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SOME NEW VARIABLES IN NEARBY ASSOCIATIONS AND GALACTIC CLUSTERS*†‡

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ABSTRACT

Data are presented for 20 new variable stars discovered in some of the nearby galactic clusters and associations. These variables include 9 eclipsing binaries (including 4 doubtful cases), 3 variable emission-line or peculiar stars, and 8 variables of unknown type.

I. INTRODUCTION

In the course of a photoelectric search for β Cephei stars in the nearest associations and galactic clusters (Hill 1967), a number of other variable stars were discovered. Some of them were already known and had been inadvertently included with the program stars, but the search did result in the discovery of twenty new variables of differing types. This paper presents a brief description of these variables.

II. RESULTS

The methods of observing and reducing the data have already been described (Hill 1967) and will not be repeated here. The new variables listed in Table 1 are divided into three groups: eclipsing binaries, Be and peculiar stars, and variables of unknown type. The periods quoted in Table 1 for the eclipsing binaries may be grossly in error because: (1) the observations were made at almost the same hour angle each night, and (2) the periods had to be determined by trial and error since the method of Lafler and Kinman (1965) was not suited to these eclipsing binary data. A discussion of the individual stars follows.

a) Eclipsing Binaries

HD 13716.—This star, classified as B0.5 III and B1 Ia, varies by ~0.06 mag. Petrie and Pearce (1962) state that the radial velocity is variable. Part of one eclipse may be included in the present observations. A *very tentative* eclipsing binary.

HD 13758.—This star, classified B1 V, B5 III, and B5 IV, is a possible eclipsing binary (see Fig. 1). A period of $0^d.7074 \pm 0^d.0005$ was derived from limited data (fourteen observations on four nights). A radial velocity of −14 km/sec is given by Barbier and Boulon (1960). If this star is a member of h and χ Persei, then its radial velocity is probably variable also, since the mean cluster velocity is −44 km/sec.

HD 254699.—At least two periods, $1^d.0748 \pm 0^d.0002$ and $2^d.1497 \pm 0^d.0004$, represent the data. The depth of the minimum is ~0.15 mag. The light curve is shown in Figure 2 for the shorter period. A certain eclipsing binary.

HD 53649.—No period could be determined because of insufficient data. Brightness variations of ~0.15 mag were detected. A *tentative* eclipsing binary.

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TABLE 1

OBSERVATIONAL DATA

HD or BD	Star	Ass. or gal. cl.	MK	V	B-V	U-B	$(U-B)_o$	M_V	Δmag (min-max)	Period (days)	v sin i (km/sec)	Notes
					ECLIPSING BINARIES							
13716	57°525	Per I	B0.5 III	8.27	0.32	-0.59	-1.03	-5.4	0.06		160	1
13758	57°527	Per I	B1 V	9.05	0.33	-0.53	-0.99	-4.6	0.05	0.7074	≥280	
254699	23°1286	Gem I	B1 V	9.04	0.40	-0.46	-0.96	-4.0	0.15	1.0748:	130	2
53649	-8°1733	Field star	B0.5 III	9.12	0.26	-0.66	-1.08		0.15			3
53756	-12°1777	Field star	B2 IV	7.32	-0.08	-0.78	-0.92		0.23	4.1237		
203025	57°2309	Cep II	B2 III	6.41	0.20	-0.49	-0.78	-4.67	0.05		210	4
61°2213	4	NGC 7160		8.92	0.17	-0.46	-0.74	-1.8	0.08		220	5
	4	NGC 7380		10.19	0.40	-0.12	-0.51	-3.1	0.06	0.52292:		6
216629	61°2361	Cep III	B2pe	9.29	0.72	-0.19	-0.92		0.32	1.401:	170	7
					VARIABLE Be AND PECULIAR STARS							
13890	56°478	Per I	B1 IIIp	8.50	0.19	-0.64	-0.97	-4.6	0.09	1.241:	50	
14422	Oo 2138	Per I	B0 IV:pe						0.04		≥280	
39340	26°985	Gem I	B3 V						0.22		≥330	
					VARIABLES OF UNKNOWN TYPE							
12993	57°498	Per I	O5	8.95	0.20	-0.79	-1.20	-4.4	0.03			
39291	55 Ori	Ori I	B2 III	5.33	-0.19	-0.87	-0.91	-3.0	0.05		160	
42379	21°1143	Gem I	B1 II	7.42	0.34	-0.55	-1.00	-5.6	0.04		72	8
138485	ζ Lib	Sco II	B2 Vnn						0.03		360	9
142184	-23°12569	Sco II	B2 Vnn	5.42	-0.04	-0.62	-0.76	-1.1	0.03		400	10
206165	9 Cep	Cep II	B2 Ib	4.73	0.27	-0.55	-0.88	-6.23	0.06		33	
216200	14 Lac	Lac I	B3 IV:	5.91	0.08	-0.51	-0.73	-3.9	0.03		225	11
218674	48°3950	Lac I	B3 IV	6.73	-0.01	-0.57	-0.73	-2.8	0.06		≥330	12

