INTERMEDIATE BAND PHOTOMETRY OF RR LYRAE VARIABLES IN ω CEN AND 47 TUC

D. H. P. JONES

Mount Stromlo and Siding Spring Observatories, Research School of Physical Sciences, Australian National University, Australia

I have recently prepared for publication a study of 100 field RR Lyraes which were measured on the u, k, b, y, β system described by Jones (1971). It is shown that the following indices

$$\beta_1 = \beta - 0.125(k-b) + 0.103(b-y)$$
$$(u-b)_3 = (u-b) - 0.93(b-y) - 0.62(k-b) - 1.95(\beta - 2.75)$$
$$(k-b)_2 = (k-b) - 0.826(b-y) + 0.25(\beta - 2.75)$$

correlate strongly with θ_{eff}, $\log g$ and [Fe/H] respectively. Figures in that paper show the tightness of the correlations.

Six RR_{ab} variables were observed in ω Cen: Nos. 7, 33, 46, 74, 79 and 125 (twice) on the numbering system of Martin (1938). A 12 arcsecond aperture was always used. The seven observations were treated together as observations of one variable with the following results:

$$\theta_{\text{eff}} = 0.78 \pm 0.02$$
$$\log g = 2.65 \pm 0.33$$
$$[\text{Fe/H}] = -1.45 \pm 0.34$$
$$\log(\mathfrak{M}/L) = -1.97 \pm 0.33 \text{ in solar units.}$$

Sargent (1965) analysed Fehrenbach's F giant in ω Cen and found $[\text{Fe/H}] = -1.59 \pm \pm 0.19$ when abundance anomalies among the different elements are ignored. The metal abundance is also in good accord with Kinman's (1959) classification of the red giants as type B (intermediate line weakening). The mass-to-luminosity ratio is in good accord with that found by Newell *et al.* (1969) for the horizontal branch stars. The luminosities of these variables may be estimated in two ways. They may be identified with the field halo RR Lyraes discussed by Clube and Jones (1971), who found $\langle M_v \rangle = +0.9$. A suggested downward revision to 1.3 has been severely criticized by Aslan (1971) and so is not considered here. With the above $\mathfrak{M}/L$ ratio, $M_v = +0.9$ corresponds to $\log \mathfrak{M} = -0.49$. Alternatively Christy's (1966) relation between luminosity and transition period from fundamental to first overtone indicates $\langle M_v \rangle = +0.6$; correspondingly $\log \mathfrak{M} = -0.31$.

From the $(b-y)$, β, plot a colour excess $E(b-y) = 0.09 \pm 0.04$ was derived. The blue horizontal branch stars are expected to respect the $k-b$, $b-y$ relation of the Population I stars, for at their temperature the K line vanishes whatever the abundance. Observations of two blue horizontal branch stars in ω Cen require a shift of $E(b-y)$

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$=0.10 \pm 0.02$ to bring them on to the Population I relation. This reddening corresponds to $E(B-V)=0.14$. If $\langle M_v \rangle = 0.8$ is accepted for the RR Lyraes then the true distance modulus of ω Cen is 13.4.

In the field of 47 Tuc there are only three RR Lyraes (Table I), two of which have been studied by Feast *et al.* (1960). Figure 1 gives the light curve of HV 810 which lies closest to the cluster. A 12 arcsecond aperture was always used, and because of the

TABLE I

RR Lyraes in the field of 47 Tuc

Variable	Bailey type	P (days)	Distance from 47 Tuc	$\langle y \rangle$	[Fe/H]
HV 809 (UX Tuc)	a	0.509	55.′2	13.97	-1.3 ± 0.5
HV 810	a	0.735	2.2	13.43	0 ± 0.4
HV 814	c	0.371	21.6	13.90	-1.2 ± 0.3

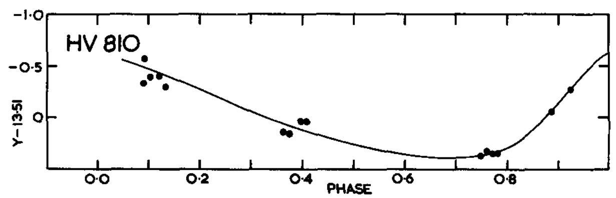

Fig. 1. Light curve of HV 810 as a function of phase $\phi = 1.36110$ (Helio JD-2440444.272).

