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Variable stars in the globular cluster NGC 7006

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Our BVR CCD photometric study of the globular cluster NGC 7006 permitted us to find two new suspected RR Lyrae variables. A cluster chart is presented with the position of known and suspected variables marked.

The globular cluster NGC 7006 (C 2059+160, $b = -19°$, $l = 64°$) is highly interesting from many points of view, in particular, for its richness in variable stars. According to the Catalogue of Variable Stars in Globular Clusters (Clement et al., 2001), it contains 76 variables, most of which are RR Lyrae variables, the RR1 to RR0 ratio being 8:55. This ratio, together with the average period $P_{\rm RR0} = 0.570$ (Wehlau et al., 1999), permits us to refer to the cluster as an Oosterhoff type Oo I object abundant with RR Lyrae variables. Therefore, a search for undetected variables of this type is of interest.

In the Catalogue (Clement et al., 2001), data for two pairs of variables with practically the same coordinates are given without any comments. The stars of the first pair (v34 and v59) have different positions in the cluster chart (cf., for instance, Wehlau et al., 1999), and the chart position of v34 does not agree with its coordinates (the correct coordinates are given in the Table below). In the Catalogue (Clement et al., 2001), this star is marked as "prob not var", and as shown below (Fig. 1), it cannot be either an RR Lyrae star or a red variable according to our photometric data.

Another pair of variables (v41 and v74) deserve a more detailed consideration. In the study of variables in the globular cluster NGC 7006, Rosino and Ciatti (RC, 1967) determined periods for the majority of the known variables, v1 – v52 (among them, v41 was not present), and found twenty-one new variables. The position of v74, one of these new variables, given in their chart is the same as the position of v41 in the Sandage (1954) chart. Later Pinto and Rosino (1973) determined periods for all the variables that had not been determined by RC (1967), and they gave different periods for v41 and v74. Therefore the question arises: what are the two stars (v41 and v74) with different periods that Pinto and Rosino (1973) observed? According to Wehlau et al. (1992), L. Rosino explained, in a private communication, that v74 was a rediscovery of v41.

Our search for variables is based on CCD observations carried out in 1995 with the Zeiss-1000 telescope of the Special Astrophysical Observatory (Russia). Wide-band filters and the K585 detector provided the BVR Johnson–Cousins photometric system. The whole chip (530×580 pixels) covers a field of $149'' \times 212''$ on the sky, the scale is $15.27''$/mm. After the CCD frames had been bias-subtracted and flat-field-corrected, photometry was carried out using the ESO-Midas package. Reductions of the instrumental magnitudes to the standard BVR_c system made use of the CCD photometric standards (Odelwahn et al., 1992) located in the investigated cluster field. Exposure times in the B, V, and R bands were respectively 600, 300 and 180 seconds, and a maximum time interval between

consecutive exposures in the B, V and V, R bands did not exceed 15 minutes. In such a case, the B, V and V, R magnitudes of a variable correspond to the same phase of its variability. Although the cluster is relatively not dense ($\log \rho_o = 2.908$, Webbink 1985), reliable photometry could be obtained for stars with $r \geq 19''$.

In order to search for as yet undetected variables, the method proposed by Kadla and Gerashchenko (1982) was used. For this purpose, color-magnitude diagrams (CMD's) (V *vs.* $(B-V)$ and V *vs.* $(V-R)$) were plotted (Fig. 1) using variables' magnitudes obtained from two consecutive V, B and V, R exposures and the mean magnitudes from 3 B, 5 V, and 4 R exposures for other stars.

