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A SURVEY OF VARIABLE YELLOW SUPERGIANTS IN THE SOUTHERN MILKY WAY

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Forty-three supergiants of spectral type F0–G8, including the RV Tauri star U Mon and the small-amplitude cepheid HR 4768 have been monitored in brightness for about a month. Three new variables are announced. HR 6109—a comparison star and a member of a spectroscopic binary with P = 40 days (Eggen 1973)—is suspected to be a δ Scuti star. HR 4912 shows a range of $0^{m}.32$ in B; the period is between 44 and 68 days. The cepheid nature of HR 4912 cannot be established on the basis of our data. HR 4110—the central star of the galactic cluster IC 2581—shows a range in B of $0^{m}.07$ and its most likely period is about 59 days. Arguments are offered against the possible cepheid interpretation of HR 4110. The variability of HR 2910, HR 3026, and HD 67458 is suspected. The star R Pup which has been claimed and disclaimed as a variable for a century, did not show significant variation during our observing period.

Key words: supergiants—variable stars—cepheids—δ Scuti stars

I. Introduction

Surveys of F and G supergiants (Fernie and Hube 1971; Fernie 1976; Henriksson 1977; Percy, Baskerville, and Trevorrow 1979), have been carried out with moderate success in discovering small-amplitude cepheids or cepheid-like supergiants, i.e., stars that, because of their position on the H-R diagram and their light variation may be interpreted as classical cepheids. Many of these stars have long periods and small (typically $0^{m}.1$ to $0^{m}.2$) amplitudes, e.g., 89 Herculis (HD 163506) with $P \sim 70$ days, (Fernie 1981); V810 Centauri (HD 101947) with $P \sim 125$ days (Fernie 1977; Eichendorf and Reipurth 1979); Tr 27-102 (HD 159378) with $P \sim 80$ days (van Genderen and Thé 1978), and BL Telescopii with $P \sim 65$ days (van Genderen 1977). The relative absence of galactic cepheids with $P > 45$ days, as compared to extragalactic samples, has been known for a long time; therefore the interpretation of these long-period variables as cepheids constitutes a very important problem. However, such interpretation is still in debate (van Genderen 1980).

These surveys have also provided us with a large number of stars that according to their spectral types and luminosities should show some kind of variability, but on the contrary do not even show the small irregular fluctuations typical of many other yellow supergiants, e.g., ζ Monocerotis (HD 67594) (Stift 1979). Although placing a star in the H-R diagram is not always easy and accurate work, there exist some well-documented cases of nonvariable stars inside the instability strip (Fernie and Hube 1971; Schmidt 1972). This still constitutes an interesting and challenging problem to be explained by the theory of stellar evolution and pulsation.

Although the number of stars monitored in those previous surveys is rather large, they are by no means complete. There are still many bright stars ($m_v > 7$ mag) that have never been monitored and in which one can see potentially interesting cases, variable or constant, that can increase the statistics of the supergiant behavior in the instability strip region of the H-R diagram. With this in mind, the photometric study of some bright stars never monitored before was undertaken.

II. The Sample

Stars were selected according to the following criteria: availability in the sky, i.e., south of declination $+10°$ and in the right ascension range 7–20 hrs; spectral type between F0 and G8 and luminosity classes I and II (stars of types G5–G8 and luminosity class II were generally avoided for being probably too far outside the instability strip); $m_v > 7$ although a few fainter stars were included; and previously not monitored.

The main sources of candidates were the Catalogue of Bright Stars (Hoffleit, 1964), the Catalogue of MK Spectral Classifications (Jaschek, Conde, and de Sierra 1964) and the compilation of Supergiants in the Milky Way (Buscombe 1973). In all 41 stars were selected; they are listed in Table I. The RV Tauri-type star U Monocerotis and the small-amplitude cepheid HR 4768 were included as well.

III. Observations

The photoelectric photometry was carried out with the no. 1 0.4-m and 0.6-m telescopes at the Cerro Tololo Inter-American Observatory, from 1979 April 25 to May 22. An FW-130 (S-20) detector in a cold box, adapted to a pulse-counting system was used.

In order to be able to observe as many stars as possible in the course of the night, it was decided to observe only through one filter. Since detection of variability was the

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principal aim, the Johnson *B* (as opposed to *V*) filter was chosen because it is this color in which F and G supergiants are expected to have their largest amplitude.

For each program star two nearby (within 5 degrees) comparison stars of similar color and magnitude were selected. The photometry was carried out differentially going through the cycle P-C1-P-C1-C2-sky once or twice a night. The diaphragm used was 27 arc seconds in diameter. Stellar magnitudes were corrected for differential extinction using the Cerro Tololo average extinction coefficient $k_B = 0.23$. Magnitude differences between program and comparison stars were obtained by linear interpolation in time.

IV. Results

Table I lists all the stars monitored; the columns give the following information: first through third, identifications of the star; fourth, spectral type; fifth, visual magnitude; sixth, number of observations; seventh and eighth, comparison stars; and ninth and tenth, variability indicator parameter *r*. The *r* parameter is defined by Fernie and Hube (1971) as

$$r = \langle |(\Delta m)_i - \langle \Delta m \rangle| \rangle \quad .$$

The subscripts of *r* in Table I, P-C1, C1-C2, or P-C2 refer to what stars, program (P) or comparisons (C1,C2) have been used to compute Δm.

