-0.491
3693.763	0.328	-0.258	-0.359	-0.482
3694.738	0.065	-0.259	-0.366	-0.516
3695.775	0.862	-0.264	-0.379	0.000

UBV DIFFS.(HD164429-HD162132) P=0.517468

HJD 2440000+	PHASE	VISUAL	BLUE	UV
1097.873	0.857	0.000	0.000	-0.447
1103.868	0.442	0.000	0.000	-0.430
1108.876	0.120	0.000	0.000	-0.441
1114.921	0.802	0.000	0.000	-0.428
1117.967	0.688	0.000	0.000	-0.424
1121.831	0.155	0.000	0.000	-0.440
1444.890	0.463	0.000	0.000	-0.427
1445.836	0.291	0.000	0.000	-0.427
1447.869	0.219	0.000	0.000	-0.427
1449.858	0.063	0.000	0.000	-0.455
1450.860	0.000	0.000	0.000	-0.470
1450.880	0.038	0.000	0.000	-0.455
1452.863	0.870	0.000	0.000	-0.449
1459.776	0.402	0.000	0.000	-0.428
1459.865	0.230	0.000	0.000	-0.427
1459.925	0.517	0.000	0.000	-0.432
1461.777	0.096	0.000	0.000	-0.451
3670.027	0.510	0.027	-0.141	-0.432
3673.814	0.828	0.030	-0.143	-0.445
3674.885	0.898	0.025	-0.152	0.000
3675.686	0.446	0.034	-0.122	0.000
3678.813	0.489	0.027	-0.143	-0.426
3679.806	0.408	0.015	-0.149	-0.427
3680.771	0.273	0.030	-0.139	-0.416
3681.000	0.715	0.034	-0.143	-0.423
3683.834	0.192	0.023	-0.142	-0.429
3684.833	0.122	0.015	-0.148	-0.457
3685.806	0.003	0.011	-0.163	-0.466
3686.809	0.941	0.016	-0.164	-0.461
3689.842	0.802	0.025	-0.144	-0.443

TABLE II (Continued)

UBV DIFFS.(HD170973-HD170200) P=0.945099

HJD 2440000+	PHASE	VISUAL	BLUE	UV
1097.899	0.959	0.000	0.000	0.861
1107.918	0.560	0.000	0.000	0.881
1116.865	0.027	0.000	0.000	0.858
1119.901	0.239	0.000	0.000	0.867
1121.864	0.330	0.000	0.000	0.868
1122.869	0.380	0.000	0.000	0.871
1444.861	0.076	0.000	0.000	0.862
1445.858	0.131	0.000	0.000	0.866
1449.881	0.388	0.000	0.000	0.871
1451.900	0.524	0.000	0.000	0.883
1452.886	0.568	0.000	0.000	0.885
1459.900	0.989	0.000	0.000	0.855
1459.910	0.000	0.000	0.000	0.852
1460.783	0.923	0.000	0.000	0.861
3670.892	0.418	0.725	0.716	0.880
3673.834	0.531	0.709	0.703	0.884
3674.913	0.673	0.711	0.715	0.879
3675.714	0.520	0.717	0.702	0.000
3678.833	0.820	0.710	0.697	0.872
3679.852	0.898	0.709	0.698	0.860
3680.893	0.000	0.703	0.694	0.857
3683.855	0.134	0.715	0.000	0.856
3684.876	0.214	0.705	0.693	0.853
3685.845	0.239	0.714	0.699	0.872
3686.836	0.288	0.715	0.702	0.874
3689.877	0.506	0.716	0.703	0.882
3690.888	0.576	0.713	0.697	0.877
3691.832	0.574	0.719	0.706	0.875
3692.864	0.666	0.714	0.706	0.883
3693.854	0.714	0.710	0.708	0.874
3694.852	0.770	0.717	0.713	0.879
3695.866	0.843	0.713	0.713	0.872

