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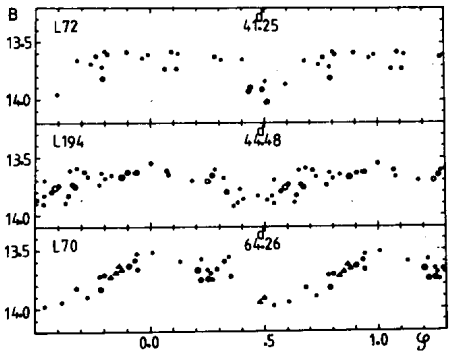
THREE NEW RED VARIABLE STARS, V10 AND V15 IN M13

Up to now four red variable stars V10 (with unknown period), V11, V15 and L973 (Sawyer-Hogg, 1973; Fuenmayor and Osborn,1974) were known in the globular cluster M13 = NGC6205. On the same 43 blue plates, on which L973 was studied (Russev and Russeva, 1979a) we investigated the variability of V10 and V15, as well as nine red giants. The latter are Nos.70, 72, 194, 240, 252, 261, 353, 414 and 877 in Ludendorff's (1905) catalogue and Nos. 309, 310, 382, 398, 403, 409, 434, 444 and 513, respectively, in Kadla's (1966) catalogue. Our plates cover about four years,from 1974 to 1978. The photometric system is near the B one, as it was announced in the paper on L973. In addition to this observational material we have also used the data for V15 from Russev's (1973a) publication and the unpublished measurements of the same 23 blue plates from the State Astr.Inst. collection in Moscow for V10, L194, 240, 252, 261, 353, 414 and 877 (J.D.2437790-41093). Besides we have used Osborn and Fuenmayor's (1977) measurements for V10, V15, L261 and L414 (J.D. 2439658-40439), as well as those by Pike and Meston (1977) for V10 and L70 (J.D. 2441069 - 41160). In general we have not established essential systematic deviation in the B-systems of the different authors.

New variables. As a variability criterion of the investigated nine program stars we have adopted the mean error ($\varepsilon = \frac{(Bi-\bar{B})}{n}$) of their mean magnitudes ($\bar{B}$), obtained from the available individual measurements (Bi). It was assumed that we could suspect in variability those stars, for which ε is greater than the accuracy of the photometry $\pm 0^{m}.08$. L70, 72, 194, 240 and 261 proved to be such stars. Recently the star L70 was suspected in variability also by Pike and Meston (1977). The analysis of the available observations permitted the construction of light curves for

L70 (from 48 observations in all), L72 (40 observations) and L194 (64 observations), which are shown in Fig.1. The light curve elements are:

for L72 Max = J.D. 2442307.6 + $41^{d}.25 \cdot E$ (before J.D.2443000)
Max = J.D. 2442315.9 + $41^{d}.25 \cdot E$ (after J.D.2443000)
for L194 Max = J.D. 2437810.8 + $44^{d}.48 \cdot E$
for L70 Max = J.D. 2442324.0 + $64^{d}.26 \cdot E$



In Fig. 1 the measurements by Russev are denoted with crosses those by Pike and Meston with triangles and our observations with dots. The size of the symbols is proportional to the numbers of observations per night.

We must note that when constructing the light curve of L72 it was necessary to admit the shifting of the light curve maximum with about $8^{d}.3$ for the time after J.D. 2443000 in comparison with its position for the earlier observations. That is why we consider the light curve of L72 preliminary and in need of specification.

These three new variables are physical members of M13 according to the radial velocities measured by Popper (1947) and the proper motions (Cudworth and Monet, 1979).

V10 and V15. The light curves of these two variables, constructed with the help of the following elements:

for V10 Max = J.D. 2439670.0 + $35^{d}.62 \cdot E$
for V15 Max = J.D. 2441061.5 + $39^{d}.23 \cdot E$

are shown in Fig.2. The symbols are the same as in Fig. 1. Osborn and Fuenmayor's (1977) observations are denoted with x-es. The scattering in the light curve of V10 is probably due first and

foremost to the fact that the star has close optical companions and is difficult to measure. Here we confirm the period $39^d.23$ for V15, obtained by Osborn and Fuenmayor (1977). This period is approximately 7/2 of Russev's period and is used by Russev and Russeva (1979c) for the explanation of the observations published there.