From the distribution of values of *r*, the noise level has been estimated at $r = 0^m.025$ and has been assumed to be the same for all the stars. Only those stars exhibiting larger values of *r* have been considered as potential variables. That this is the case for the well-known RV Tauri star U Mon and the small-amplitude cepheid HR 4768, can be seen from their values $r_{\text{P-C1}} = 0.119$, $r_{\text{C1-C2}} = 0.008$ and $r_{\text{P-C1}} = 0.103$, $r_{\text{C1-C2}} = 0.006$, respectively. When $r_{\text{C1-C2}}$ is larger than $r_{\text{P-C1}}$ or $r_{\text{P-C2}}$, the variability is suspected in one of the comparison stars; the other *r* value usually helps in deciding whether it is C1 or C2.

Those stars suspected of variability are listed in Table II. Observations are listed in Tables III-X.

V. Discussion

U Mon (*HD 59693*). This star is a well-known RV Tauri-type star and it was included just because of its availability during our observing run. Our observations, displayed in Figure 1(a), show a maximum. The light-curve elements of Kukarkin et al. (1969) give a period of 92.26 days and predict a minimum at only 7 days from our observed maximum. Different elements were obtained by Isles (1975); he obtains a period of 91.32 ± 7 days. Our observations are consistent with Isles' ephemeris since he predicts a deep minimum very near to the expected minimum according to the behavior exhibited in Figure 1(a), (note arrows in the figure).

The sets of data of DuPuy (1973), Wisse and Wisse (1973), and our own observations were run through a Fourier analysis for unequally spaced data (Deeming 1975), resulting in a broadly defined period between 83–93 days. Such a large range is not surprising in view of aliasing effects, the existence of two minima per cycle, and the apparently unpredictable nature of RV Tauri stars. However, Isles' (1975) ephemeris seems to work very well.

HR 2910. This dF6 star (Hoffleit 1964) was used as C1 for HR 2933 and HR 3045. It is a double star together with HR 2909. They are stars 6190 B and 6190 A, respectively, in the Catalogue of Double Stars (Aitken 1932). Special care was taken in excluding from the diaphragm the star HR 2909. Although the scatter in P-C1 is rather larger than in P-C2 (Table IV), its duplicity and the fact that very few observations were obtained do not permit us to reach any conclusion; however it may be variable and it deserves further study.

R Puppis (*HR 2974*). This star was listed as a variable in the late nineteenth century (Gould 1879), but it was found to be constant later in the present century (White 1975). Recently the star has been reported to show variations with ranges $0^m.16$ in *U*, $0^m.12$ in *B*, and $0^m.05$ in *V* during a month interval in 1977 (Stift 1979). Grieve (1980) does not detect any significant variation in 1979. Eggen (1980) from observations over the last 20 years does not find any variation larger than $0^m.02$. Our observations (Table V, Fig. 1(b)) spread over a month, show a range of $0^m.03$ in *B* for P-C1 and $0^m.02$ for C1-C2, i.e., R Pup appears probably constant.

HR 3026. This star had been originally classified as G8 I*ab* (Bidelman 1957). Morgan and Keenan (1973) reclassified the star as K1 I*a*–I*ab* and defined it as a standard of this spectral type. The nearby star HR 3027 has a spectral type M2 II–III and Bidelman (1957) reached the conclusion that they do not form a physical pair. The observations of Table VI suggest a long period, that, together with its K1I*a*–I*ab* spectral type, make the star a good candidate to be a semiregular variable of the type SRd. Further observations are needed.

HR 2859, HR 3699, HR 4114, and HR 4786. All these stars are listed as VAR? in the Catalogue of Bright Stars (Hoffleit 1964) but no significant variation was detected in the present survey.

HR 4110. It is listed as VAR? in the Catalogue of Bright Stars (Hoffleit 1964). Our observations plus those of Madore (1980) for January 1980—i.e., about eight months apart—are listed in Table VII and plotted in Figure 1(c). The range in *B* is $0^m.07$. The constancy of C1 was tested against C2 and the program star HR 4114.

Figure 1(c) suggests a period of about 40 days. We applied Deeming's (1975) technique for period search but the period cannot be established on the basis of our data alone due to the presence of aliases, which are suspected due to the shape of the window power spectrum. Four periods were identified as the most likely ones; they are 34.87, 40.26, 47.80, and 58.82 days. When these periods

