THE RADII OF RR LYRAE STARS

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Balona (1977) has described a modification of the Wesselink technique of radius determination which takes into account the effects of observational errors using the Principle of Maximum Likelihood. This leads to a tighter period - radius relationship for Cepheids than obtained by the classical method and suggests that some of the problems associated with radii estimation of RR Lyraes may be due to the incorrect statistical treatment of the data. With this in mind, we have applied the Maximum Likelihood technique to well-observed RR Lyraes. Except for two stars, the data used were taken from the literature.

The resulting period - radius relationship is shown in Fig. 1. The large scatter must to a great extent reflect the generally poor data, especially the radial velocities. Nevertheless, in contrast to past attempts using the classical Wesselink technique, we obtain meaningful radii for all the stars. We can find no correlation between metallicity and position in the diagram. However, the c-type RR Lyraes (crosses) do seem to have shorter periods than the others (as expected if they are first harmonic pulsators), but the evidence is hardly conclusive.

We obtain the mean quantities $\langle R \rangle$ = 11.7 solar radii and $\langle \log P \rangle = -0.28$ after "fundamentalizing" the c-type variables (van Aldaba and Baker 1971). This period corresponds to a mean effective temperature $\langle \log T_{eff} \rangle = 3.85$ (Lub 1977), giving $\langle M_V \rangle = -1.3$. This is considerably brighter than the currently accepted value.

Woolley and Savage (1971) have shown that if the surface

A. G. Davis Philip and D. S. Hayes (eds.), The HR Diagram, 241-243. All Rights Reserved.

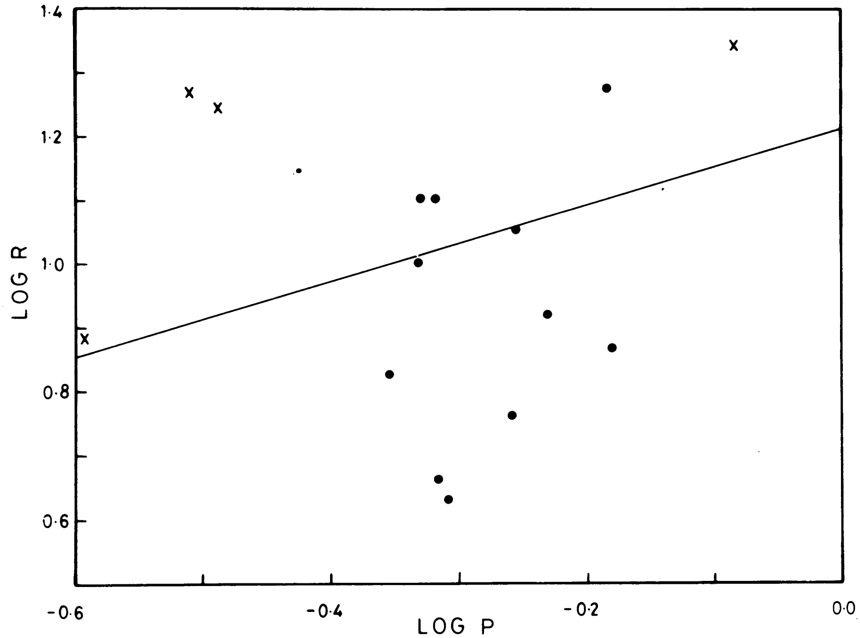

Fig. 1. The period - radius diagram for RR Lyrae stars. The straight line is an extension of the relation for classical Cepheids.

brightness is a function of effective gravity as well as color index, then the Wesselink radius will be an overestimation. This could explain our result, but the theory takes no account of shock wave radiation. One way out of the problem is to exclude the rising branch from the solution for the radius, as it is during this time that rapid accelerations and shock wave formation takes place.

The resulting period - radius relationship when this is done is shown in Fig. 2. Two stars give meaningless radii and have been omitted. We now find $\langle R \rangle = 8.0$, $\langle \log P \rangle = -0.27$ so that $\langle M_V \rangle = -0^{m}.3$. This is closer to the accepted value, but is still a magnitude too bright.

We conclude that it may be possible to obtain trustworthy radii for RR Lyraes using the Wesselink method provided good velocity curves and accurate photometry can be obtained. To minimize problems associated with shock wave radiation the rising branch must be omitted from the solution. At present the data are too few and too poor to define a reliable period - radius relationship.

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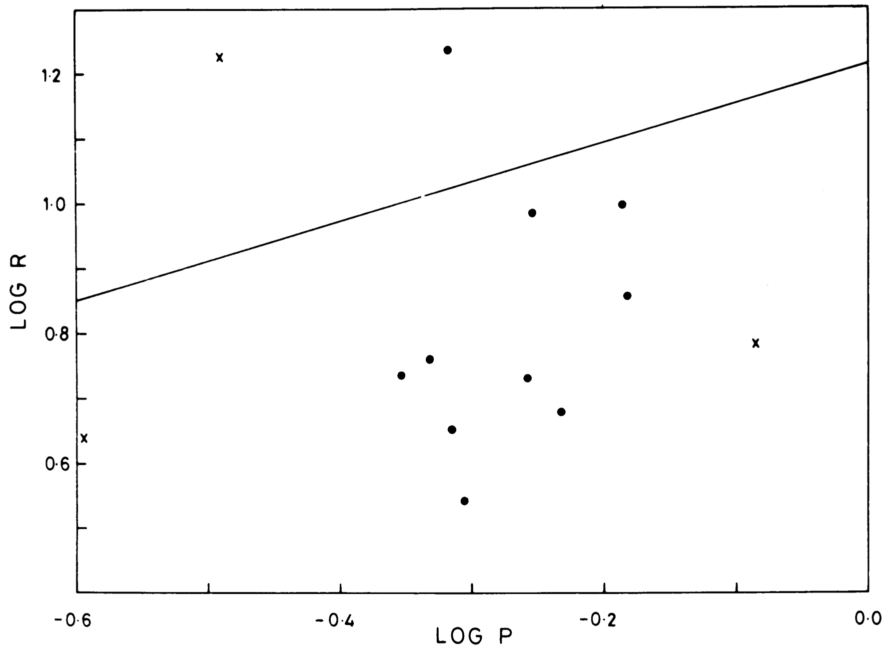

Fig. 2. The period - radius diagram for RR Lyraes obtained by excluding the rising branch from the radius solution. The straight line is an extension of the relation for classical Cepheids.

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