



# TOWARDS ADDING GLOBULAR-CLUSTER VARIABLES TO THE GENERAL CATALOGUE OF VARIABLE STARS

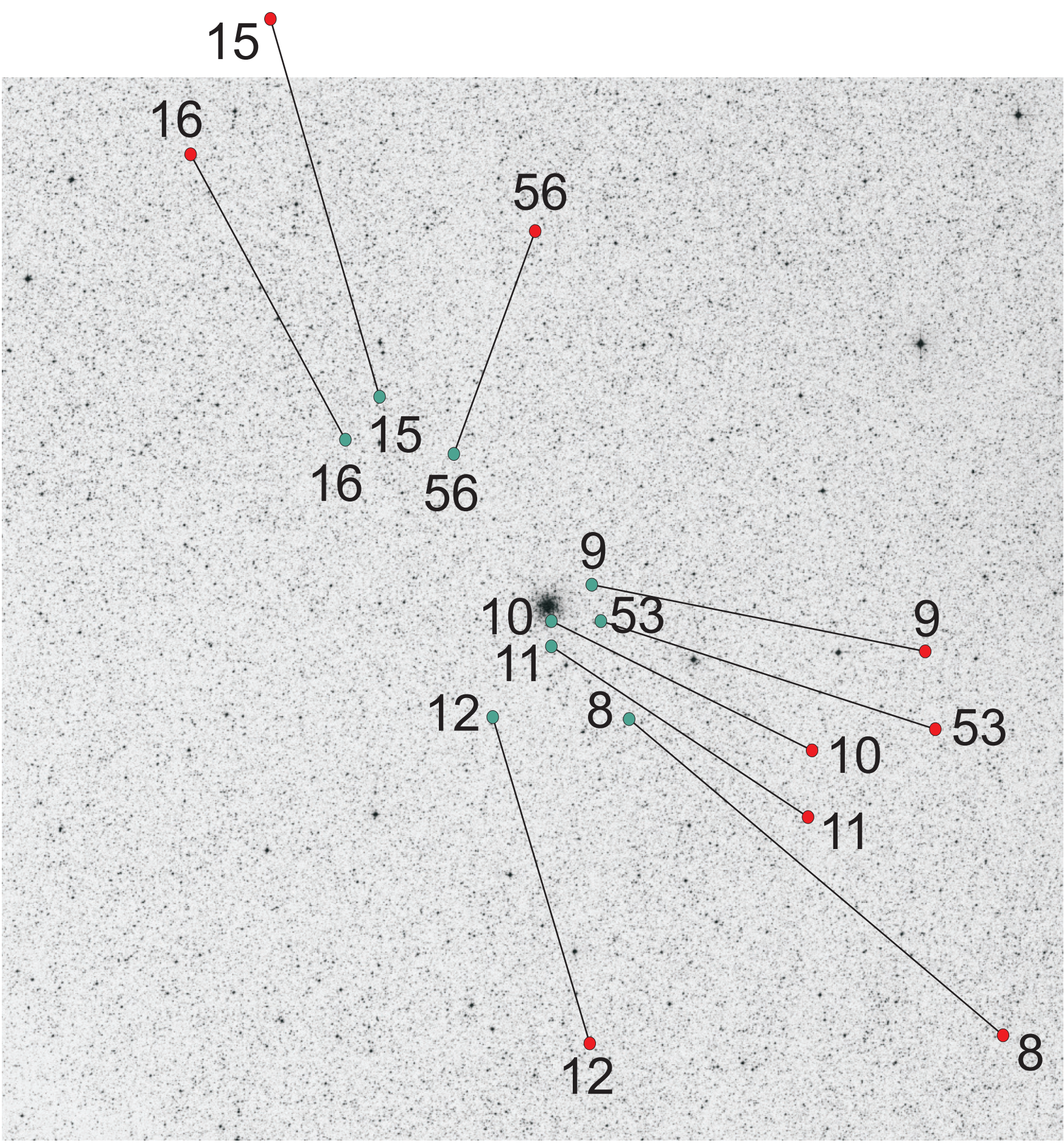
N.N.Samus<sup>1,2</sup>, E.V. Kazarovets<sup>1</sup>, E.N. Pastukhova<sup>1</sup>, T.M. Tsvetkova<sup>1</sup>