TABLE I

STARS OBSERVED AND THEIR COMPARISONS

HR	HD	NAME	Sp T.	V	N	C1 (HR or HD)	C2 (HR or HD)	r_{P-C1}	r_{C1-C2}	REMARKS
2785	57118		F0Iab-Ib	6.08	7	2788	2868	0.013	0.015	
2786	57146		G0II	5.40	7	2607	2686	0.013	0.012	
	57321		F2II	7.06	6	2866	2876	0.009	0.012	
2803	57623	δ Vol	F8II	3.97	7	2662	2754	0.014	0.004	
2833	58526		G3Ib	5.97	7	2866	2876	0.004	0.015	
2859	59067		G8Ib+B	5.78	7	2832	2868	0.012	0.008	
	59693	U Mon	F8eIb	6.10:	7	2832	2868	0.119	0.008	RV Tauri Star
2881	59890		G1Ib	4.64	6	3018	3079	0.008	0.006	
2933	61227		F0II	6.30	5	2910	2906	0.030	0.043	r_{P-C2}=0.014: HR 2910 variable?
2974	62058	R Pup	G0Ia	6.64	6	3018	3079	0.012	0.006	
3026	63302		G8Iab	6.71	6	3029	3064	0.056	0.020	variable?
3045	63700	ξ Pup	G3Ib	3.34	7	2910	2906	0.037	0.043	r_{P-C2}=0.005: HR 2910 variable?
3102	65228	11 Pup	F8II	6.02	7	3255	3276	0.006	0.015	
3291	70761		F2Ib	5.89	9	3430	HD 67458	0.009	0.031	
3445	74180		F2Ia	3.89	8	3444	HD 74842	0.005	0.006	
3459	74395		G2Ib	4.63	7	3297	3538	0.019	0.032*	
3496	75276		F2Iab	5.75	8	3444	HD 74842	0.017	0.006	
3699	80404	ι Car	F0I	2.24	10	3598	3693	0.008	0.012	
4110	90772		F0Ia	4.66	10	4061	4134	0.026	0.004	New Cepheid-like Supergiant
4114	90853		F0II	3.82	10	4061	4134	0.008	0.004	
4319	96436	65 Leo	sgG7	5.55	9	4265	4414	0.007	0.011	
4325	96566		sgG5	4.60	7	4413	4384	0.004	0.006	
4441	100261	o^1 Cen	G0Ia	5.07	8	HD 100773	4513	0.011	0.002	
4522	102350		G0II	4.10	8	HD 100773	4513	0.006	0.002	
4768	108968		cF	5.44	11	4749	4764	0.103	0.006	Small-Amplitude Cepheid
4786	109379	β Crv.	G5II-III	2.66	11	4691	4803	0.012	0.016	
4912	112374		cF6	6.76	10	4803	4881	0.123	0.026	New Cepheid-like Supergiant
	115400		F5Iab	7.50	9	4980	4989	0.011	0.012	
5171	119796		G8Ia	6.23	11	5113	5124	0.014	0.003	
5621	133683		F9Ib	5.76	11	5645	5700	0.013	0.015	
5660	135153	1 Lup	F0I	4.90	12	5688	5657	0.013	0.020	
5667	135345		G5Ia+B	5.20	12	5698	5699	0.007	0.011	
6030	145544	δ TrA	G2II	3.84	10	6037	6109	0.005	0.037	r_{P-C2}=0.024: HR 6109 variable
6058	146143	γ^1 Mon	F8Iab	4.96	10	5921	HD 145158	0.008	0.007	
	151097		F8Iab	7.60	11	HD 151337	HD 150248	0.007	0.017	
6392	155603		G5Ia	6.22	9	6045	6454	0.002	0.007	
6553	159532	θ Sco	F0Ib	1.88	9	6649	6597	0.008	0.008	
6615	161471	ι^1 Sco	F2Ia	2.98	8	6649	6597	0.006	0.008	
6724	164584	7 Sgr	F5II	5.35	9	6595	6836	0.012	0.008	
	168393		F0I	7.44	8	6930	HD 170715	0.012	0.007	
	175580		G2I	6.76	7	7303	7266	0.008	0.006	
	180028		F6Ib	7.23	7	7303	7266	0.005	0.003	
7389	182900		F5Ib	5.72	8	7354	7332	0.004	0.009	

* Two observations are very uncertain.

are used to phase the observations, only P = 58.82 days produces a reliable smooth light curve (Fig. 2) and therefore we consider it as our best estimate. In Figure 1(c), Madore's (1980) observations were shifted back to our epoch for P = 58.82 days and (for comparison) P = 34.87 days.

HR 4110 is the central star of the open cluster IC 2581 and has been demonstrated to be a member of the cluster (Lloyd Evans 1969). Several spectral classifications have been published: F0 I*a* (Bidelman 1954), A7 I*a* (Lloyd Evans 1969), A5 I*a* (Malaroda 1973), A6 I*a* (Malaroda 1975), A9 I*a* (Garrison, Hiltner, and Schild 1977),

TABLE II

NEW VARIABLES AND STARS SUSPECTED OF VARIABILITY

HR (or HD)	Observed range in B (mag.)	Remarks
2910	0.08	variable? Table IV
3026	0.23	variable? Table VI
HD 67458	0.13	variable?
4110	0.07	new small-amplitude supergiant Table VII, Fig. 2
4912	0.32	new small-amplitude supergiant Table IX, Fig. 4
6109	0.14	new δ Scuti star? Table X, Fig. 1-e

TABLE III

U Mon (P) Relative to HR 2832 (C1) and HR 2868 (C2)

JD 244 0000.+	P-C1	P-C2
3989.557	1.743	1.468
3993.508	1.698	1.396
3994.509	1.696	1.393
3997.511	1.739	1.431
4008.508	1.878	1.590
4015.484	1.969	1.682
4016.484	2.041	1.760

TABLE IV

HR 2910 (C1) Relative to HR 2933 (P) and HR 2906 (C2)

JD 244 0000.+	P-C1	P-C2
3994.536	0.561	1.944
3997.532	0.560	1.934
4008.532	0.633	1.920
4015.502	0.608	1.892
4016.495	0.626	1.919

TABLE V

R Pup (HR 2979) (P) Relative to HR 3018 (C1) and HR 3079 (C2)

JD 244 0000.+	P-C1	C1-C2
3993.522	1.749	0.458
3994.523	1.748	0.467
3997.522	1.761	0.465
4008.520	1.767	0.476
4015.496	1.782	0.472
4016.490	1.781	0.464

TABLE VI

HR 3026 (P) Relative to HR 3029 (C1)

JD 244 0000.+	P-C1
3989.602	2.026
3993.542	2.100
3997.539	2.106
4013.482	2.128
4015.503	2.257
4016.502	2.160

TABLE VII

HR 4110 (P) Relative to HR 4061 (C1) and HR 4134 (C2)

JD 244 0000.+	P-C1	C1-C2
3989.665	-1.078	0.920
3993.606	-1.090	0.915
3994.602	-1.099	0.919
3997.591	-1.108	0.919
4008.585	-1.151	0.908
4003.540	-1.151	0.908
4015.551	-1.142	0.910
4016.547	-1.142	0.915
4253.825*	-1.138	0.930
4254.805*	-1.130	0.913
4255.793*	-1.122	0.918
4256.787*	-1.129	0.918

* Madore (1980)

TABLE VIII

HR 4768 (P) Relative to HR 4749 (C1)

JD 244 0000.+	P-C1	B(HR 4768)*
3989.737	-0.976	6.08
3992.680	-0.869	6.19
3993.651	-1.094	5.97
3996.709	-1.065	6.00
3997.633	-1.016	6.04
4008.627	-0.827	6.23
4013.585	-1.072	5.99
4015.589	-1.799	6.26
4015.660	-0.802	6.27
4016.585	-1.010	6.05

* Assuming B(HR 4749)=7.06.