UBV DIFFS.(HD179527-HD180613) P=1.160898

HJD 2440000+	PHASE	VISUAL	BLUE	UV
1445.931	0.503	-0.876	-0.848	-0.520
1449.960	0.974	-0.896	-0.870	-0.544
1449.990	0.000	0.000	0.000	-0.553
1450.929	0.808	-0.883	-0.853	-0.524
1452.969	0.566	-0.876	-0.850	-0.520
1453.926	0.390	-0.878	-0.842	-0.517
1455.913	0.102	-0.885	-0.857	-0.526
1461.824	0.193	-0.876	-0.837	-0.510
1461.933	0.287	-0.876	-0.841	-0.502
1463.945	0.020	-0.894	-0.862	-0.543
3670.907	0.103	-0.885	-0.849	-0.544
3671.948	0.000	-0.889	-0.855	-0.542
3672.869	0.793	-0.884	-0.852	-0.529
3674.933	0.571	-0.879	0.000	0.000
3675.833	0.346	-0.872	-0.831	-0.510
3677.944	0.165	-0.892	-0.856	-0.541
3678.878	0.969	-0.905	-0.871	-0.552
3679.878	0.831	-0.893	-0.855	-0.519
3680.902	0.713	-0.884	-0.839	0.000
3681.914	0.584	-0.882	0.000	0.000
3683.882	0.279	-0.877	-0.852	-0.542
3684.885	0.144	0.000	-0.843	-0.539
3685.850	0.975	-0.896	-0.867	-0.547
3686.845	0.832	-0.884	-0.856	-0.532
3689.885	0.451	-0.878	-0.843	-0.525
3690.899	0.324	-0.878	-0.844	-0.513
3691.852	0.145	-0.891	0.000	-0.519
3692.875	0.826	-0.891	-0.854	-0.550
3693.885	0.896	-0.897	-0.867	-0.550
3694.861	0.727	-0.875	0.000	0.000
3695.877	0.612	-0.871	-0.837	-0.513

UBV DIFFS.(HD223358-HD224893) P=1.092

HJD 2440000+	PHASE	VISUAL	BLUE	UV
803.945	0.383	0.000	0.000	0.116
808.945	0.962	0.000	0.000	0.112
809.943	0.876	0.000	0.000	0.099
820.904	0.913	0.000	0.000	0.101
829.945	0.192	0.000	0.000	0.115
1237.632	0.520	0.000	0.000	0.104
1238.608	0.414	0.000	0.000	0.099
1239.610	0.331	0.000	0.000	0.111
1240.608	0.245	0.000	0.000	0.109
1245.653	0.865	0.000	0.000	0.103
1245.800	0.000	0.000	0.000	0.082
1251.613	0.323	0.000	0.000	0.113
1252.610	0.236	0.000	0.000	0.113
1253.615	0.156	0.000	0.000	0.111
1256.598	0.888	0.000	0.000	0.108
3670.969	0.781	0.831	0.000	0.000
3671.966	0.694	0.840	0.497	0.112
3672.945	0.591	0.832	0.486	0.118
3673.946	0.507	0.853	0.000	0.000
3678.944	0.084	0.850	0.495	0.108
3679.929	0.986	0.828	0.493	0.099
3680.956	0.927	0.844	0.490	0.095
3681.966	0.852	0.839	0.492	0.091
3683.948	0.666	0.832	0.494	0.105
3684.945	0.579	0.861	0.514	0.128
3685.942	0.492	0.846	0.500	0.116
3686.943	0.409	0.849	0.511	0.121
3689.953	0.165	0.837	0.500	0.109
3690.964	0.091	0.839	0.493	0.091
3691.956	0.000	0.828	0.487	0.083
3692.953	0.913	0.841	0.494	0.100
3693.972	0.846	0.835	0.486	0.096
3694.967	0.757	0.839	0.504	0.108
3695.960	0.666	0.841	0.497	0.108

od to fit our U data without success. The period of $0^{d}8183$ suggested by Winzer will not satisfy our data. We thus conclude that the star is constant in V. One of the comparison stars, HD 97138, is variable and we plan to try to determine a period for that star.

2. HR 5187 = HD 120198 = 84 Ursae Majoris

Observations of this B9p(EuCr) star using HR 5142 (HD 119024) as the comparison star indicate a decided variation in U light with an amplitude of more than $0^{m}04$. Periodicity is not indicated in B or V light where the indicated variation might be attributed to scatter. The period of $1^{d}38$ is in near perfect agreement with Winzer's period of $1^{d}37999$. If we assume that 1621 cycles have passed since his initial epoch and our observed maximum in U light, we obtain an improved period of $1^{d}37996 \pm 0.00008$. Constancy of the second comparison star, HR 5238, seemed much less certain than for the star we used for the plot, but Winzer used it for his curves. The shape of the U curve with a broad maximum appears very similar to that of Winzer as can be seen in Figure 1. We could not have determined a period from our V or B curves. Winzer's data do show a better indication of a period in those colors.