NOTES TO TABLE 1

1. Velocity variable; tentative eclipsing binary.
2. Period is uncertain.
3. Tentative eclipsing binary.
4. Spectroscopic binary; tentative eclipsing binary.
5. Velocity variable; tentative eclipsing binary.
6. Period is uncertain.
7. Period is uncertain.
8. Velocity variable.
9. Velocity variable.
10. Velocity variable.
11. Velocity variable.
12. Velocity variable.

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HD 53756.—This star, classified as B2 IV, is an eclipsing binary with a period of $4^d.1237$ (see Fig. 3).

HD 203025.—This star is a spectroscopic binary with a period of $5^d.41364$ (Plaskett and Pearce 1930). Light variations of ~0.05 mag were found. A light curve, drawn with this period, has the appearance of an eclipsing binary; but because the data are not well distributed in phase, this conclusion is a *tentative* one.

NGC 7160-4 (NGC 7160-3, Hayford 1932).—Hayford (1932) found that the radial velocity was variable ($2K \sim 200$ km/sec). The light variation is ~0.08 mag, but no period could be determined. A *very tentative* eclipsing binary.

NGC 7380-4.—At least three periods, $0^d.52292 \pm 0^d.00005$, $1^d.04584 \pm 0^d.00010$, and $2^d.09168 \pm 0^d.00020$, represent the data. The results, which indicate an eclipsing binary, are shown in Figure 4 for a period of $1^d.04584$.

HD 216629.—This star, classified B2pe or B3e, is a certain eclipsing binary (see Fig. 5). Two periods, $1^d.401 \pm 0^d.003$ and $2^d.802 \pm 0^d.006$, fit the data. The depth of the minimum is ~0.3 mag.

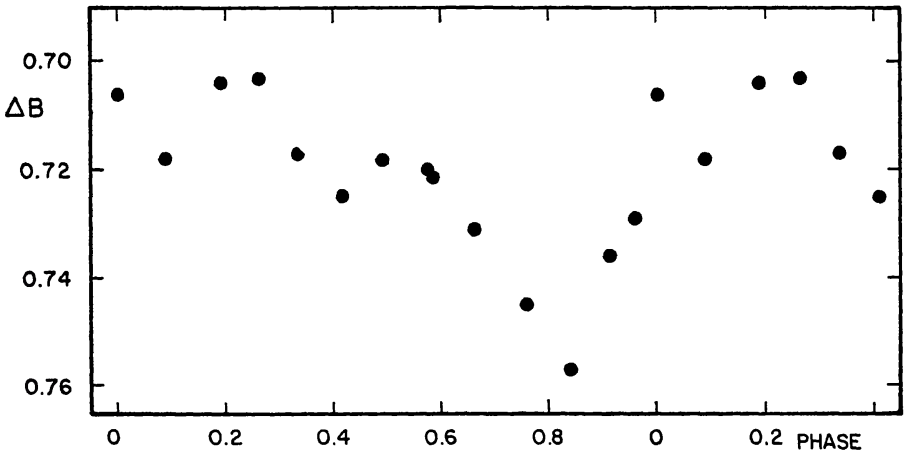

FIG. 1.—Photoelectric observations of HD 13758. The comparison star is HD 16310. The blue magnitude differences are given in the sense HD 16310 *minus* HD 13758. The period is $0^d.7074$.