TABLE IX

HR 4912 (P) Relative to HR 4803 (C1) and HR 4881 (C2)

JD 244 0000.+	P-C1	C1-C2
3989.758	1.600	-0.594
3992.701	1.627	-0.517
3993.669	1.637	-0.619
3994.687	1.678	-0.640
3997.647	1.677	-0.637
4008.645	1.837	-0.624
4013.598	1.906	-0.633
4015.602	1.923	-0.643
4015.674	1.871**	-0.720**
4016.600	1.903	-0.621
4254.854*	1.613	-0.599
4255.839*	1.617	-0.635
4255.805*	1.617	-0.640
4256.797*	1.630	-0.651

* Madore (1980)
** poor observing conditions

TABLE X

ι TrA (HR 6109) (C2) Relative to HR 6037 (C1) and HR 6030 (P)

JD 244 0000.+	C1-C2	P-C1
3989.840	0.495	-1.208
3992.761	0.527	-1.214
3993.821	0.459	-1.208
3996.757	0.459	-1.207
3997.754	0.528	-1.203
4008.798	0.572	-1.221
4013.651	0.522	-1.207
4013.786	0.520	-1.206
4015.643	0.431	-1.195
4016.646	0.459	-1.201

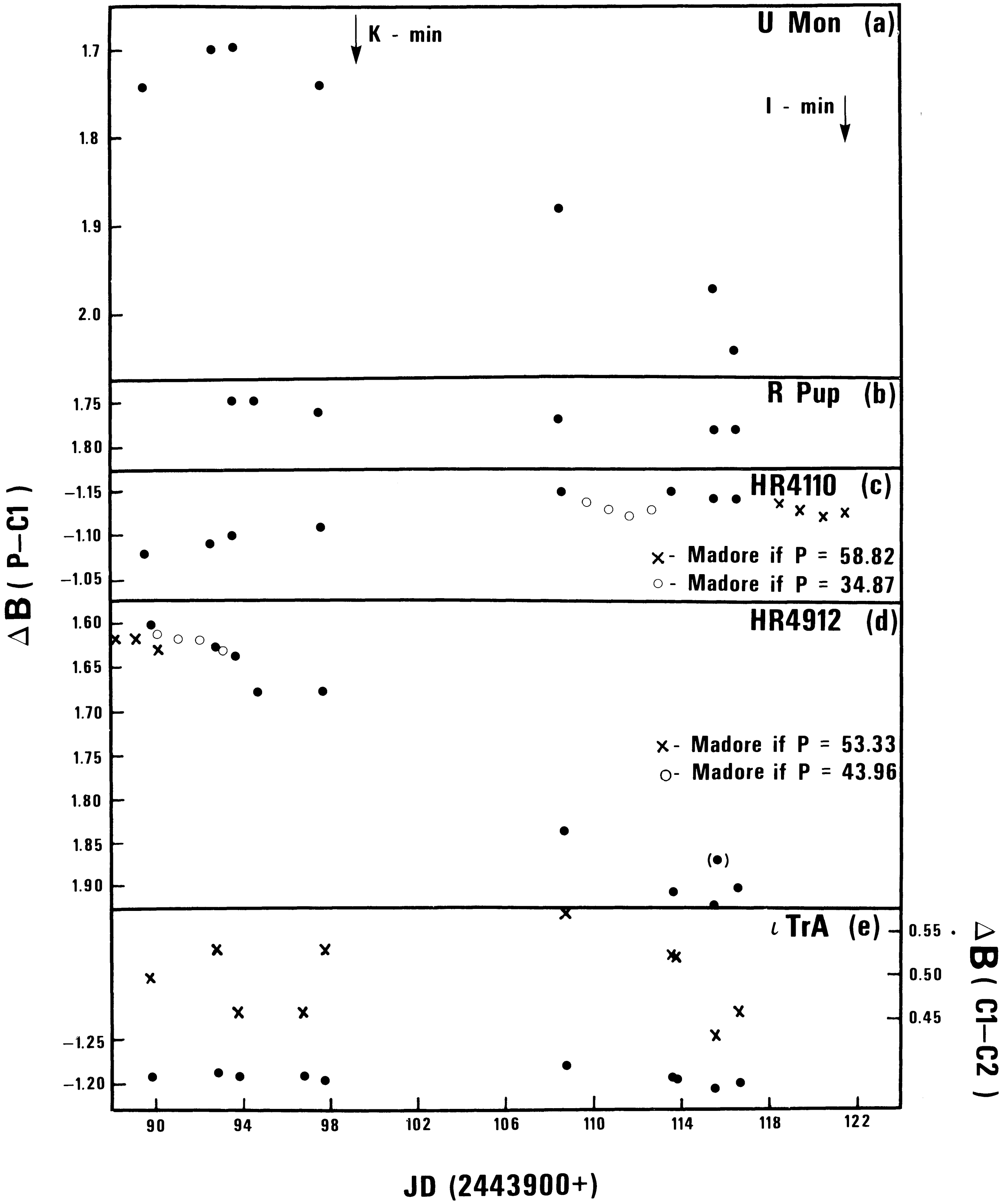

FIG. 1—(a) Magnitude differences of U Mon relative to HR 2832. The arrows K-min and I-min mark the time of the minimum predicted by Kukarkin et al. (1969) with P = 92.26 and Isles (1975) with P = 91.32. (b) R Pup relative to HR 3018. No variation, other than a very slight decrease in magnitude (0^m03) was detected. (c) Variation of HR 4110 relative to HR 4061 (see text). (d) Variation of HR 4912 relative to HR 4803 (see text). (e) Crosses show the variation of ι TrA (C2) relative to HR 6037 (C1). The constancy of HR 6037 and HR 6030 (P) is shown by the dots.