3. HR 6176 = HD 149822

This star of spectral type B9p[SiCr(Sr)] appears to vary in U light only as can be seen from Figure 2. The
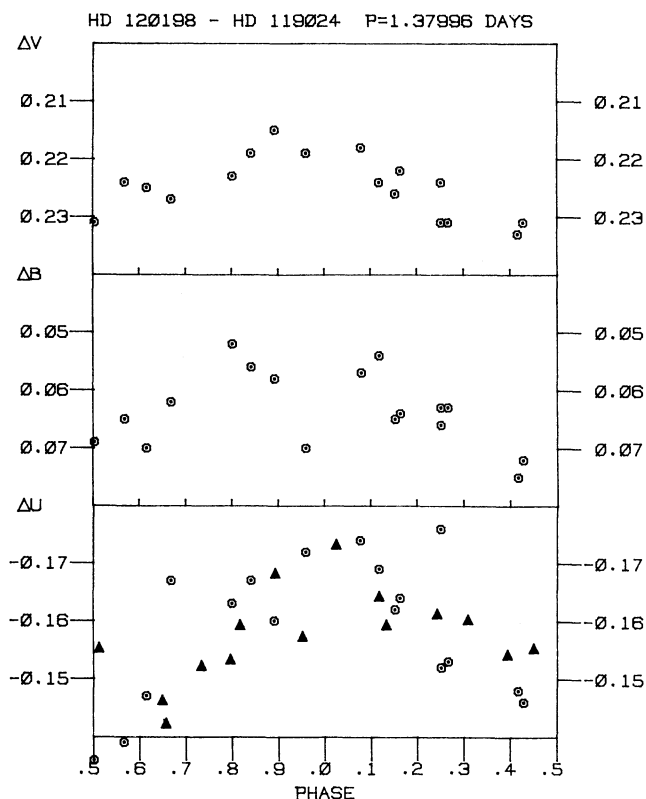
FIG. 1—Photometric observations of HD 120198 are plotted according to the ephemeris HJD (U_{max}) = 2441444.80 + 1.37996 E. The circles indicate our observations from the summer of 1978 and the triangles are Winzer's observations. A difference of -0.065 magnitude was added to his ΔU values.

FIG. 2—Photometric observations of HD 149822 plotted according to the ephemeris HJD (U_{max}) = 2441459.05 + 1.45876 E. A difference of -0.887 magnitude was added to Winzer's ΔU observations. Our data do not indicate a period in V or B.

amplitude of the variation is about 0^m02 which is barely within our instrumental precision. Winzer also found variation in U only. Our period of 1^d455 is almost exactly equal to his period of 1^d4590. If we assumed 1523 cycles since his initial epoch we obtain the improved period of $1^d45876 \pm 0.00008$.

4. HR 6234 = HD 151525 = 45 Herculis

We had observed this B9p(Cr) star previously but insufficient and sometimes questionable data had prevented reliable period determination, so we had not published a result. These data indicated a large variation in U light so that in that color the period was readily determined to be 1^d312 (see Fig. 3). There is an indication of variability in V and B light but we could not have obtained a period from either of those colors. We used the Am star HD 151956 for our comparison whereas Winzer found it to be slightly variable. We saw no evidence of that. If we assume 1696 cycles since his initial epoch and our maximum U light, we obtain the improved period of $1^d31159 \pm 0.0001$.