Discussion. At the first sight it seems odd that the periods of several red variables in M13 (V10,V15,L72,L194 and L973) fall in the region from 35^d to 45^d, which, as is known, are found comparatively rarely among the variables of this type in globular clusters. It must be noted, however, that if we could doubt to a certain extent in the reliability of the periods obtained for V10 and L72, we believe that the periods of the remaining four stars are beyond any doubt. On the other hand, according to its period ($64^d.26$), amplitude ($0^m.48$) and shape of the light curve the variable L70 may be compared with the long-period variable V11 (P= $91^d.77$, $A_B=0^m.67$) known long since in M13.

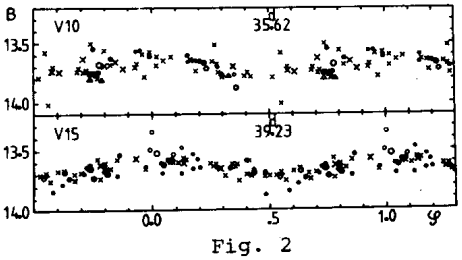


Fig. 2

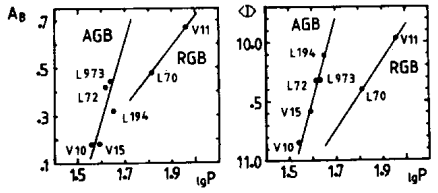


Fig. 3

Fig. 3 presents the period-amplitude (A_B) diagram, as well as the period-magnitude (<1>) ones of the seven red variables in M13 known up to now. The amplitudes are for V10-$0^m.18$, V15-$0^m.18$, L72-$0^m.42$, L194-$0^m.32$ and L70-$0^m.48$ from the present article (Fig.1 and Fig.2), and for L973 (P=$43^d.27$)-$0^m.45$ and V11-$0^m.67$ from our recent publications (Russev and Russeva, 1979a, 1979b).The infrared

magnitudes <I> for V11, V15, L194 and L973 are from Russev's (1973b) work, while for V10, L70 and L72 they were additionally determined from the same observational material.

On both diagrams two sequences may be distinguished clearly, the one for the lesser amplitude variables with periods 35^d-45^d, and the second one formed by L70 and V11 with $P \gtrsim 50^d$. We must note immediately that on the colour-magnitude diagram, constructed using the infrared magnitudes <I> and the colour (B-I) (Russev, 1973b), the first group stars fall on the asymptotical giant branch (AGB), while L70 and V11 are on the prolongation of the giant branch (RGB) at higher luminosities and lower temperatures. Thus the period-luminosity dependence of the investigated variables in M13 is divided in two sequences with a different slope of both these evolutionary star groups. A confirmation of the obtained result for this cluster, as well as for other globular clusters in our Galaxy is necessary.

This investigation will be published in detail elsewhere.

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References:

Cudworth, K., and Monet, D., 1979, AJ, 84, 774
Fuenmayor, F., and Osborn, W., 1974, IBVS, No. 952
Kadla, Z., 1966, Iz. Pulkova Obs., 24, 93
Ludendorff, H., 1905, Publ.Potsdam Obs., 15, No. 50
Osborn, W., and Fuenmayor, F., 1977, ApJ. 82, 395
Pike, C., and Meston, C., 1977, MN, 180, 613
Popper, D., 1947, ApJ. 105, 204
Russev, R., 1973a, Perem.Zvezdi, 19, 181
Russev, R., 1973b, Astron.Zh., 51, 122
Russev, R., and Russeva, T., 1979a, IBVS No. 1534
Russev, R., and Russeva, T., 1979b, IBVS No. 1624
Russev, R., and Russeva, T., 1979c, Perem.Zvezdi, 21, 169