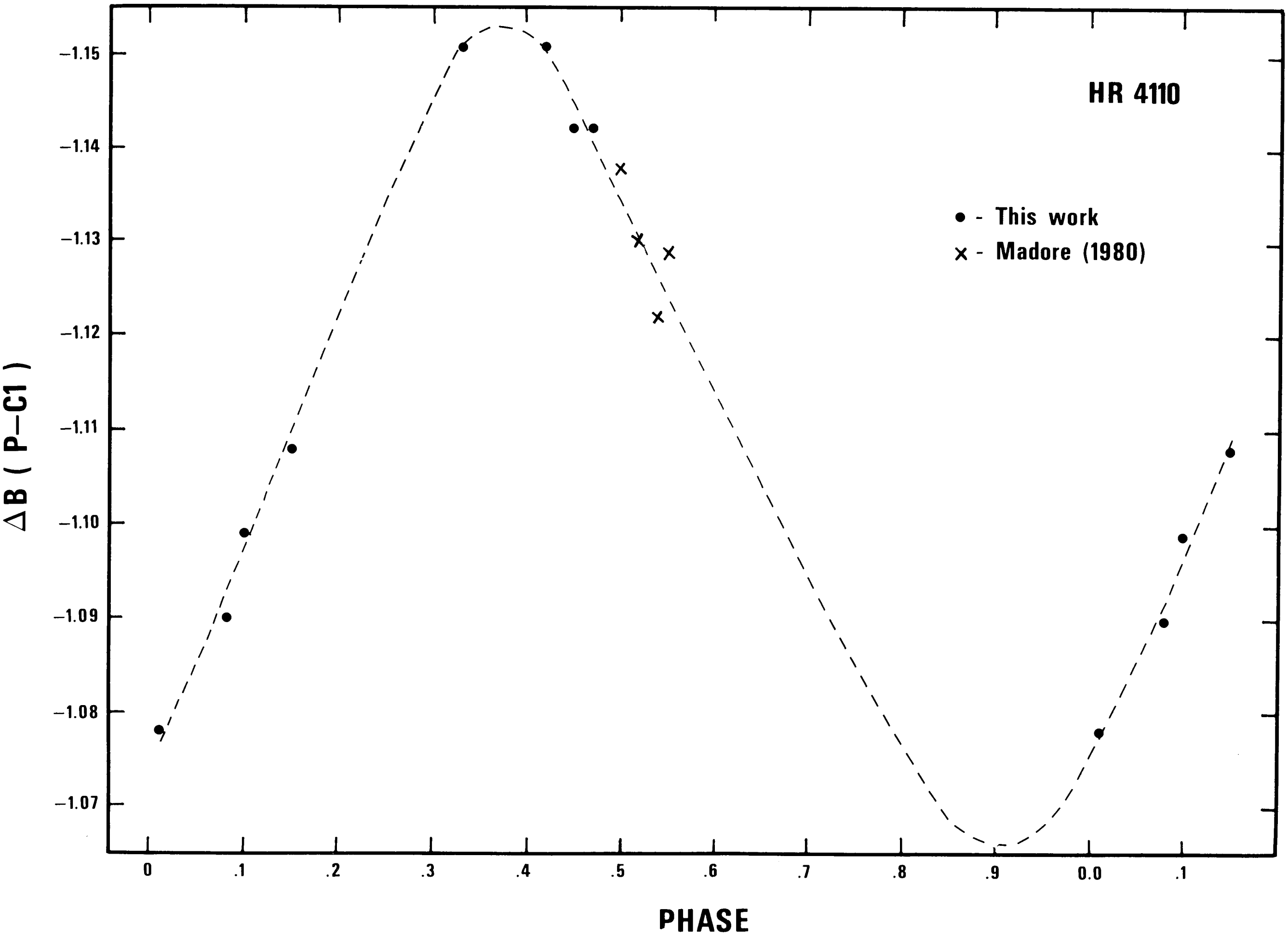

FIG. 2—Observations of HR 4110 phased to the epoch JD = 2443989. and P = 58.82 days. The light curve suggested by the data is shown by the blank free-hand drawn broken curve.

and A7 I*a*–0 (Turner 1978). Fernie (1963) comments, with respect to the absolute magnitude and color, that they are "... more consistent with a late - A I*a*" spectral type. In the Photoelectric Catalogue (Blanco et al. 1968), single photometric observations by different observers, have ranges of $0\overset{m}{.}09$ in V and $0\overset{m}{.}12$ in B, supporting the variable nature of the star.

By adopting the values $M_V = -8.6$, $(B-V) = 0.52$ and $E_{B-V} = 0.42$ from the exhaustive work of Lloyd Evans (1969) and using Flower's (1977) color-$T_{\rm eff}$ calibration and bolometric correction, we find $T_{\rm eff} = 8500$ K corresponding to the spectral type A5 I*a*. These values put HR 4110 well outside the instability strip of Cox and Hodson (1978), arguing against its cepheid nature.

