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VARIABLE STARS IN THE GLOBULAR CLUSTER M72

NGC 6981 (M72), $l = 35^{\circ}2$, $b = -33^{\circ}7$, is a variable-rich Oo IA cluster. The cluster is classified as CC IX (concentration class) and according to Kukarkin (1974) has a radius $R = 2'.94$. The list of 42 stars in the Third Catalogue of Variable stars (Sawyer-Hogg 1973) contains 28 RR Lyrae variables with known periods, 11 with no period determinations, 2 non-variables and one red variable (V42). The four variables (V2, V27, V35, V39) detected at larger distances $3'.6 \leq R \leq 5'.2$, all have a positive X coordinate. Periods have been determined for the first three and hence there are 25 known RR Lyr variables with $R \leq 2'.5$. A comparison of the position of the stars on the reproduced plates with the accompanying lists of Shapley (1920), Shapley and Ritchie (1920) and Sawyer-Hogg (1953) indicates that the X coordinates of V29 and V41 should have an opposite sign, i.e. minus and plus correspondingly. These errors have not been corrected in catalogue of Sawyer-Hogg (1973).

During the past 40 years no further search had been made for variable stars in this cluster and no periods were determined for 13 (V6, V19, V22, V26, V30, V33, V34, V36 - V41). In order to check the variability of the 11 stars with unknown periods and search for as yet undetected variables the method proposed and applied for M3 (Kadla & Gerashchenko, 1982) was used. It is based on an analysis of a color-magnitude diagram obtained from measurements of two plates (or CCD) taken "simultaneously". A variable is thus at identical phase and the RR Lyrae stars are located in a definite strip. By indicating the possible variables the diagram considerably narrows down the number of stars which need further investigation.

We had at our disposal a pair of the necessary CCD (B,V) exposures obtained with the 90 cm Dutch telescope at La Silla. Details on the observations, methods of reduction are given in the paper by Brocato et al. (1996). The field includes 33 stars with $R < 2'.5$ in the variable star list (Sawyer-Hogg, 1973). Photoelectric standards obtained by Dickens (1972) were used to transform the instrumental magnitudes. The resulting $V - (B - V)$ diagram (Figure 1) includes 239 stars in the magnitude range $15^m50 < V < 18^m00$, the known variable stars being denoted by an asterisk.

The positions of V6, V19 and V33 on the color-magnitude diagram indicate that they belong to the GB. Of the four stars (V13, V22, V26 and V34) located in the vicinity of the RHB stars only V13 has a known period, V22 is listed as a non-variable and the last two are most probably RHB stars. It was difficult to identify the 5 variables with $R \leq 0'.4$ found by Sawyer-Hogg (1953). The reproduced plate of the cluster does not have the necessary quality and no known variables are marked, although according to the listed coordinates V40 is located close to the known variable V13.

The coordinates, V and $B - V$ of the 9 suspected variable stars in the RR Lyr variability strip are given in Table 1. Their positions were determined using as a reference frame the coordinates system given in the catalogue of Sawyer-Hogg (1973).

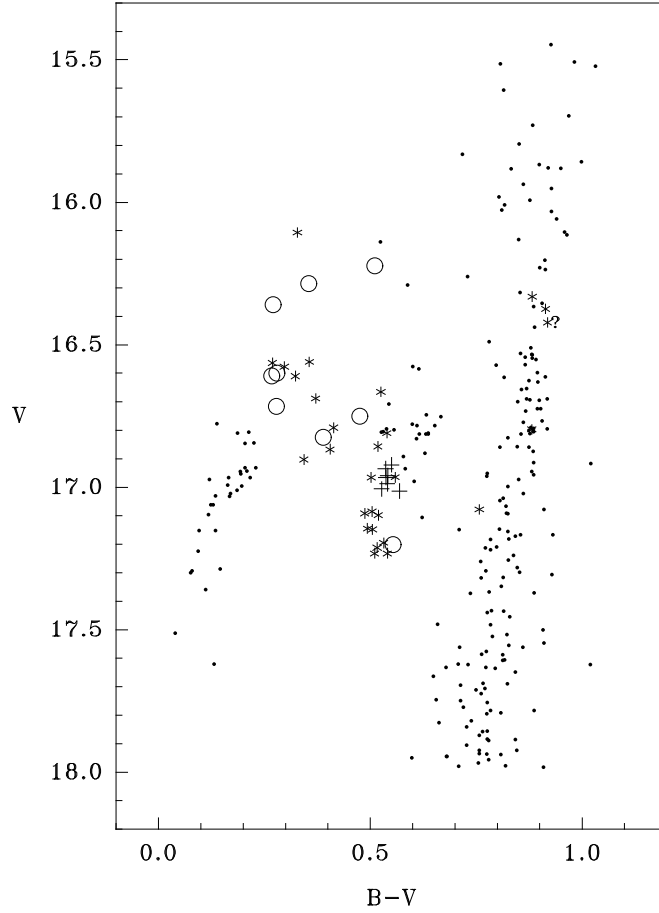


Figure 1. The color-magnitude diagram for the globular cluster NGC 6981. The known RR Lyrae stars are denoted by asterisks, the stars from Table 1 (S) - circles, (R) - pluses.

