5. ON THE DETERMINATION OF PROPER MOTIONS AND RADIAL VELOCITIES OF SHORT-PERIOD CEPHEIDS

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It is of extreme importance to determine mean absolute magnitudes M and the $P-L$ relation for the short-period galactic cepheids. These stars do not form a homogeneous group, and before we can investigate their luminosities we need criteria for dividing them into sufficiently homogeneous sub-groups. Such criteria have been suggested by Pavlovskaja [1], Notni [2] and Kurochkin [3], but none seems quite reliable. Evidence for the inhomogeneity of the system of short-period cepheids, both in the Galaxy and in the globular clusters, has been summarized by van den Bergh [4]. He showed that these variables could be ordered into a sequence of progressively changing characteristics:

(i) class II globulars;
(ii) class I globulars and variables with large $|z|$ ($|z| > 3000$ pc);
(iii) variables between the Sun and galactic centre;
(iv) variables in the solar neighbourhood.

The variables in the nucleus could not be fitted into this scheme. The class II globulars are those containing more than 30% of type *c* variables, and in which also the mean period of the type *a* variables exceeds 0^d60. The study of short-period variables with large z-coordinates is seen to be of great importance. If a mean velocity of 200 km/sec is assumed for such stars, the proper motions at a distance of 3000 pc will be $0''.010$–$0''.015$, a quite determinable value. A list of stars with $|z| > 2000$ pc is given at the end of this paper. An M of $+0^m5$ was adopted in calculating z.

In the globular clusters M 3 [5] and NGC 4590 [6] there is some evidence for the existence of a $P-L$ relation. In this connexion Woltjer [7] has shown that a definite $P-L$ relation is satisfied by the three RR Lyrae stars with periods less than 0^d2. These stars are: SX Phe, $P=0^d056$, $M=+4^m5$; AT Vel, $P=0^d111$, $M=+2^m2$; δ Sct, $P=0^d194$, $M=+1^m6$. While the results are not very reliable, it is certain that these stars are much fainter than the majority of short-period variables ($V=47$ km/sec, $\sigma=37$ km/sec). Cepheids with $P<0^d2$ are very interesting, and more data on their proper motions and radial velocities are needed.

At the fourth Moscow conference on cosmogony (1954), Detre drew attention to the absence of cepheids with $0^d2<P<0^d4$ and asymmetrical light-curves (*a* type) in globular clusters, whereas such stars are known in the Galaxy. The motions of these stars are very different from those of the majority of short-period cepheids, especially of type *c* stars with the same periods. These *a* type stars give a solar velocity of 48 km/sec, so that their kinematics do not show any difference from those of the stars studied by Woltjer. Therefore the determination of proper motions and radial velocities of stars with $P<0^d4$, as also of type *c* variables with any periods, are of extreme interest. This will enable the determination of mean absolute magnitudes at different mean periods, and so help to solve the problem of the $P-L$ relation.

In accordance with a recommendation made by Plaut at the 1953 Groningen conference on galactic research, a list of proper motions of variable stars in the Toulouse section of the *Astrographic Catalogue* was recently published [8]. After the appearance of a list of proper motions of short-period cepheids [9] the motions of the stars SX Aqr, RW Ari, AV Peg, SS Psc, SS Tau and AU Vir were determined in Moscow. The motion of CY Aqr was improved. The proper motions are being determined as before by comparing the position of proper motion stars from plates taken at the beginning of the century for astrographic catalogues with those on plates taken with the 38 cm astrograph of the Moscow Observatory. This work will be continued in the coming years.

Thus, in our opinion, it is most important and interesting:

1. To determine the proper motions of RR Lyrae type variables with known radial velocities (the proper motions of stars with an asterisk in the list require redetermination).

2. To determine the proper motions and radial velocities of the following short-period cepheids:

(*a*) short-period cepheids with $P < 0^d4$;

(*b*) *c* type variables with any periods;

(*c*) short-period cepheids with $|z| > 2000$ pc.

A list of RR Lyrae type variables brighter than 13^m5 at minimum with known radial velocities, and a list of stars of the above-mentioned three groups are given below. Some stars of the last group (*c*) are contained in one of the three former groups. This indicates that these stars deserve attention from both points of view.