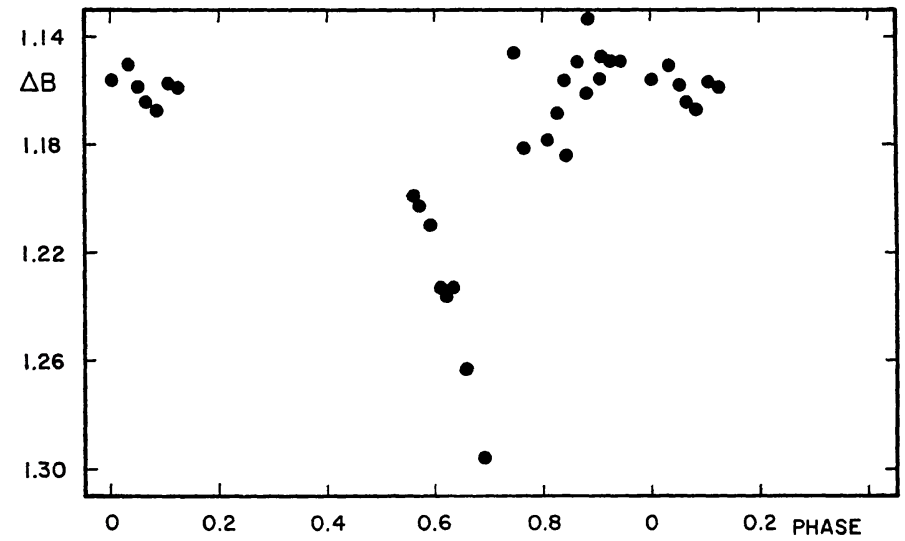

FIG. 2.—Photoelectric observations of HD 254699. The comparison star is HD 43753. The blue magnitude differences are given in the sense HD 254699 *minus* HD 43753. The period is $1^d.0748$.

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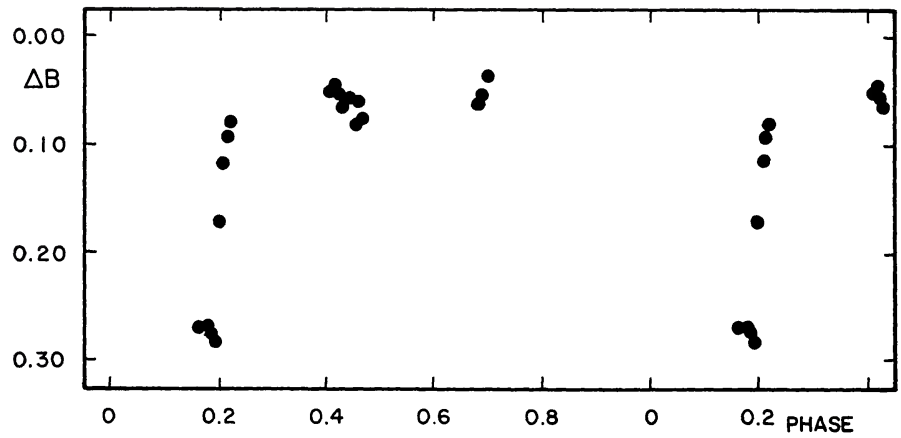

FIG. 3.—Photoelectric observations of HD 53756. The comparison star is HD 51756. The blue magnitude differences are given in the sense HD 53756 *minus* HD 51756. The period is $4^{d}.1237$.