5. HR 6718 = HR 164429

We had also observed this B9p(SiSr) star previously but the data were inferior to those obtained in this 1978 observing run. Our period search program determined a
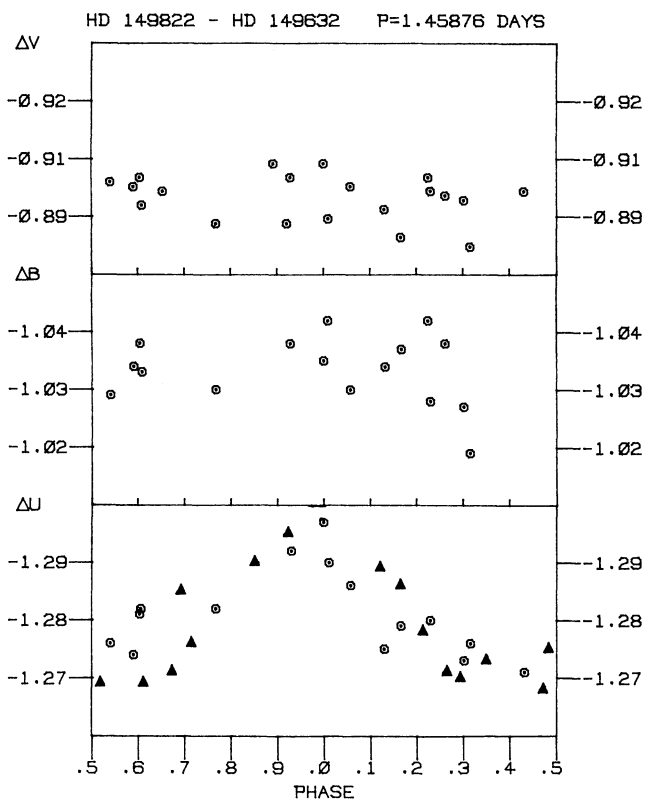
period of 0^d5175. The amplitude is greater in U but it can be seen from Figure 4 that the period could have been obtained from the blue light curve also. Winzer had found the same period and his U curve appeared similar to ours. He found less variation in the V and B observations than we did. The period of this star was confirmed by Catalano, Maguzza, and Strazzulla (1979) who reported a period of $0^d517436$ determined from the U light curve. They state "the amplitude and shape of our light curve are in good agreement with Winzer's one". It appears that their brightness maximum is wider than ours or Winzer's appears to be, but they do have a more thorough coverage of the curve. If we assume that 4319 cycles have passed since Winzer's initial epoch we get the improved period, $0^d517468 \pm 0.00001$.

6. HR 6958 = HD 170973

This peculiar star of spectral type A0p(SiCr) was found to be variable in U light with a period of 0^d945 in perfect agreement with Winzer's period of 0^d9451. As can be seen from Figure 5, there is some evidence of variation in V and B light but the period could not have been obtained from those curves. The appearance of the U curve is very similar to Winzer's curve. If 2350 cycles have passed since his initial epoch, the improved period
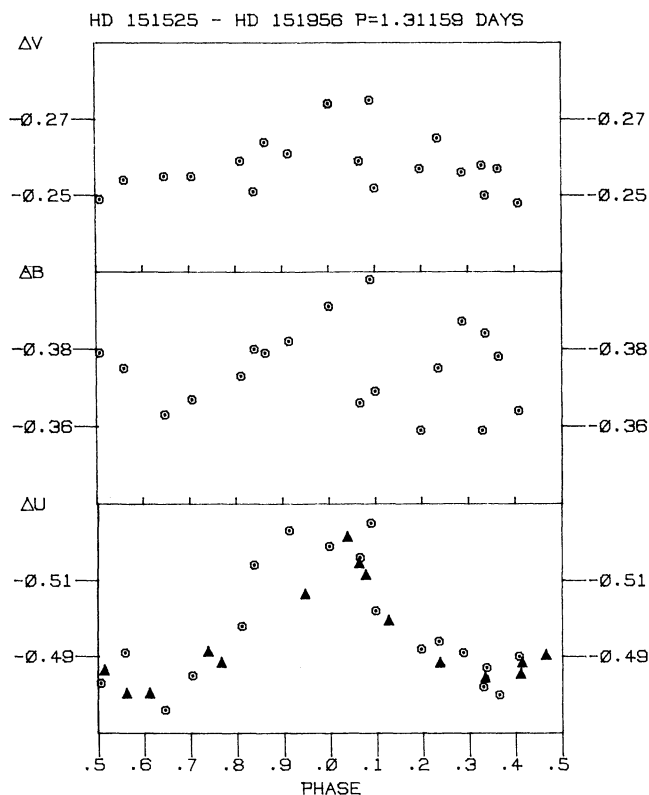
FIG. 3—Photometric observations of HD 151525 plotted according to the ephemeris HJD (U_{max}) = 2441463.62 + 1.31159 E. A difference of −0.280 was added to each of Winzer's ΔU observations. The scatter in ΔB observations is not explained.

FIG. 4—Photometric observations of HD 164429 plotted according to the ephemeris HJD (U_{max}) = 2441450.86 + 0.517468 E. A difference of −0.295 magnitude was added to the ΔU values observed by Winzer Periodic variation is indicated in all colors.

is $0\overset{d}{.}945099 \pm 0.00008$.