Table 1. *List of short-period cepheids with known radial velocities for which proper motions must be determined and re-determined*

1	BO Aqr	14	SV CVn*	27	BB Eri	40	RV Leo	53	AR Ser
2	V341 Aql	15	SW CVn	28	BC Eri	41	TV Leo	54	AV Ser
3	TZ Aur*	16	RV Cap*	29	SS For	42	TV Lib	55	BF Ser
4	RU Boo	17	YZ Cap	30	SZ Gem	43	Y Lyr*	56	T Sex
5	SV Boo	18	RX Cet	31	SW Her	44	V LMi*	57	U Tri
6	SW Boo*	19	RZ Cet	32	AF Her	45	EZ Lyr	58	AM Vir
7	SZ Boo*	20	V Com	33	AG Her	46	ST Oph	59	AS Vir
8	UU Boo	21	Z Com	34	AT Her	47	AO Peg	60	AT Vir
9	RW Cnc*	22	RY Com	35	CE Her	48	CG Peg	61	AV Vir
10	RX CVn	23	W Crt	36	SZ Hya	49	XX Pup	62	BB Vir
11	RR CVn*	24	X Crt	37	VX Hya	50	BB Pup	63	BN Vul
12	RZ CVn	25	DX Del	38	WZ Hya	51	V440 Sgr		
13	ST CVn*	26	SV Eri	39	XX Hya	52	AN Ser		

* For stars so indicated, proper motions need to be re-determined.

List of short-period cepheids the proper motions and radial velocities of which should be determined

(*a*) Variable stars of RR Lyrae type with $P < 0^d4$

1	XY And	15	AH CMi	29	Z For	43	TT Lyn	57	ET Per
2	CY And	16	VW Cap	30	RR For	44	AQ Lyr	58	HH Pup
3	DK And	17	IU Car	31	Z Gru	45	BH Lyr	59	CW Sge
4	AX Aqr	18	V499 Cen	32	RS Gru	46	DD Lyr	60	V376 Sgr
5	DN Aqr	19	V535 Cen	33	IT Her	47	EZ Mon	61	V1176 Sgr
6	V672 Aql	20	SW Cru	34	LW Her	48	VY Nor	62	V1640 Sgr
7	V706 Aql	21	V508 Cyg	35	V357 Her	49	V413 Oph	63	V487 Sco
8	V766 Aql	22	V759 Cyg	36	EL Hya	50	V439 Oph	64	V557 Sco
9	V793 Aql	23	RV Del	37	SU Hyi	51	V524 Oph	65	SV Scl
10	V895 Aql	24	CS Del	38	SX Hyi	52	V567 Oph	66	CW Ser
11	EZ Ara	25	EG Del	39	DE Lac	53	V816 Oph	67	RW TrA
12	YZ Boo	26	EX Del	40	AQ Lib	54	V959 Oph	68	AO Tuc
13	AH Cam	27	BK Eri	41	EH Lib	55	GM Ori	69	AN Vel
14	X CMi	28	BY Eri	42	CW Lup	56	TV Pav	70	WW Vir

(*b*) Short-period cepheids of *c* type with $P > 0^d4$

1	HO Car	3	CH Del	5	CG Lib	7	RZ Pyx	9	AM Tuc
2	CE Del	4	DT Gem	6	IM Oph	8	YZ Tau	10	DK Vel

(*c*) Variable stars of RR Lyrae type with $|z| > 2000$ pc

1	AX Aqr	4	SZ CVn	7	Z For	10	RV Leo	13	WW Vir
2	RX CVn	5	V Com	8	RR For	11	TX Scl		
3	SV CVn	6	BY Eri	9	RS For	12	UV Scl		

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6. ESTIMATES OF THE ZERO-POINT OF THE $P-L$ RELATION, REDUCED TO A UNIFIED SYSTEM

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Dr Pskovsky summarized recent determinations of the zero-point by different authors. He reduced these to a uniform system, similar to that adopted by Parenago (*Var. Stars*, **10**, 193, 1954). In this system M_{pg} for the short-period cepheids is $+0^m5$, the velocity of the Sun relative to cepheids is 20 ± 2 km/sec, and the distance to the galactic centre 7·2 kpc. The results were presented in the form of a table, but for simplicity are reproduced here as an annotated list. If there are two numbers after an entry, the first refers to the original determination, the second to that revised by Pskovsky. The zero-point correction is to the Shapley $P-L$ relation, and so is identical with ΔM in Weaver's paper, which follows. Errors are root mean square, and account has been taken, where necessary, of a dispersion of $\pm 0^m3$ in the $P-L$ relation (Kukarkin).

Pskovsky finds from these determinations a weighted mean zero-point correction of $-1^m37 \pm 0^m30$.

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