On the other hand, the star is situated in the region of the H-R diagram where Maeder (1980) predicts amplitudes of $0\overset{m}{.}05$ in V on the average.

The P-L-C relation for B9–A5 supergiants derived by Maeder (1980)

$$\log P = -0.346\, M_{\rm bol} - 3 \log T_{\rm eff} + 10.60$$

predicts $P = 61$ days in good agreement with our determination of $P = 58.82$ days. More observations are needed for verification and improvement of the period.

HR 4768. This small-amplitude cepheid was discovered by Stobie and Alexander (1970) who derived a period of 3.3428 ± 0.0003 days. We run our observations (Table VIII) together with those of Stobie and Alexander (1970), Stobie and Balona (1979), and Grieve (1980), through Deeming's (1975) period search routine. They lead to the period 3.24281 days. The above observations span over ten years and do not show significant variations in either period or in amplitude.

In Figure 3 we have phased our observations using the ephemeris

$$\text{Max (JD)} = 2440393.66 + 3.3428E.$$

given by Stobie and Alexander.

HR 4912. This star is a new small-amplitude supergiant. Our observations and those of Madore (1980) are listed in Table IX and plotted in Figure 1(d). They show a range in B of $0\overset{m}{.}32$ and a rather long period. The scat-

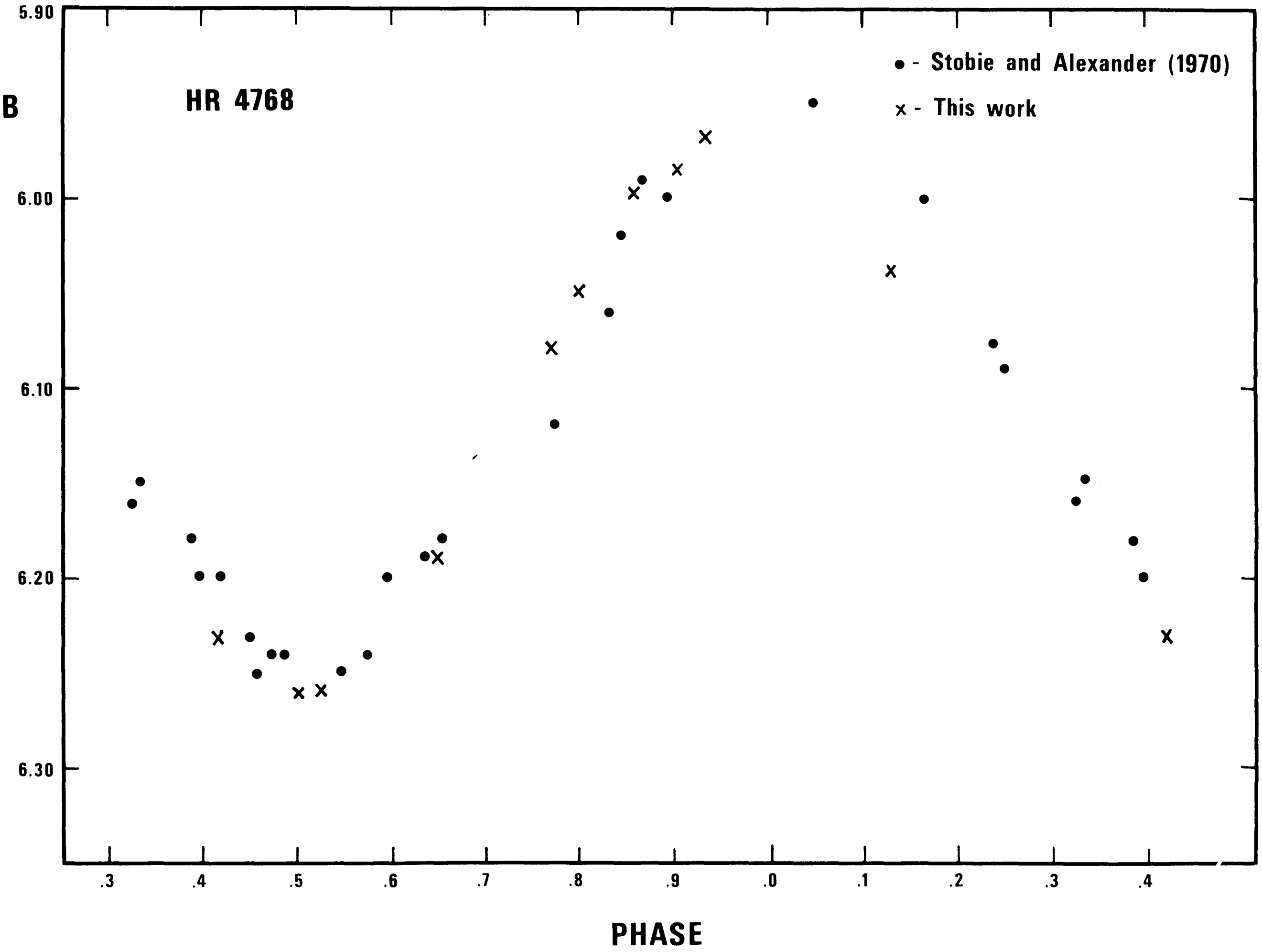

FIG. 3—Variation of HR 4768 phased according to the formula Max (JD) = 2440393.66 + 3.3428 *E* (Stobie and Alexander 1970).

ter of C1-C2 indicates that probably HR 4803 (C1) is not a good comparison star. Again as for HR 4110, the Fourier power-spectrum analysis (Deeming 1975) suggests the periods 43.96, 53.33, and 67.80 days. Figure 1(d) shows Madore's (1980) observations shifted back to the epoch of the figure for the periods 43.96 and 53.33 days. If P = 67.80 days, Madore's observations would not appear on the figure. Figure 4 shows the light curve phased to the three periods. In this case it is not easy to judge from the shape of the light curve which is a better estimate, although a glance at the figure suggests that P = 43.96 days is probably closer to reality.

