

UBVI Time-series Photometry of the Old LMC Globular Cluster Reticulum

V. Ripepi¹, M. Monelli², M. Dall'Ora², G. Bono², C. Corsi², F. Caputo², L. Pulone², V. Testa², G. Andreuzzi², R. Buonanno², G. Marconi³, M. Marconi¹, M. Di Criscienzo¹, J. Storm⁴, S. Degl'Innocenti⁵

¹ INAF-Osservatorio Astronomico di Capodimonte, Via Moiariello 16, 80131 Napoli, Italy

² INAF-Osservatorio Astronomico di Monteporzio, Via di Frascati 33, 00044 Rome, Italy

³ European Southern Observatory, 3107 Alonso de Cordova, Santiago, Chile

⁴ Astrophysikalisches Institut Potsdam, An der Sternwarte 16, 14482 Potsdam, Germany

⁵ Dipartimento di Fisica, University of Pisa, via Buonarroti 2, 56127, Pisa, Italy

Abstract

We present new *UBVI* CCD observations of the old LMC globular cluster RETICULUM. These data allowed us to re-determine periods and light curves and to identify 4 double mode RR Lyrae stars. A comparison with the theoretical instability strip in the $M_V - \log P$ plane shows good agreement between theory and observations when an apparent distance modulus of $(m - M) = 18.45 \pm 0.12$ mag (i.e. $(m - M)_0 = 18.39 \pm 0.12$ mag) is assumed.

Introduction

GLC 0435-59 (RETICULUM) is an old globular cluster placed about 11 degrees in the north-west direction with respect to the bar of LMC. It is bound to this galaxy and is part of its halo system. RETICULUM is already known to host 32 RR Lyrae (Walker 1991), and its metallicity has been estimated by means of medium resolution spectra: $[Fe/H] \approx -1.71 \pm 0.1$ (Suntzeff et al. 1992).

Observations and data reduction

We collected *UBVI* data with SUSI2 at NTT (La Silla, Chile) during three different runs in 1999-2000-2001. In addition we got from the NTT archive some *VI* frames obtained with SUSI1 during 1995. In total we obtained about 33 phase points in *UBV* and around 12 in *I*. A few long exposures have also been taken in order to provide deep Color-Magnitude Diagrams (CMD).

NTT during the these two filters with Data reduction have been performed by using the usual procedures (IRAF package), whereas the photometry has been carried out by using DAOPHOT/ALLFRAMES packages (Stetson 1987). An accurate photometric calibration has been obtained by observing several Landolt (1992) standard fields, complemented in *BVI* with new standard stars by Stetson (2000). In the following we shall concentrate on some results from the *BV* photometry only.

The RR Lyrae variables

In order to obtain well sampled light curves for the RR Lyrae stars, we coupled our BV data with those by Walker (1992). This operation was easy since the photometric agreement is good (< 0.02 mag in BV). The resulting time series include about 63 epochs and span around 10 years, allowing a precise determination of the periods and, in turn, of light curves for the majority of RR Lyrae in RETICULUM. The latter were fitted with spline functions in order to derive the colors. An example of light curves in $UBVI$ with over-imposed a spline fit to the data is shown in Fig. 1 for a fundamental (V37) and a first overtone (V36) pulsator.

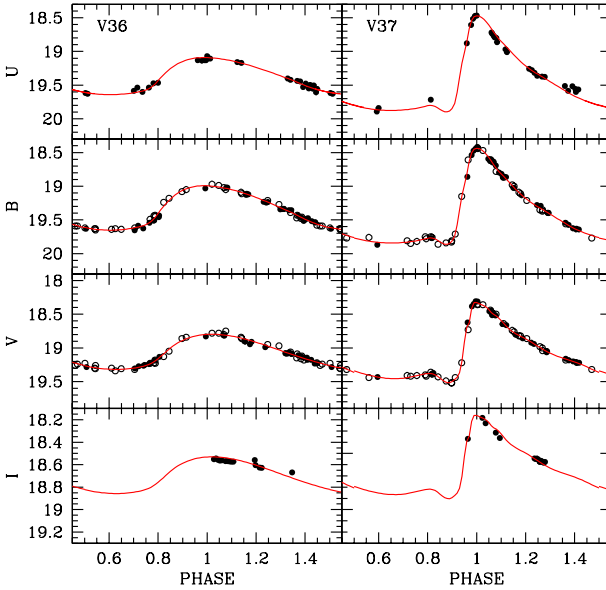


Figure 1: Light curves for V36 (RRc) and V37 (RRab). The open and filled circles denote photometry from Walker (1992) and from this paper, respectively. Solid lines show a spline fit to the data. Note the use of B and V spline fits as templates to fit U and I light curves respectively (due to the lack of sampling in these bands).

An important result obtained on the basis of the present observations is the discovery of four double mode (RRd) pulsators among RETICULUM RR Lyrae stars: namely the stars V41, V72, V98 and V110. A detailed discussion of the properties of these RRd stars, as well as of the procedures quoted above, will be given in a forthcoming paper (Ripepi et al. in preparation).

Comparison with the theory of pulsation

In Figure 3 we show the comparison between the observed and predicted RR Lyrae instability strip in the $M_V - \log P$ plane. This plane is interesting since it allows to estimate the

apparent distance modulus of the cluster by constraining the observed RR_c distribution to match the predicted blue limit of the pulsation region, under the assumption of solar-scaled chemical composition (see Caputo 1997 and Caputo et al. 2000). This method is only slightly dependent on the uncertainties on pulsation models and, in particular, on the treatment of convection, which mainly affects the red boundary of the strip (see Fig. 3). As shown in Fig. 3 the distance of RETICULUM estimated with the quoted method is $(m - M)(\text{RETICULUM}) = 18.45 \pm 0.12$ mag, where the error includes the theoretical uncertainties and the metallicity error. Assuming a reddening of 0.02 mag (Ripepi et al. in preparation) this means $(m - M)_0(\text{RETICULUM}) = 18.39 \pm 0.12$ mag.

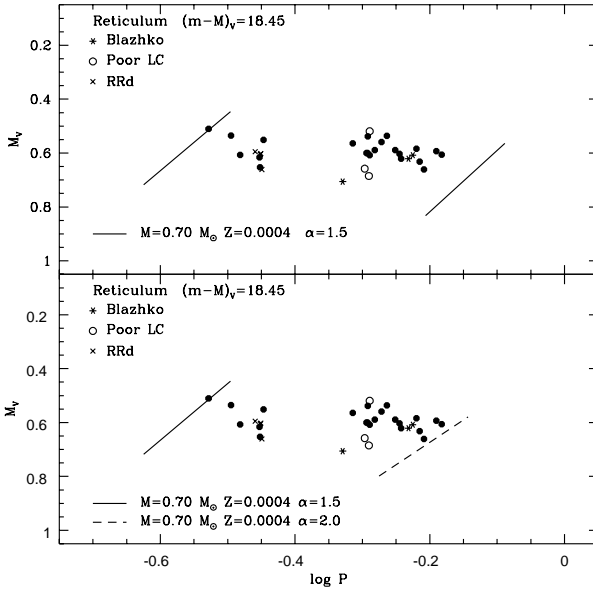


Figure 2: RR Lyrae of RETICULUM in the $M_V - \log P$ plane. The upper and lower panel show the difference in the predicted red edge of the fundamental pulsators by using a different assumption of the mixing length parameter α in the convective treatment (see labels).

Acknowledgments. It is a pleasure to thank G. Clementini who kindly analysed the four double mode pulsators with her software GRATIS.

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