DOUBLE-MODE RR LYRAE STARS IN THE DRACO DWARF GALAXY AND IN OTHER STELLAR SYSTEMS

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Eleven double-mode (dm) RR Lyrae stars, with periods midway between the periods for the c-type and ab-type RR Lyrae stars, have been identified in the Draco dwarf galaxy by reanalyzing the photometry of Baade and Swope (1961) for 35 stars. The stars are V11, 72, 75, 83, 112, 138, 143, 156, 165, 169 and 190, three of which previously were noted as dm RR Lyraes by Goranskij (1982). The methods of Stellingwerf (1978) and Stobie (1970) were used to find the periods. The period ratios, periods and amplitudes suggest that the stars radially pulsate simultaneously in the fundamental and first overtone modes. The beat masses, estimated from the P_1/P_0 vs. P_0 diagram (Petersen 1973), using as calibration the King Ia (Y=0.299, Z=0.001) models of Cox, Hodson and Clancy (1983, hereafter CHC), are M_{beat}/M_o=0.65 for nine stars, =0.60 for V75 and =0.55 for V165. If the mass loss rate prior to arriving on the horizontal branch is proportional to the metal abundance (Stobie 1971, CHC), V75 and V165 should be more metal rich than the other nine dm RR Lyraes. In the period-amplitude (P-A) diagram, at a given amplitude, V165 has a smaller period shift relative to the standard M3 line than do the higher mass stars. Subsequently, the correlations of Preston (1959) and Sandage (1982) suggest that it is more metal-rich than the other nine dm RR Lyrae stars in Draco. Furthermore, reanalysis of the P-A and period-mean magnitude relations of all the RR Lyrae stars in Draco shows evidence for a widespread range in the metal abundances. Stars with large period shifts relative to the M3 relation are found to be more luminous than stars with smaller period shifts. The frequency of variable amplitude (ie. Blazhko effect) RR Lyrae stars is greatest for the ab-type stars with short periods. The brightnesses of the highest maxima appear to fit the P-A relation, and the amplitudes of the lowest maxima are variable, with V123 being an extreme example. Figure 3 of Szeidl (1975) shows the analogous situation for M3 RR Lyrae stars with the Blazhko effect. These findings suggest that the amplitude variability is related to the mode-switching activity of the dm RR Lyrae stars.

In the Ursa Minor dwarf galaxy, five probable dm RR Lyrae stars

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have been identified from among the stars measured by van Agt (1967, 1968). The stars are: V44,V49,V57,V58 and V83. Until more accurate photometry is available for these stars it will not be possible to estimate their masses. A dm RR Lyrae star with M_{beat}/M_o=0.65 also has been discovered in the LMC globular cluster NGC 2257 (Nemec, 1983; Nemec, Liller and Hesser 1984). Reanalysis of the Sandage, Katem and Sandage (1981) photometry for seven M15 dm RR Lyraes confirms the CHC period ratio for V17. Other P_1/P_0 ratios found include: 0.7461 for V26, 0.7469 for V39, 0.7439 for V51, 0.7432 for V54, 0.7450 for V58, and 0.7454 for V61. Preliminary analysis of the Martin (1938) photometry for 54 stars in the Galactic globular cluster ω Centauri (Nemec and Norris 1983) shows no evidence for double-mode RR Lyrae stars.

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DISCUSSION

Hesser: John Norris became so interested in these results when he visited Victoria this summer that he punched up all the old ω Cen RR Lyrae data. Nemec analysed them and found no double-mode variables. This was quite disappointing to those of us who think ω Cen shares many properties in common with the dwarf spheroidals.

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