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V3, V5 AND FOUR NEW VARIABLE STARS IN THE FIELD OF M56

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M56 (NGC 6779) is a galactic globular cluster lying on a rich stellar field at $\alpha = 19^{\rm h}14^{\rm m}.39$, $\delta = +30^\circ05'.45$ (1950), $l = 62^\circ.66$, $b = +8^\circ.34$.

The Third Catalogue of Variable Stars in Globular Cluster (Sawyer-Hogg, 1973) contains three red variable stars V2, V3 and V5 in M56 with unknown periods. These stars are physical members of the cluster according to their proper motions (Rishel et al., 1981) and the position in the colour–magnitude diagram (Barbon (1965) and Russev (1998)). We have investigated the variability of these three variables as well as 10 red giants. The latter fall on the red giant branch (RGB) in the colour–magnitude diagram of M56 at $B - V > 1^{\rm m}.0$.

This study is based on 115 blue plates (ZU21 emulsion + GG385 filter) and 15 plates in system V (103a-D emulsion + GG495 filter) taken with the 2-m telescope of the NAO "Rozhen" (Bulgaria) and with the 60-cm reflector of the Belogradchic Astronomical station (Bulgaria) during 15 years, from 1977 to 1993. All plates were measured with an iris diaphragm photometer using Barbon's (1965) standard sequence and a photoelectric sequence kindly placed at our disposal by Russev (unpubl.). The photometric error is ± 0.05 mag.

New Variables. As a variability criterion of the investigated program stars we have adopted the mean error $\left(\varepsilon = \dfrac{B_i - \overline{B}}{n}\right)$ of their mean magnitudes ($\overline{B}$), obtained from the available individual measurements (B_i). It was assumed that we could suspect in variability those stars, which have ε larger than the accuracy of the photometry. Table 1 lists the stars suspected in variability. The columns 1, 2 and 3 give Küstner (1920), Barbon (1965) and Rosino (1951) numbers of the stars, respectively. The next columns give the average values of the blue magnitudes ($\overline{B}$), the number of their measurements, the mean error (ε) and the average values of colours ($\overline{B} - \overline{V}$).

Stellingwerf's (1978) PDM method was used for searching the periods of the program stars. We have not found any evidence for variability of the stars with Nos. 166, 179, 224, 244, 247, and 304 in Küstner's (1920) catalogue. The analysis has shown that K 204, K 235, K 251 and K 343 are undoubtedly variable stars. The light curve elements are:

$$\begin{aligned}
&\text{Max} = \text{JDH } 2443283.53 + 32^{\rm d}.55 \times E \quad \text{for K 204,}\\
&\text{Max} = \text{JDH } 2443290.14 + 29^{\rm d}.91 \times E \quad \text{for K 235,}\\
&\text{Max} = \text{JDH } 2443284.52 + 26^{\rm d}.18 \times E \quad \text{for K 251,}\\
&\text{Max} = \text{JDH } 2443292.88 + 22^{\rm d}.18 \times E \quad \text{for K 343,}
\end{aligned}$$

Table 1: A list of the investigated red giants and red variable stars in M56.

K No.	B No.	R No.	$\overline{B}$	n	$\overline{B}-\overline{V}$	lg P	A_B	$\triangle f$
166	I 77	–	15.02	113	1.50	–	–	–
179	I 66	881	15.19	115	1.41	–	–	–
204	I 140	–	14.95	111	1.57	1.51	0.24	0.45
224	–	–	15.20	110	1.37	–	–	–
235	–	–	14.85	101	1.48	1.48	0.52	0.43
244	–	–	15.08	85	1.35	–	–	–
247	I 60	871	15.07	115	1.52	–	–	–
251	–	–	14.76	60	1.08	1.42	0.60	0.42
304	–	–	14.70	101	1.27	–	–	–
343	–	–	14.98	100	1.33	1.35	0.52	0.33
V2	–	–	15.24	115	1.34	–	–	–
V3	–	–	14.86	112	1.97	1.62	0.30	0.50
V5	–	–	14.92	102	1.94	1.50	0.48	0.45

and their phase curves are shown in Fig. 1. From the average light curves we obtained the amplitudes A_B and asymmetry parameters, $\triangle f = f_{min} - f_{max}$, of the stars (Table 1, columns 8 and 9).

The question of the membership of the investigated ten red giants is very important. The stars K 179 and K 247 are cluster members according to their proper motions (Rishel et al., 1981) and K 166 and K 204 – according to the radial velocity measurements (Harris et al., 1983). The rest stars, including the three new variables, probably belong to the cluster by their positions in the colour–magnitude diagram and their distances from the cluster center (for K 235: $41\farcm7$, K 251: $19\farcm3$ and K 1343: $32\farcm8$). It should be noted, however, that any solution of the problem of the cluster membership for the new variable stars has to await from the results of the other two criteria, such as proper motion and radial velocity measurements.

V2, V3 and V5. The light curves of V3 and V5, constructed with help of the following elements:

$$\text{Max} = \text{JDH } 2443288.40 + 42\fd12 \times E \quad \text{for V3,}$$
$$\text{Max} = \text{JDH } 2443295.40 + 31\fd33 \times E \quad \text{for V5,}$$

and their phase curves are shown in Fig. 2. Two periods seem to fit the observations of V3. The alternative period, $34\fd86$ produced a better light curve for Wehlau and Sawyer Hogg's (1985) data from OHP and UWO plates. We consider the light curve of V3 as preliminary and requiring specification. The scattering in the light curves (Fig. 1 and 2) is probably due to sudden changes in brightness or shifting of the light curve maxima similar to those observed for L70 and L973 in M13 by Russev and Russeva (1979) and Russeva and Russev (1980).

