THE PERIOD-LUMINOSITY RELATION FOR CEPHEIDS IN GLOBULAR CLUSTERS

B. V. KUKARKIN and A. S. RASTORGOUEV
Sternberg Astronomical Institute, U.S.S.R.

The period-luminosity relation for Cepheids in globular clusters has been investigated many times (e.g. Fernie, 1964; Kwee, 1968; Frolov, 1970; Demers, 1971).

The method of determination of the apparent distance moduli was recently revised by Kukarkin and Russev (1972). Instead of using a single absolute magnitude for RR Lyrae variables, the magnitudes according to pulsation theory (Christy, 1966, 1971) were adopted. The inhomogeneity of the absolute magnitudes of the RR Lyrae variables had already been established long ago (Pavlovskaya, 1953), but it attracted attention only recently. The different methods for determining the distance moduli of globular clusters were calibrated according to the new absolute magnitudes of the RR Lyrae variables. The problem consisted in the determination of the absolute magnitudes of the Cepheids in globular clusters according to the apparent distance moduli.

The photographic observations of 9 Cepheids in the globular clusters M5, M10, M12, M13 and M80 were made by A. S. Rastorgouev in the *B* photometric system on

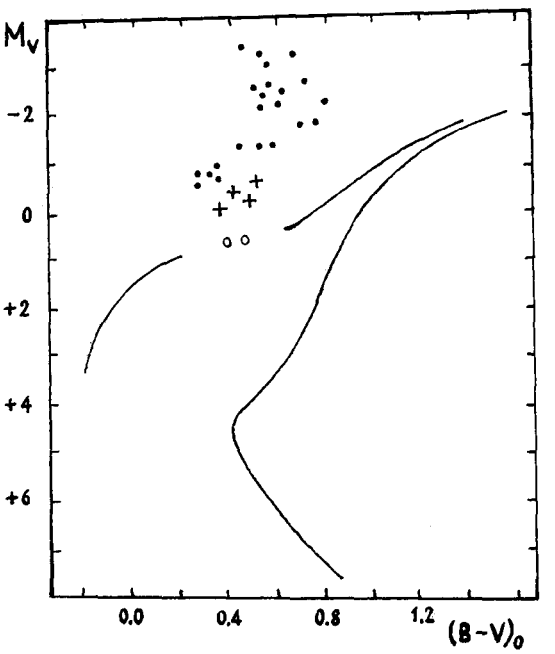

Fig. 1. Location of globular cluster Cepheids in the colour-magnitude away. Crosses represent peculiar Cepheids.

J. D. Fernie (ed.), Variable Stars in Globular Clusters and in Related Systems, 180–184.

plates obtained at our Crimean Station. The results are given in Table I. (The observations will be published separately).

All the observations of Cepheids in globular clusters by different authors were reduced to the *BV* photometric system. The results are given in Table II. In the first column the NGC number of the globular cluster is given; in the second the number of

TABLE I

Crimean photographic observations

NGC	Var	log*P*	*B*
6205	V1	0.164	15.10
6205	V6	0.325	14.40
6205	V2	0.708	13.20
6254	V3	0.896	13.80
6218	V1	1.190	12.72
6093	V1	1.212	14.10
6254	V2	1.273	12.65
5904	V42	1.411	11.90
5904	V 84	1.423	12.05

TABLE II

Reduced photographic observations

NGC	Var	log*P*	$\langle V\rangle$	$\langle B\rangle$	$\langle B-V\rangle$	$\langle B-V\rangle_0$	mod$_V$	M_V	M_B
5139	43	0.063	13^{m}38	13^{m}84	0^{m}46	0^{m}32	13^{m}84	−0^{m}46	−0^{m}14
5139	92	0.129	13.96	14.45	0.49	0.35	13.84	+0.12	+0.47
5139	60	0.130	13.49	13.87	0.38	0.24	13.84	−0.35	−0.11
7078	1	0.158	14.85	15.17	0.34	0.23	15.30	−0.47	−0.24
6205	1	0.164	14.19	14.49	0.41	0.38	13.93	−0.15	+0.23
6402	76	0.276	15.84	16.60	0.76	0.27	16.33	−0.49	−0.22
6205	6	0.325	13.89	14.39	0.50	0.47	13.93	−0.04	+0.43
5139	61	0.357	13.44	14.07	0.63	0.49	13.84	−0.40	+0.09
6402	2	0.445	15.64	16.44	0.80	0.31	16.33	−0.69	−0.38
5139	48	0.651	12.77	13.41	0.64	0.50	13.84	−1.07	−0.57
6205	2	0.708	12.86	13.28	0.42	0.39	13.93	−1.07	−0.68
6254	3	0.896	12.80	13.59	0.79	0.56	13.92	−1.12	−0.56
6402	17	1.083	14.79	15.93	1.14	0.65	16.33	−1.54	−0.89
6402	7	1.133	14.75	15.97	1.22	0.73	16.33	−1.58	−0.85
5139	29	1.168	11.88	12.83	0.95	0.81	13.84	−1.96	−1.15
5272	154	1.185	12.48	12.97	0.49	0.47	14.82	−2.34	−1.87
6218	1	1.190	–	12.72	–	–	14.09	–	−1.54
7089	1	1.192	13.42	13.99	0.57	0.50	15.44	−2.02	−1.52
6093	1	1.212	13.44	14.20	0.76	0.58	15.45:	−2.01:	−1.43:
7089	5	1.244	13.29	13.86	0.57	0.50	15.44	−2.15	−1.65
6402	1	1.272	14.09	15.31	1.22	0.73	16.33	−2.24	−1.51
6254	2	1.273	11.74	12.56	0.82	0.59	13.92	−2.18	−1.59
7089	6	1.284	13.20	13.70	0.60	0.53	15.44	−2.34	−1.81
5904	42	1.411	11.28	11.84	0.56	0.51	14.33	−3.05	−2.54
5904	84	1.423	11.42	12.01	0.59	0.54	14.33	−2.91	−2.37
5139	1	1.465	10.89	11.68	0.79	0.65	13.84	−2.95	−2.30
7089	11	1.525	12.21	12.72	0.51	0.44	15.44	−3.23	−2.79