rarity of good seeing at this zenith distance, the light curve required four observing seasons to complete. The Radcliffe period required a slight revision of approximately one cycle a year so that $P^{-1} = 1.36110$ for Figure 1. In Figure 2 the three variables are plotted on the colour magnitude array of Eggen (1972). HV 810 lies about 0.7 mag. above the horizontal branch which raises the possibility that it is affected by cluster background or an unseen companion. However this variable has an amplitude Δy of one magnitude which places it on the upper envelope of the period amplitude plot for field RR Lyraes. Correction for a companion would place it beyond the other variables. It is widely accepted that the period amplitude plot is an indicator of metal abundance with the highest amplitude variables being the most metal weak when the period is around 0.7 day. The solar metal abundance of HV 810, found from narrow band photometry is an exception to this rule. If HV 810 were given a low amplitude more accordant with its metal abundance then it would be necessary to postulate an unseen star at the sky position used: consequently the difference in brightness between the variables and the horizontal branch would be even greater.

While the other two variables have magnitudes closer to the horizontal branch, their metal abundances are substantially lower. HV 810 has an exceptionally high metal abundance for an RR Lyrae variable, and in view of the fact that it lies so close to one of the metal richest globular clusters known, it seems safe to accept it as

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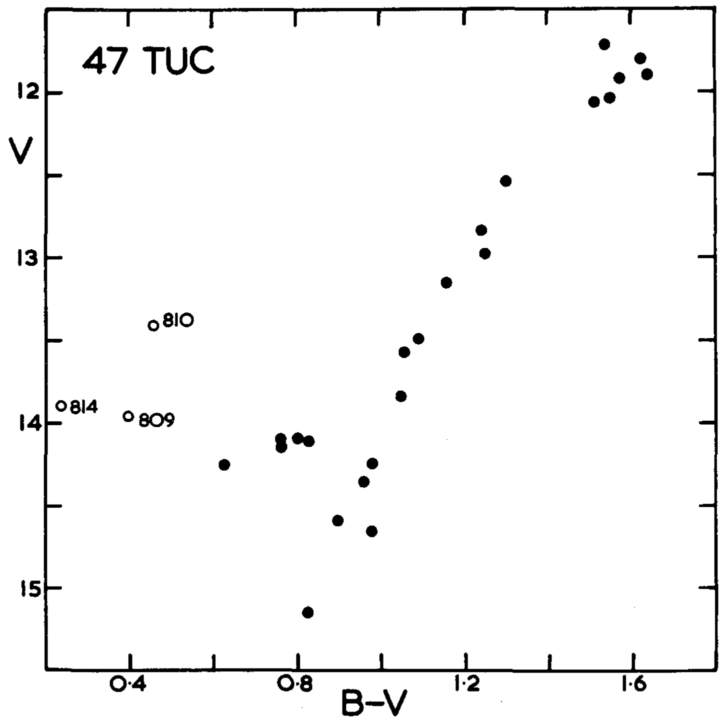

Fig. 2. Colour magnitude array of 47 Tuc. Filled circles are constant stars measured by Eggen. Open circles are the variables discussed in this paper identified by their HV numbers.

a member. The narrow band photometry gives for this star:

$$\theta_{\rm eff} = 0.78 \pm 0.01$$
$$\log g = 2.71 \pm 0.23$$
$$\log(\mathfrak{M}/L) = -1.92 \pm 0.23$$

This star seems so exceptional that at present there is no meaningful way to estimate the luminosity. The other two variables are too weak in metals and too far from the cluster to be members.

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DISCUSSION

Feast: Could you remind us of the proper motion position for the RR Lyraes in the region of 47 Tuc.

Jones: I believe Murray's observations indicate that HV 814 is a non-member. HV 810 had an unreliable proper motion because of crowding.

Demarque: What is your error estimate on the mass to light ratio?

Jones: A factor of two.

Schwarzschild: (a) May I ask at what phase of the light curve the observed colors are taken? (b) Is the calculated $\log g$ the same then as the 'static' $\log g$?

Jones: (a) Where $y = \langle y \rangle$ on the falling branch; (b) $\log g$ is the apparent gravity.

van den Bergh: What would main sequence fitting give for the absolute magnitude of HV 810?

Jones: Recent work by other people at Mt. Stromlo does not confirm the colours derived by Tifft from photographic transfers. Until this work is complete the question remains open.

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