The analysis of the data for V2 has not indicated any variability.

The variables V3 and V5 are the brightest ($\overline{V} = 12\fm89$ for V3 and $12\fm98$ for V5) and the reddest ($\overline{B}-\overline{V} = +1\fm98$ and $+1\fm94$ for V3 and V5 respectively) stars in M56. According to their periods, amplitudes and shape of the light curves the variables V3, V5 and K 204 fall in the group of the smaller amplitude variables in the globular clusters with periods from $30^{\rm d}$ to $45^{\rm d}$. As it is known, such stars are found comparatively rarely among the variables of this type in such aggregates. The comparison with the red variable stars in M13 and in other globular clusters in our Galaxy is necessary.

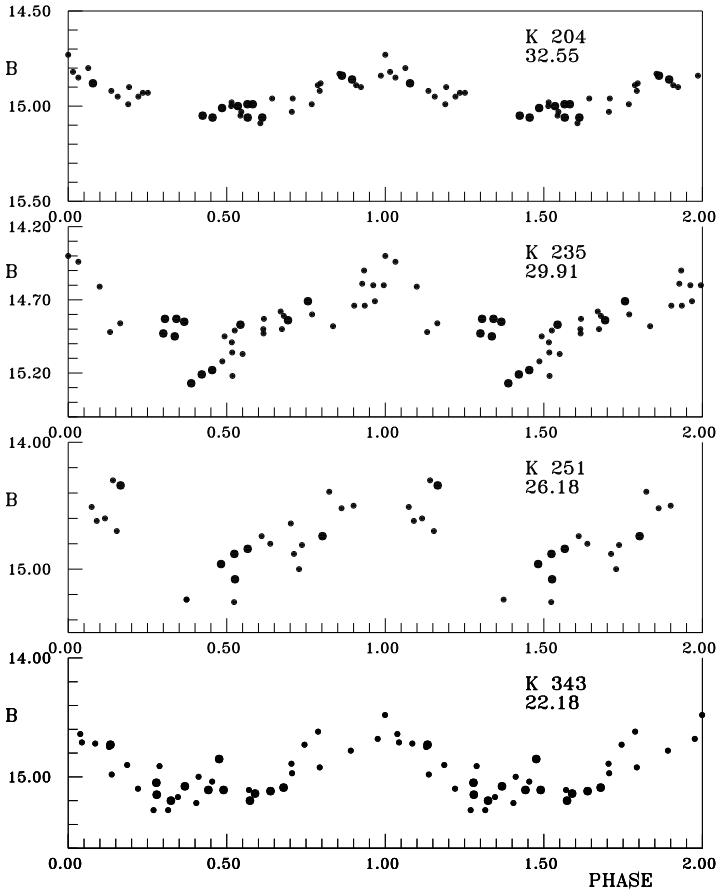

Figure 1. Light curves of new red variables in the field of M56. The size of the symbols is proportional to the number of observations per night.

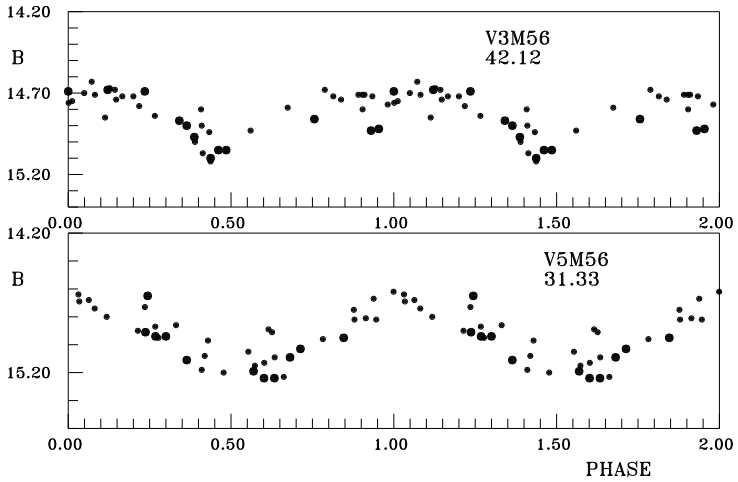

Figure 2. Light curves of V3 and V5. The size of the symbols is the same as in Fig. 1.

References:

Barbon, R., 1965, Asiago Obs. Contrib., No. 175
Harris, H., Nemec, M. and Hesser, E., 1983, PASP, 95, 256
Küstner, F., 1920, Veröff. U. Sternw. Bonn., No. 14
Rishel, B., Sanders, W. and Schöder, R., 1981, A&A Suppl., 45, 443
Rosino, L., 1951, Asiago Obs. Contrib., ser. VIII, v. X, 135
Russev, R.M., 1998, in the press
Russev, R.M. and Russeva, T., 1979, IBVS, No. 1534
Russeva, T. and Russev, R.M., 1980, IBVS, No. 1769
Sawyer Hogg, H., 1973, Publ. David Dunlap Obs., 3, No. 6
Stellingwerf, R.F., 1978, ApJ, 224, 953
Wehlau, A. and Sawyer Hogg, H., 1985, AJ, 90, 2514