

# TWO-COLOUR PHOTOMETRY OF RR LYRAE VARIABLES IN NGC 6981

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**Abstract.** NGC 6981 = M72 is a globular cluster with a late-type integrated spectrum (G3) and an ultraviolet excess of  $\delta(U-B) = 0.15 \pm 0.05$ , which places the cluster in the class of intermediate-to-high metal abundance clusters such as M3. The colour-magnitude diagram shows a horizontal branch populated on both sides of the variable star region. Previous work on the periods of the variables has indicated that the cluster is of Oosterhoff type I, with  $\overline{P}_{ab} \approx 0.55$  day. Some results from *B* and *V* photometry of 21 RR Lyrae variables are described. Original measurements of about 50 candidate variables were made, including some possible new variables found by blinking plate pairs, but crowding and background photometric problems reduced the number of variables for which reasonable quality data could be obtained with the available 100-in plate material.

A new red variable near the centre of the cluster was discovered in the course of the work.

There appear to be relatively few *c*-type variables in the cluster, in spite of some uncertainties regarding undiscovered small-amplitude variables near the cluster centre. The sample discussed contains only one *c* type. The light and colour variations are derived and correlations between the light-curve parameters are discussed.

In particular the period-amplitude relation is similar to those of the clusters M3 and NGC 6171, both relatively metal-rich and also of Oosterhoff type I. The colour-magnitude diagram shows that there is no overlap in colour between *ab* and *c*-type variables, or between variable and non-variable stars. The period-colour diagram is used to derive physical parameters for the variables, using both linear and non-linear pulsation theory. The results essentially confirm earlier work on variables in other globular clusters in yielding a mean mass  $\sim 0.5 M_{\odot}$  or less and a helium abundance  $\sim 30\%$ , but the considerable uncertainties in these results, following work by van Albada and Baker (1971) are emphasized. A mean mass-to-light ratio of  $\log \{(\mathfrak{M}/\mathfrak{M}_{\odot})/(L/L_{\odot})\} = -1.93$  is derived for the four clusters M3,  $\omega$  Cen, NGC 6171 and NGC 6981 from their period-colour relations.

Details of this work are given in Dickens and Flinn (1972).

## References

- Albada, T. S. van and Baker, N. H.: 1971, *Astrophys. J.* **169**, 311.  
Dickens, R. J. and Flinn, R.: 1972, *Monthly Notices Roy. Astron. Soc.* **158**, 99.

## DISCUSSION

*Baker:* In clusters like this one, in which the number ratio of type-*ab* stars to type-*c* stars is very large, one would like to know more about possible selection effects which may create a bias against the discovery of type-*c* stars. An even better example is M3, which has a very small relative number of type-*c* stars, even for an Oosterhoff group I cluster. The number of stars per period interval for the type-*c* stars is much smaller than that for type-*ab* stars. This is odd, since the horizontal branch of M3 is well populated on both sides outside the variable strip. If there really is a gap on the HB in the region of the type-*c* variables, it might have very interesting implications for the evolution theory of HB stars.

*Dickens:* To be sure about the completeness, one should make photometric measurements of all stars in a given region of a cluster (or at least those in the relevant magnitude intervals). In most, if not in all clusters, this has not been done, so some incompleteness, at least among the smaller amplitude *c*-type variables, could well be present.