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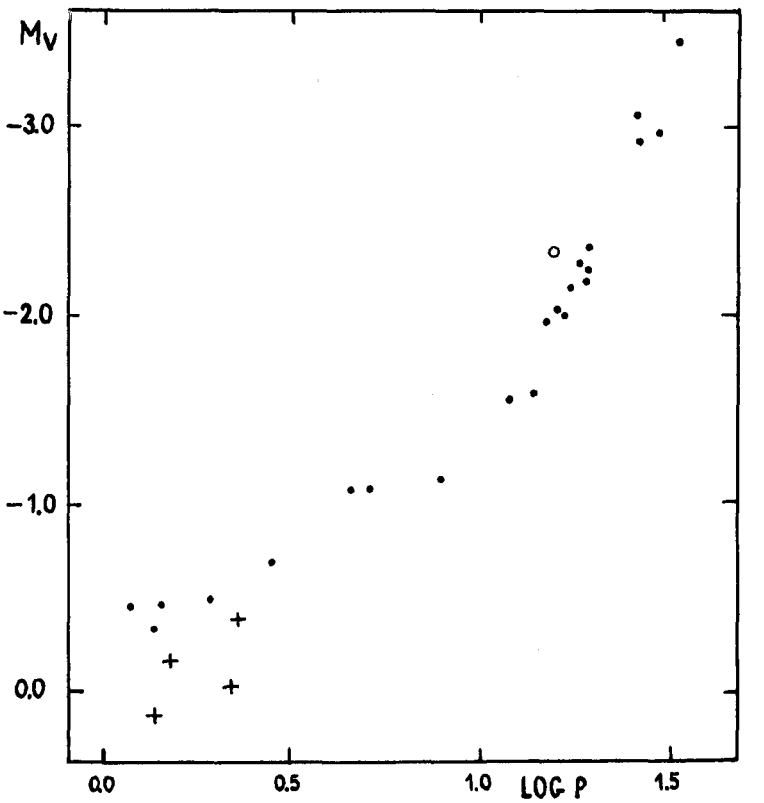
the variable according to the catalogue of Sawyer Hogg (1955); in the third the logarithm of the period; in the fourth and fifth the apparent mean magnitudes $\langle V \rangle$ and $\langle B \rangle$; in the sixth the value $\langle B-V \rangle$; in the seventh $\langle B-V \rangle_0$; in the eighth the apparent distance modulus mod_V; in the ninth and tenth the absolute magnitudes M_V and M_B.

In Figure 1 the positions of the Cepheids on the colour-magnitude diagram are given. The instability strip of the Cepheids in globular clusters is slightly different from those of the Classical Cepheids. Four Cepheids indicated by crosses differ from the other Cepheids in some relations (see e.g. Figure 4).

In Figures 2 and 3 the period-luminosity relations in V and B are given. The above-mentioned four Cepheids are again shown by crosses. The peculiarity of these Cepheids is illustrated by the example of the variables V 60 and V 92 in the globular cluster ω Centauri. Figure 4 gives the light curves of these variables (Martin, 1938). The curve of V 60 is very similar to those of other Cepheids with the same period. The curve of V 92 is very different!

It is possible that these four Cepheids are in phases of evolution different to the majority of Cepheids in globular clusters (Schwarzschild, 1970).



Figs. 2. and 3. The period-luminosity relations for globular cluster Cepheids.