Two spectral types are given, G0 in the Henry Draper Catalogue and cF6 in the Catalogue of Bright Stars. Very little information on this star can be found in the literature. Whether it is a classical cepheid is not known yet and cannot be assessed on the basis of our data alone. Further study is urged.

ι Trianguli Australis (*HR 6109*). This star was used as the second comparison star for HR 6030 which fortunately turned out to be constant, allowing us to discover the variability of ι TrA. It is a spectroscopic binary with a period of 40 days (Eggen 1973). The separation between ι TrA and its 9.42-magnitude companion is 24.″7 (Landolt 1969); this means that by centering the star in our 27″ diaphragm we succeeded in blocking out any contaminating light from the companion.

In panel (e) of Figure 1 we have plotted the observations listed in Table X. The magnitude differences P-C1 show the constancy of these two stars while the scatter of C1-C2 values makes evident the variable nature of ι TrA (C2).

The variability of ι TrA and its spectral type dF4 (Hoffleit 1964) suggest that ι TrA may be a δ Scuti variable. Since the time distribution of our observations is less than ideal for a short period determination, no further analysis was done. More appropriate observations are needed. The observations in Table X will be useful, in the future, for refining the period.

In summary, three new variable stars are announced: ι TrA (HR 6109) as a probable δ Scuti star and the yellow supergiants HR 4110 and HR 4912. Also the variability of HR 2910, HR 3026, and HD 67458 is suspected. The star R Pup (HR 2974), reported sometimes as a variable

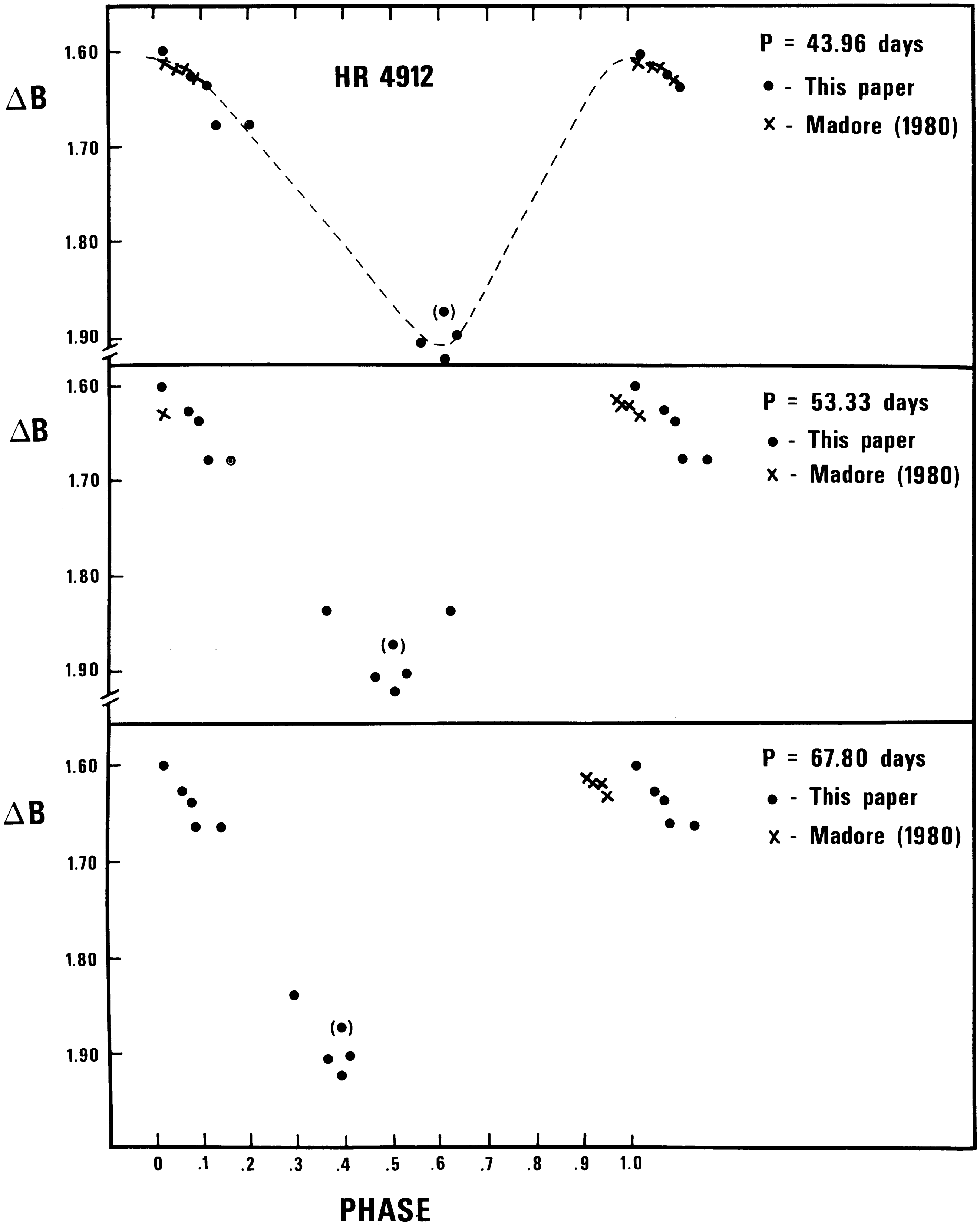

FIG. 4—Observations of HR 4912 relative to HR 4803 phased to the epoch JD = 2443989. and the periods 43.96, 53.55, and 67.80 days. Although the three periods fit the data reasonably well, P = 43.96 days seems to be the best. The point between brackets should be considered of lower weight due to the poor quality of the observing conditions at the time.

