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ON TWO POSSIBLE GROUPS OF PULSATING BLUE STRAGGLERS WITH DIFFERENT MASSES IN GLOBULAR CLUSTERS

13 pulsating blue stragglers are now known in 4 globular clusters: ω Cen (3), M 3 (1), NGC 5466 (5), and NGC 5053 (4). Their periods ($0^{d}.031$ - $0^{d}.063$), $\langle V\rangle$, $\langle B\rangle$, $\langle B\rangle - \langle V\rangle$, light amplitudes ($0^{m}.08$ - $0^{m}.51$ V), M_V, and light curves (excluding ω Cen and M 3) are summarized by Nemec (1989). $\langle B\rangle - \langle V\rangle$ are unknown for NGC 5053.

We used globular cluster distance moduli system of Kukarkin (1974) with his values of [Fe/H] and E_{B-V} and model stellar atmosphere grid of Kurucz (1979) with input parameters log g = 4, [Fe/H] corresponding to each of the globular clusters studied, and $(B - V)_o = (\langle B\rangle - \langle V\rangle) - E_{B-V}$. In such a way we calculated for these pulsating blue stragglers their mean values of T_e, BC, M_V, M_{bol}, $(V - K)_o$, and M_K. These parameters are given in Table 1. Unfortunately for 4 pulsating blue stragglers in NGC 5053 we could calculate their mean M_V only; approximate values of mean M_K for them are based on the same conventional $V - K$ = $0^{m}.57$ (averaged value for 3 stars in ω Cen).

TABLE 1

	log P	M_V	$(V-K)_o$	M_K	M_{bol}	log T_e
ω CEN						
NJL220	−1.328	+3.23	0.49	+2.74	+3.16	3.894
E39	−1.252	+3.22	0.57	+2.65	+3.16	3.884
NJL79	−1.201	+2.98	0.64	+2.34	+2.92	3.875
M 3	−1.51	+3.51	0.70	+2.81	+3.45	3.868
NGC 5466						
NH29	−1.398	+3.10	0.66	+2.44	+3.02	3.874
Anon.1	−1.342	+3.49	0.48	+3.01	+3.42	3.897
NH35	−1.298	+3.13	0.97	+2.16	+3.01	3.838
NH27	−1.292	+3.01	0.70	+2.31	+2.93	3.870
NH38	−1.268	+2.96	0.86	+2.10	+2.86	3.850
NGC 5053						
NC7	−1.460	+3.45	(0.57)	+2.88		
NC11	−1.447	+3.80	(0.57)	+3.23		
NC13	−1.433	+3.66	(0.57)	+3.09		
NC14	−1.421	+3.67	(0.57)	+3.10		

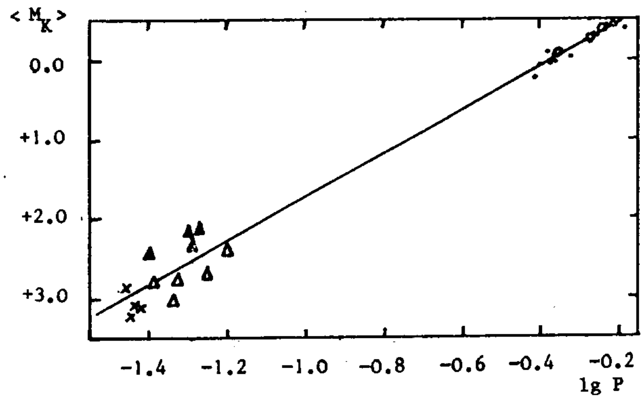

Figure 1 The P-L relation for RR Lyrae stars: $\langle M_K \rangle = -2.72 \log P - 0.99$. Besides field RR Lyraes (dots) and 4 RR Lyraes in M 4 (open circles), pulsating blue stragglers are also plotted: open triangles, crosses, and filled triangles (most massive stars).

Liu and Janes (1990a) on the base of a modern version of the Baade - Wesselink technique derived a very accurate period - luminosity relation in the K band (2.2 μm) for 13 field RR Lyrae stars with very different metallicities [Fe/H] from 0.0 to -2.20. They confirmed (once more) that even extremely different metallicities have no influence on M_K values. Therefore deviations from the straight line of the $\langle M_K \rangle$ - log P relation must be connected with deviations from the mean mass (0.5 - 0.6 solar masses) of RR Lyrae stars. Hence it would be interesting to investigate positions of pulsating blue stragglers on this relation.