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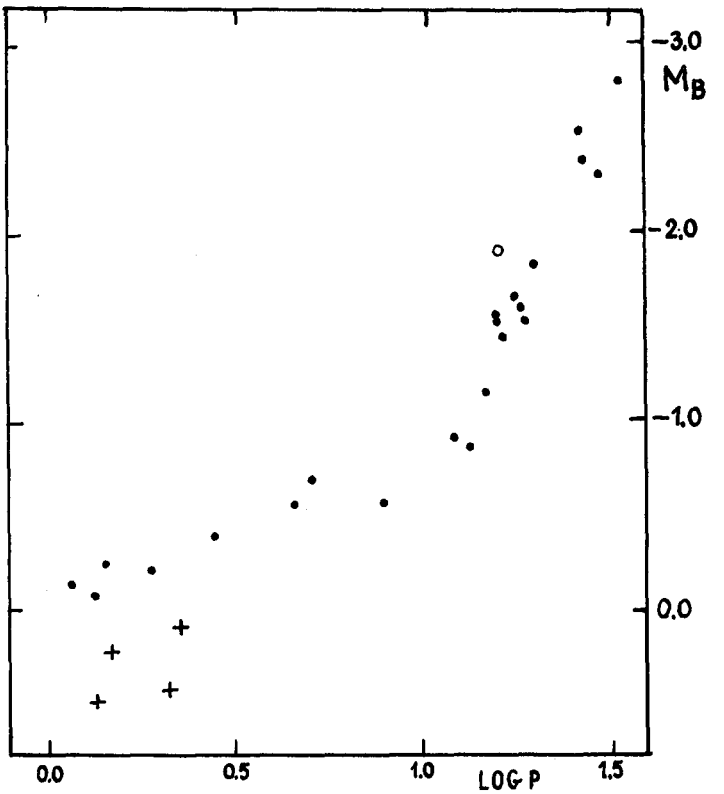

Fig. 3.

The period-luminosity relation of the Cepheids in globular clusters may be represented by the following linear equations:

$$\left.\begin{aligned} M_V &= -0.26 - 1.12 \log P \quad (\log P < 1.14) \\ &\pm 0.07 \pm 0.08 \\ M_V &= +2.66 - 3.89 \log P \quad (\log P > 1.14) \\ &\pm 0.10 \pm 0.11 \end{aligned}\right\} \tag{1}$$

$$\left.\begin{aligned} M_B &= -0.08 - 0.70 \log P \quad (\log P < 1.14) \\ &\pm 0.06 \pm 0.07 \\ M_B &= -3.51 + 4.11 \log P \quad (\log P > 1.14) \\ &\pm 0.09 \pm 0.08 \end{aligned}\right\} \tag{2}$$

The problem of the period-luminosity relation for the Cepheids in globular clusters is complicated. About 85% of Cepheids form a single physical group, but 15% have peculiarities. When using Equations (1) and (2) it is necessary to take into account not only the periods, but also the shape of the light curve and other properties.

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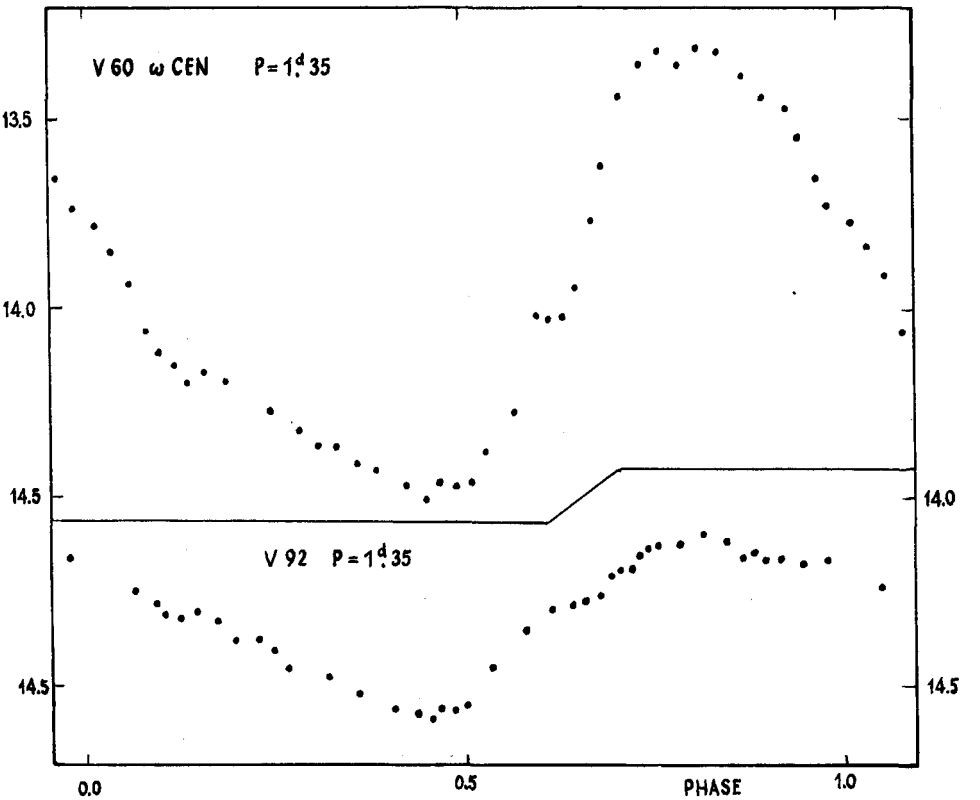

Fig. 4. Differing light-curves of two Cepheids of equal period in ω Cen.

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