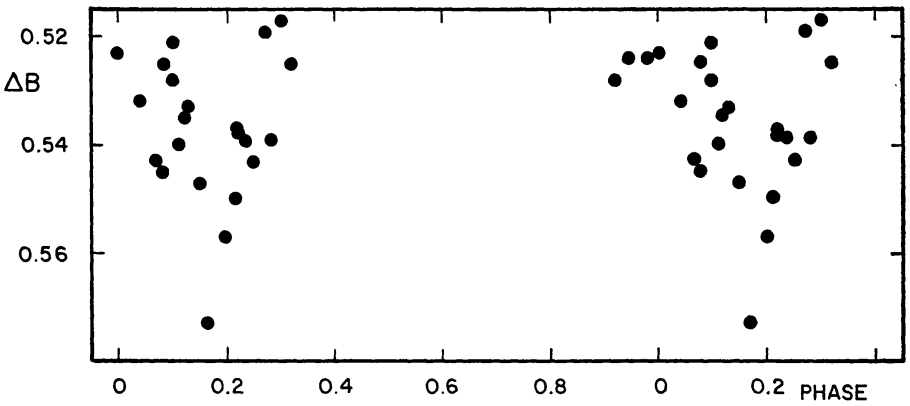

FIG. 4.—Photoelectric observations of NGC 7380-4. The comparison star is NGC 7380-1 (BD 57°2601 or HD 215714). The blue magnitude differences are given in the sense NGC 7380-4 *minus* NGC 7380-1. The period is $1^{d}.0458$.

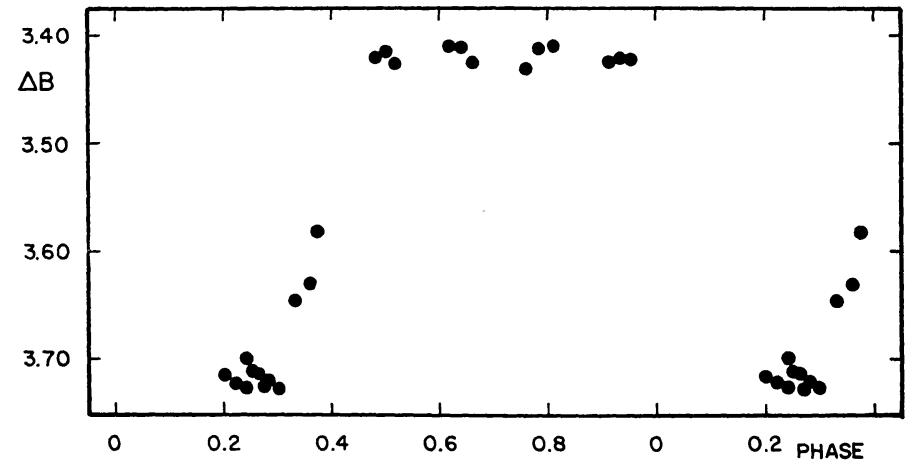

FIG. 5.—Photoelectric observations of HD 216629. The comparison star is HD 218537. The blue magnitude differences are given in the sense HD 216629 *minus* HD 218537. The period is $1^{d}.401$.

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b) Variable Be and Peculiar Stars

HD 13890.—A period of $1^d.241$: was found (see Fig. 6). I have not been able to determine whether the variations are of extrinsic or intrinsic origin. If this star is an intrinsic variable, then it may represent an extension of the β Cephei sequence to periods longer than 1^d For this reason further observations, both photometric and spectroscopic, should be made on this star which is classified B1 IIIpe.

HD 14422.—From limited data (twelve observations on three nights) I conclude that the star is variable by ~0.04 mag. Classified as B0 IV:pe.

HD 39340.—No period could be found for the variations (~0.22 mag). Petrie and Pearce (1962) state: "The structure of the hydrogen lines changes markedly between 1946 and 1952; emission at Hβ and Hγ." A probable variable Be star, although it is classified B3 V.