Fig. 1 shows that in the first approximation the relation $\langle M_K \rangle$ - log P for RR Lyrae stars (dots and open circles) is also valid for the pulsating blue stragglers in globular clusters (triangles and crosses). 13 field RR Lyrae stars (dots) are plotted according to the data of Liu and Janes (1990a). 4 additional RR Lyrae stars from the globular cluster M 4 (open circles) are plotted according to Liu and Janes (1990b); their $\langle M_K \rangle$'s were derived by these authors in the same way as for field RR Lyrae stars. The data for pulsating blue stragglers are taken from Table 1. The star in M 3 is plotted with the modified period value corresponding to fundamental pulsation (due to its sinusoidal light curve and small amplitude this star should be considered as pulsating in the mode 1H). Crosses denote provisional $\langle M_K \rangle$ values for 4 stars in NGC 5053.

Now let us try to estimate the masses of the pulsating blue stragglers in NGC 5466, M 3, and ω Cen. We used the same differential method that had been earlier used by Jorgensen and Hansen (1984) in their determination of masses of 3 blue stragglers in ω Cen comparing them with RR Lyrae stars. We consider it much better to compare pulsating blue stragglers not with RR Lyrae stars, which are giants, but with the δ Sct stars in open clusters (reliable luminosities, similar periods) which are also dwarf stars with the same log g = 4 as in the case of SX Phe stars.

We used as "comparison stars" two δ Sct variables on the main sequence of the Praesepe cluster: BX Cnc = KW 445 and BY Cnc = = KW 449. Their parameters are: P = $0^{d}.053$ and $0^{d}.058$, M_V = +1.77 and +1.82, $(B - V)_0$ = 0.201 and 0.208, correspondingly (Frolov, Irkaev, 1984, with slightly corrected M_V's).

Both known data sources on the pulsation mode discrimination for the δ Sct stars (Breger, Bregman, 1975; Tsvetkov, 1985) give for BX Cnc and for BY Cnc the same mode 1H. These stars are also not known as binaries of any sort. From the grid of Kurucz's models of stellar atmospheres with the input parameters [Fe/H] = = 0, log g = 4 we calculated from $(B - V)_0$ for BX Cnc and BY Cnc the needed values of T_e, BC, $(V - K)_0$, and after that also M_{bol} and M_K. According to modern evolutionary tracks, the masses of BX Cnc and BY Cnc are equal to 1.8 solar masses. Further we used the equation (Jørgensen, Hansen, 1984)

$$\log (\mathfrak{M}_{bs}/\mathfrak{M}_{\delta\ Sct}) = 2\Delta\log Q - 2\Delta\log P - 0.6\Delta M_{bol} - 6\Delta\log T_e,$$

where $\mathfrak{M}_{bs}$ is the blue straggler mass, $\mathfrak{M}_{\delta Sct}$ is the δ Scuti star mass, $\Delta\log Q = \log Q(\text{blue str.}) - \log Q(\delta\ \text{Sct})$, *etc*. So we could estimate the masses of the pulsating blue stragglers, assuming the fundamental pulsation for all them in ω Cen and in NGC 5466, but the 1H mode in the case of the star in M 3. Our mass estimates, separately from comparisons with BX Cnc and with BY Cnc, are presented in Table 2.

The pulsating blue stragglers in NGC 5466 NH29, 35, and 38 in Fig. 1 (filled triangles) have the highest deviations upward from the P-L line and have the highest masses. These 3 stars, maybe together with NH27, have masses in accordance with those expected from the hypothesis of coalesced binaries (see Nemec, 1989). Another group of pulsating blue stragglers placed on or downward

TABLE 2

	$\mathfrak{M}_{bs}$(BX)	$\mathfrak{M}_{bs}$(BY)	$\langle\mathfrak{M}_{bs}\rangle$
	solar masses		
ω CEN			
E39	0.48	0.56	0.5
NJL220	0.59	0.69	0.6
NJL79	0.60	0.70	0.6
M 3	0.76	0.88	0.8
NGC 5466			
NH27	0.97	1.11	1.0
NH29	1.30	1.52	1.4
NH35	1.37	1.60	1.5
NH38	1.25	1.45	1.4
Anon.1	0.42	0.49	0.5

of the P-L line have masses comparable (maybe excluding the star in M 3) with RR Lyrae masses (0.47 - 0.62 solar masses; *cf.* Liu and Janes, 1990a). So the second group can be preliminary considered as ultra-short-period RR Lyrae stars.

It is interesting to note that the 3 most massive stars in NGC 5466 (NH38, 29, and 35) have distances from the cluster center 0.7' - 0.9'. The slightly less massive NH27 has a slightly greater distance, 1.4'. Unfortunately we do not know the distance of Anon.1 in the same globular cluster, which is a much less massive object. Also, the most distant star E39 in ω Cen (18') has the smallest mass among the 3 known pulsating blue stragglers in this cluster. This may be considered as an independent ("dynamical") confirmation of the reality of the groups of pulsating blue stragglers in globular clusters having a strong difference in their masses.

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