7. HR 7283 = HD 179527 = 19 Lyrae

This peculiar star of type B9p(Si) shows variation in all three colors which is typical for silicon stars. Figure 6 is the only diagram that shows Winzer's light curves in all three colors. Our data would have permitted period determination in all three colors. We determine the period of $1\overset{d}{.}161$ from the U curve which compares with Winzer's period of "about $1\overset{d}{.}16$". If 1932 periods have elapsed since his initial epoch, the improved period is $1\overset{d}{.}160898 \pm 0.0001$.

8. HR 9017 = HD 223358

We find a greater brightness variation in U than for B or V in this A0p[Sr(SiCr)] star. Our data indicate a period of $1\overset{d}{.}092$ days but there is scatter. That may be due to the fact that the star was low in the morning sky when we observed it. Winzer determined a period of $0\overset{d}{.}9135$ from a small number of observations which indicated very small amplitude of variation. As can be seen from Figure 7 his data would not have suggested the period we determine. It is also true that our data cannot be ordered to the period Winzer found for this star. Although the period for this star is not firmly established, our data indicate a period of about one day as did the data of Winzer.
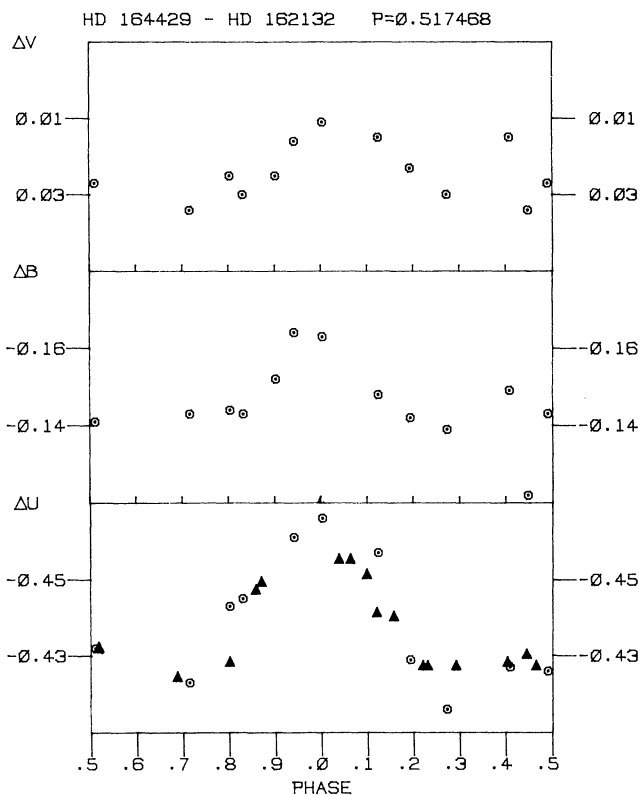
IV. Summary

For these eight stars selected from Winzer's sample, we find almost perfect agreement with his period for six of them; one we observe to be constant and for the other we find a period discrepancy. When one considers the small number of observational points that he had and the fact that those points were often drawn from two observing seasons a year or more apart using different telescopes, filters, and photomultipliers, his ability to find small amplitude variation and period which we can confirm using data taken on a single telescope in a single season is very impressive. We will continue to observe other small amplitude variables included in Winzer's sample to confirm periods.

We appreciate J. E. Winzer's permission to publish some of his data for these stars. We are indebted to Douglas S. Hall of Vanderbilt University for helpful discussions concerning this research and to the Research Corporation for the grant which made this research possible.

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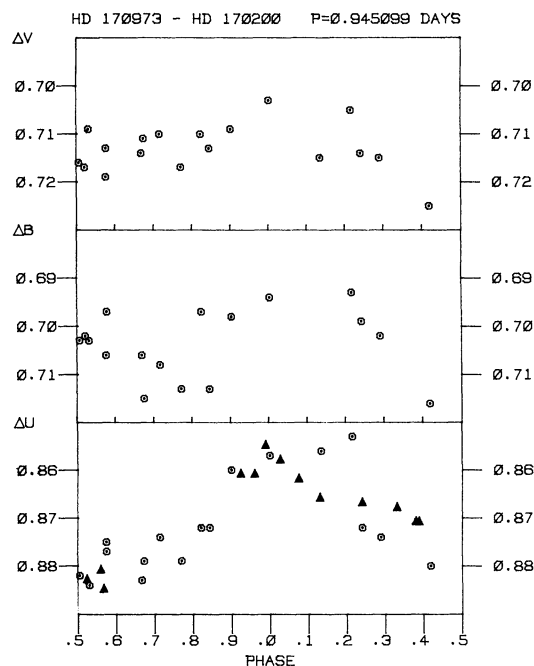Catalano, F. A., Maguzza, A., and Strazzulla, G. 1979, *I.A.U. Inf.*