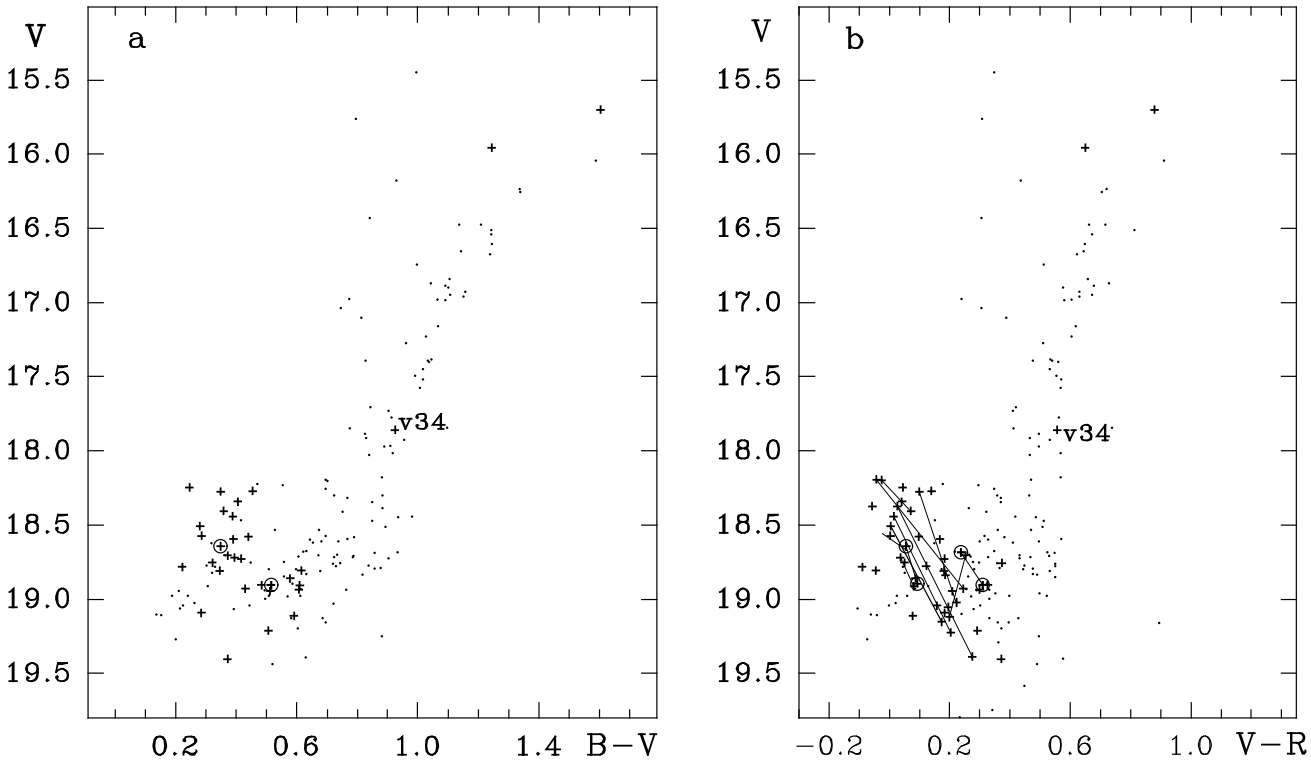

Figure 1. CMD's (a: V *vs.* $(B-V)$; b: V *vs.* $(V-R)$) of the globular cluster NGC 7006 ($r \geq 19''$). The known variables are plotted as +, the suspected ones, as $\bigoplus$. The lines connects data for two phases of the same variable.

Table. Positions and observed variations in V and R magnitudes for suspected and some of known variable stars

No.	X	Y	$\triangle V$	$\triangle R$
77	$19''.45$	$27''.91$	$0^m.2$	$0^m.2$
78	-19.31	-2.76	0.25	0.5
34	24.42	3.50	0.0	0.0
49	8.62	41.85	0.4	0.5
76	9.16	12.83	0.5	0.7

All known RR Lyrae variables occupy a definite strip on both CMD's, except v34, which is at the middle part of the giant branch and whose variability was questioned. For some variables, there are observations at two different phases of their variability in the

V and R photometric bands. Such variables are shown in Fig. 1(b) as two pluses or two $\oplus$ signs, corresponding to two phases of variability, connected with a line. Other stars located within the strip on both diagrams were investigated for variability. Two of such stars demonstrate brightness variations in the V band and especially in the R band, where observations span a longer time. Data on these suspected RR Lyrae variables are given in the Table. It contains the star number (continuing numbering the variable stars in the Clement et al. 2001 catalogue), coordinates expressed in arcseconds and determined in the coordinate system of the Catalogue (Clement et al., 2001), brightness variations of the star in the V and R bands. Also we give coordinates of known variables (v49 and v76) which were inaccurate or completely absent in the Clement et al. (2001) catalogue. All variables (known and suspected) are marked in the cluster chart (Fig. 2).

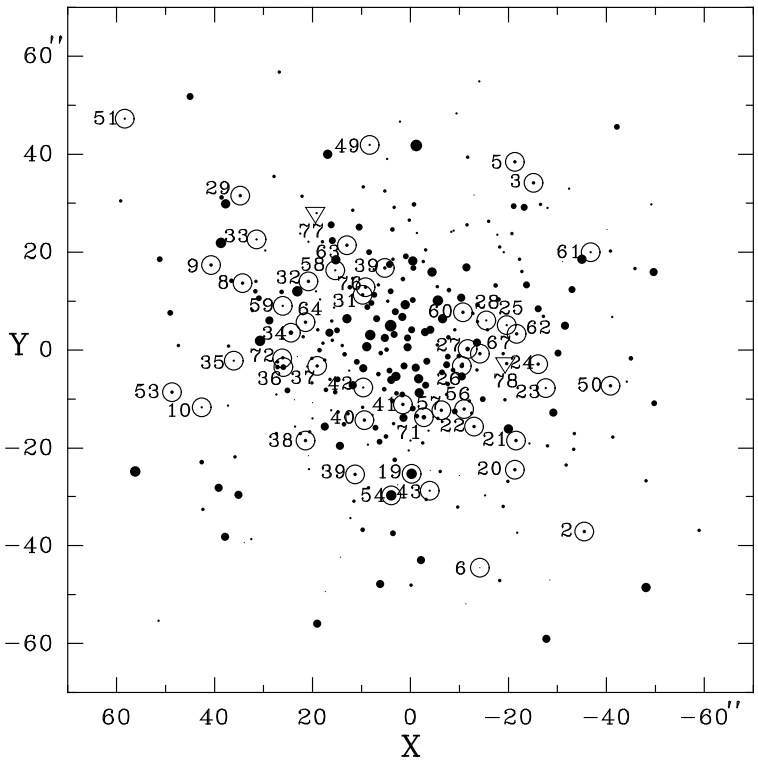

Figure 2. Identification chart for most of the variable stars in the central part of the globular cluster NGC 7006. Known variables are circled, with their identifying numbers placed, if possible, to the left of the star's image; the suspected ones are plotted as triangles, with their identifying numbers placed below the star's image.

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