(Stift 1979) and sometimes as a constant (White 1975; Grieve 1980; Eggen 1980), did not show any significant variation during our run.

It is worthwhile to mention how; by means of surveys like the present, one can still discover interesting variables among the bright stars. With HR 4110 and HR 4912, the number of long-period cepheid-like supergiants increases to at least 16 (Percy 1981), some of which have been identified as possible low-amplitude long-period cepheids; such is the case of V810 Cen (HD 101947) (Fernie 1977; Eichendorf and Reipurth 1979) and of Tr 27-102 (HD 159378) (van Genderen and Thé 1978). Arguments against their cepheid interpretation are offered by van Genderen (1980). It is fair to say that the question of whether there exist true galactic cepheids with $P > 45$ days still remains unanswered. Not much can be said at the present stage on the possible cepheid nature of HR 4110 and HR 4912, although in the case of HR 4110 we have given some arguments against this interpretation.

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REFERENCES

Aitken, R. G. 1932, *New General Catalogue of Double Stars*, Carnegie Institution, Washington.
Bidelman, W. P. 1954, *Pub. A.S.P.* 66, 249.
——— 1957, *Pub. A.S.P.* 69, 326.
Blanco, V. M., Demers, S., Douglass, G. G., and FitzGerald M. P. 1968, *Pub. U.S. Naval Observatory* 21, 1.
Buscombe, W. 1973 (unpublished).
Cox, A. N., and Hodson, S. W. 1978, in *The HR Diagram, I.A.U. Symposium No. 80*, A. G. Davis Philip and D. S. Hayes, eds. (Dordrecht: Reidel), p. 237.
Deeming, T. J. 1975, *Ap. and Space Sci.* 36, 137.
DuPuy, D. L. 1973, *Ap. J.* 185, 597.
Eggen, O. J. 1973, *Pub. A.S.P.* 85, 542.
——— 1980, *Ap. J.* 238, 919.
Eichendorf, W., and Reipurth, B. O. 1979, *Astr. and Ap.* 77, 227.
Fernie, J. D. 1963, *Observatory* 83, 33.
——— 1976, *Pub. A.S.P.* 88, 116.
——— 1977, *Inf. Bull. Var. Stars*, No. 1305.
——— 1981, *Ap. J.* 243, 576.
Fernie, J. D., and Hube, J. O. 1971, *Ap. J.* 168, 437.
Flower, P. J. 1977, *Astr. and Ap.* 54, 31.
Garrison, R. F., Hiltner, W. A., and Schild, R. E. 1977, *Ap. J. Suppl.* 35, 111.
Gould, B. A. 1879, *Res. Obs. Nac. Argentino, Cordoba*, 1, 1.
Grieve, G. R. 1980 (private communication).
Henriksson, G. 1977, *Astr. and Ap.* 54, 309.
Hoffleit, D. 1964, *Yale Catalogue of Bright Stars*, New Haven.
Isles, J. E. 1975, *J. British Astr. Assn.* 85, 156.
Jaschek, C., Conde, H., and de Sierra, A. C. 1964, *Catalogue of Stellar Spectra Classified in the Morgan-Keenan System*, La Plata.
Kukarkin, B. V., Kholopov, P. N., Efremov, Yu. N., Kukarkina, N. P., Kurochkin, N. E., Medvedeva, G. I., Perova, N. B., Federovick, V. P., and Frolov, M. S. 1969, *General Catalog of Variable Stars* (Moscow: USSR Academy of Sciences).
Landolt, A. U. 1969, *Pub. A.S.P.* 81, 443.
Lloyd Evans, T. 1969, *M.N.R.A.S.* 146, 101.
Madore, B. F. 1980 (private communication).
Maeder, A. 1980, *Astr. and Ap.* 90, 311.
Malaroda, S. 1973, *Pub. A.S.P.* 85, 328.
——— 1975, *A.J.* 80, 637.
Morgan, W. W., and Keenan, P. C. 1973, *Ann. Rev. Astr. and Ap.* 11, 29.
Percy, J. R. 1981, *Bull. A.A.V.S.O.* (in press).
Percy, J. R., Baskerville, I., and Trevorrow, D. W. 1979, *Pub. A.S.P.* 91, 368.
Schmidt, E. G. 1972, *Ap. J.* 172, 679.
Stift, M. J. 1979, *Astr. and Ap.* 80, 134.
Stobie, R. S., and Alexander, J. B. 1970, *Observatory* 90, 66.
Stobie, R. S., and Balona, L. A. 1979, *M.N.R.A.S.* 189, 641.
Turner, D. G. 1978, *A.J.* 83, 1081.
van Genderen, A. M. 1977, *Astr. and Ap.* 58 ,439.
——— 1980, *Astr. and Ap.* 88, 77.
van Genderen, A. M., and Thé, P. S. 1978, *Astr. and Ap.* (*Letters*) 64, L1.
White, S. D. M. 1975, *Ap. J.* 197, 67.
Wisse, P. N. J., and Wisse, M. 1973, *Astr. and Ap.* 23, 463.