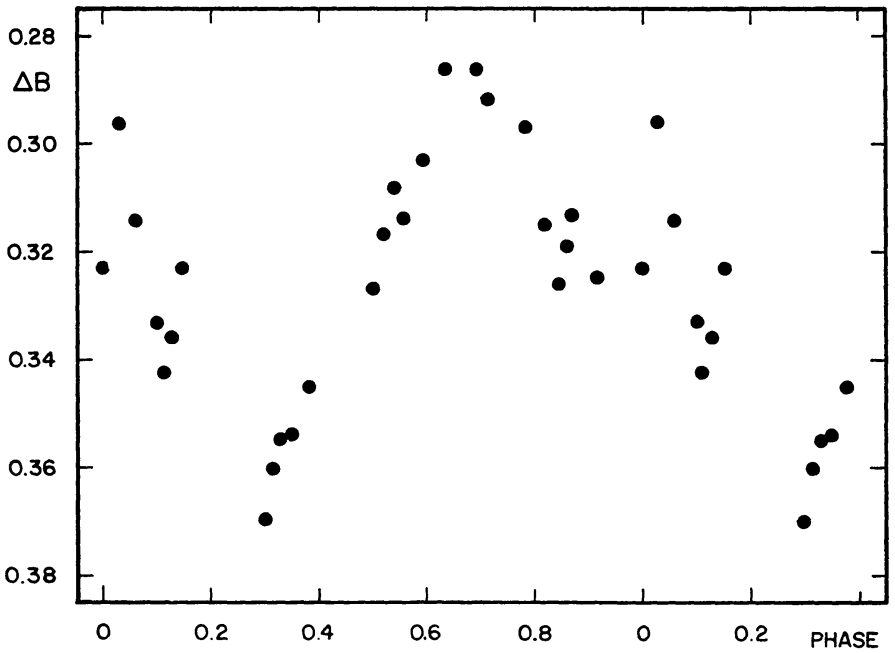

FIG. 6.—Photoelectric observations of HD 13890. The comparison star is HD 13831. The blue magnitude differences are given in the sense HD 13890 *minus* HD 13831. The period is $1^d.241$.

c) Variables of Unknown Type

HD 12993.—The magnitude of this star increased by ~0.03 mag over the period November, 1964, to February, 1965. It is classified O5 and O9 III.

HD 39291.—The variations have a range of ~0.05 mag. No period $<10^d$ could be found. The nature of the variability is not known.

HD 42379.—A radial velocity variable (Petrie and Pearce 1962). The range in light variation is ~0.04 mag, and the type of variability is unknown.

HD 138485 (ζ Lib).—Thirteen radial velocity measurements are available for this star (Feast, Thackeray, and Wesselink 1957; van Hoof, Bertiau, and Deurinck 1963). By combining these data with the present blue data, a period of $0^d.147635$ was derived. This period fitted the blue data well, but fitted the radial velocity and the ultraviolet data poorly. Initially I thought that this star was a β Cephei variable, but because of the poor fit with these latter data the variability has been classed as unknown.

HD 142184.—This star has a variable radial velocity (Buscombe and Morris 1960;

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van Hoof *et al.* 1963) and appears to be variable in brightness (~0.03 mag). More observations are needed to identify the type of variability.

HD 206165.—This star, classified as B2 Ib, varies by ~0.06 mag. A search for periods $<10^d$ was unsuccessful. The type of variability is unknown. This result disagrees with the results of Walker (1952) and de Jager (1953), who found no variations >0.01 mag.

HD 216200.—Very limited observations suggest that the star is possibly variable (~0.03 mag). Radial velocity observations by Blaauw and van Albada (1963) indicate a variable radial velocity. The type of variability is unknown.

HD 218674.—A variable star (~0.06 mag). The radial velocity is variable with a possible period of 1 month (Blaauw and van Albada 1963).

III. COMMENTS

The importance of studying eclipsing binaries in galactic clusters, as a means of improving the effective temperature scale for early-type stars, has been stressed by Kraft and Landolt (1959). However, it is unlikely that a study of the eclipsing binaries listed in Table 1, with the possible exception of HD 216629, would be of much value in this respect since the eclipses are probably partial. On the other hand, I feel sure that further observations on the stars listed as "variables of unknown type" would be rewarded by the discovery of more β Cephei stars.

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