FIG. 5—Photometric observations of HD 170973 plotted according to the ephemeris HJD (U_{max}) = 2441459.91 + 0.945099 E. A difference of +0.453 magnitude was added to the ΔU values of Winzer. Our blue data give a slight indication of period.
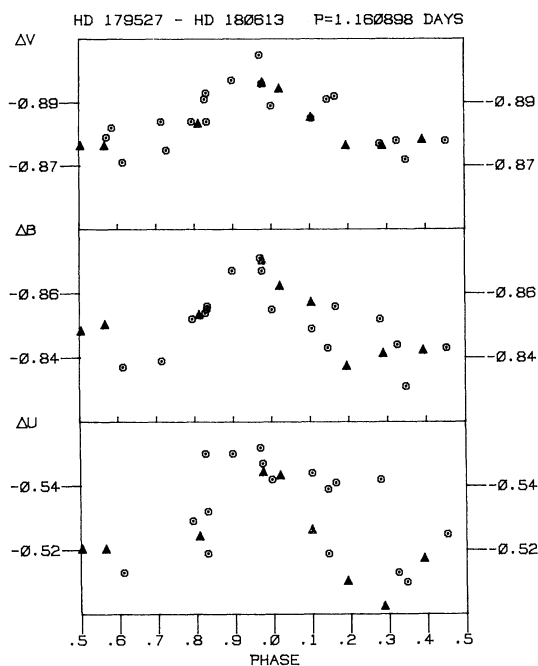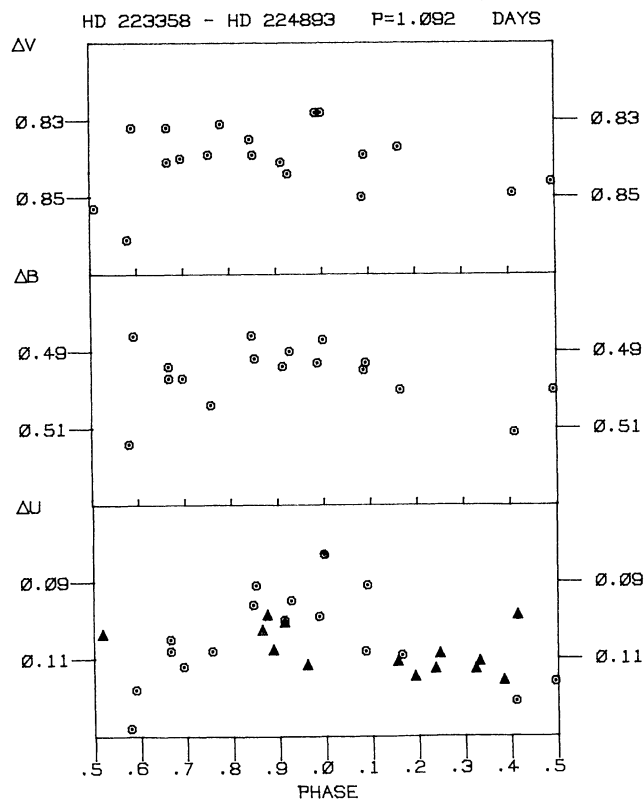

FIG. 7—Photometric observations of HD 223358 plotted according to the ephemeris HJD (U_{max}) = 2441245.80 + 1.092 E. A difference of −1.065 magnitudes was added to each of the ΔU observations of Winzer.

Bull. Var. Stars No. 1695.

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FIG. 6—Photometric observations of HD 179527 plotted according to the ephemeris HJD (U_{max}) = 2441449.99 + 1.160898 E. Winzer's data, triangles, are plotted in all three colors. Although the same comparison star was used, Winzer's values were shifted since he did not transform to the *UBV* system. Magnitude differences added to Winzer's data were: −0.043 in ΔU, −0.014 in ΔB, and +0.008 in ΔV.