Table 1. Positions and photometric data for suspected variables (S) and for possible variable stars located at the intersection with the RHB(R)

N	X (arcsec)	Y (arcsec)	V	$B - V$	N	X (arcsec)	Y (arcsec)	V	$B - V$
S1	-44.9	-36.5	16.60	0.27	R1	-68.2	-102.6	16.92	0.54
S2	-15.9	-9.5	16.83	0.38	R2	-34.9	-55.4	16.99	0.53
S3	-10.0	-4.5	16.61	0.26	R3	-23.4	-9.2	17.01	0.56
S4	-0.4	-11.9	17.20	0.54	R4	3.7	6.7	16.97	0.53
S5	0.4	2.7	16.29	0.34	R5	18.2	26.8	17.01	0.52
S6	5.4	-17.5	16.22	0.50	R6	32.3	-12.4	16.93	0.53
S7	9.6	-2.4	16.36	0.26	R7	50.9	-44.4	16.96	0.53
S8	13.6	-9.0	16.72	0.27					
S9	24.9	-9.0	16.75	0.46					

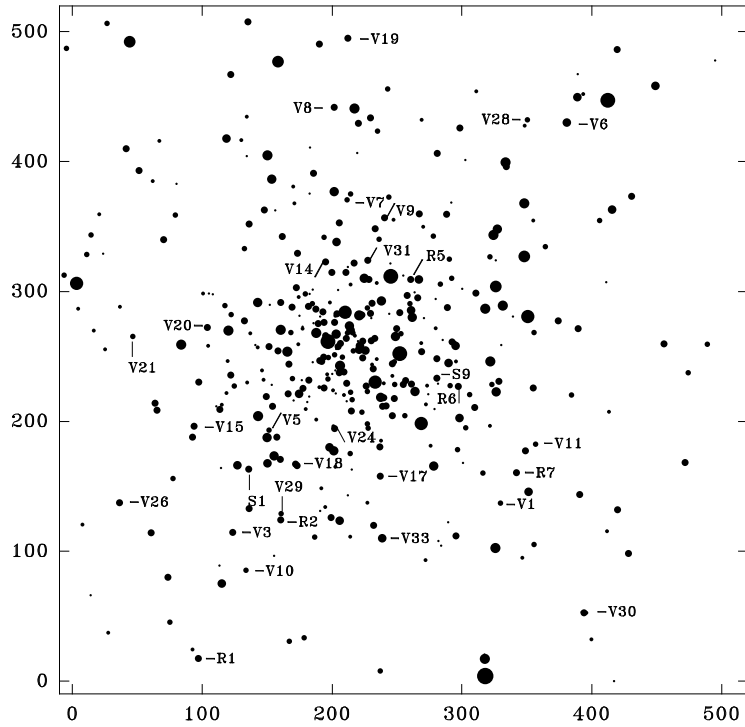


Figure 2. Chart of the cluster. The notations V, S and R preceding the star number refer to known and suspected (Table 1) variables.

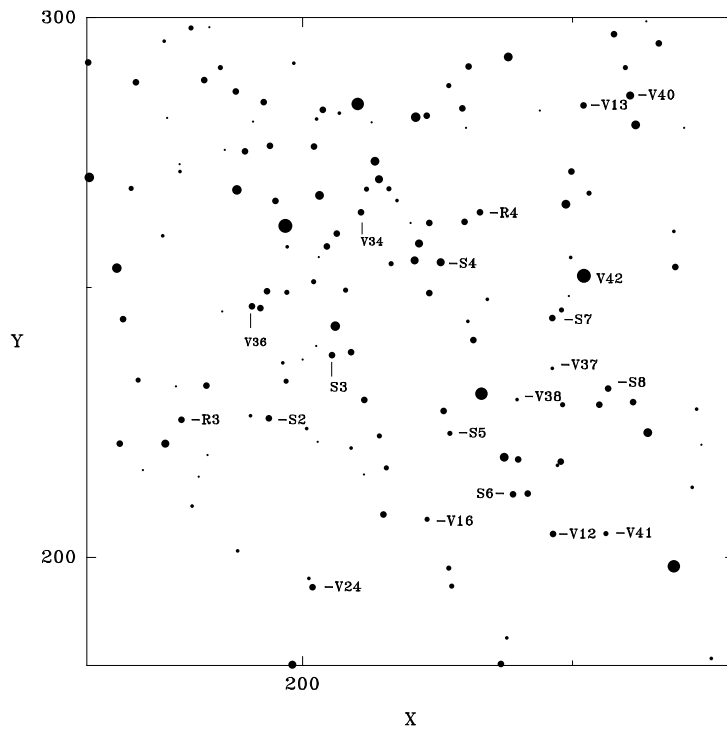


Figure 3. The central part of NGC 6981. The notation are the same as in Figure 2.

As the observed RR Lyrae instability strip slightly intersects the RHB there is a possibility that some of the latter stars are variable. The coordinates, V and $B-V$ of the stars which should be checked are listed in Table 1. The maps of NGC 6981 with known and suspected variable stars are shown in Figure 2 and Figure 3 (coordinates are in pixels, 1 pixel = $0''.44$). Almost all the suspected variables are located in the central part of cluster.

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