<sup>1</sup> Institute of Astronomy, Russian Academy of Sciences, 48, Pyatnitskaya Str., Moscow 119017, Russia

<sup>2</sup> Sternberg Astronomical Institute, Moscow University, 13, University Ave., Moscow 119992, Russia

For reasons of tradition, globular-cluster variable stars are, as a rule, not included in the GCVS. This tradition contradicts the original intention that the GCVS should contain all sufficiently well-studied and confirmed variable stars of our Galaxy. Rather many globular-cluster variables definitely vary and are well-studied. They are listed in specialized catalogues of variable stars in globular clusters, which are certainly an important source of information, but, in our opinion, should ultimately be also added to the GCVS. One of the problems not permitting to do it so far is that only rectangular coordinates, and in not quite unified systems, are available for many globular-cluster variable stars. We are on the way to reliable identification of most stars in question with modern positional catalogues. If this is not possible, we measure their equatorial coordinates. In the course of this work, we found many earlier unknown cross-identifications between the catalogue of globular-cluster variables and the GCVS/NSV catalogues, several mistakes in the catalogues.

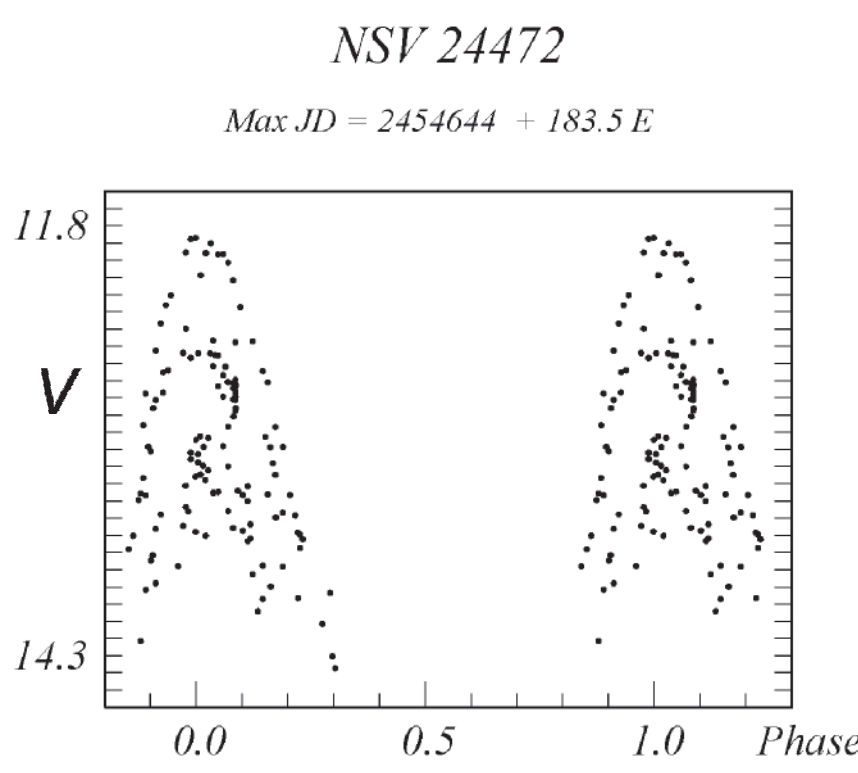
Currently, the main source of information on variable stars in globular clusters is the online catalogue of variable stars in globular clusters (CVSGC) kept by C.M. Clement (cf. Clement et al., 2001). It contains about 3000 stars, most of them listed with rectangular coordinates of different formal precision, referred to cluster centers, with only very approximate center positions given. Many stars in the CVSGC are sufficiently well-studied for the General Catalogue of Variable Stars (GCVS), provided that we drop the old rule that globular-cluster variables, in variance with open-cluster variables, should not be included. However, first we must solve the coordinate problem. So far, we have checked identifications, retrieved equatorial coordinates from a positional catalogue (mainly from 2MASS) or determined coordinates ourselves for more than 2100 variables from the CVSGC in 82 clusters (from one to almost three hundred variables in the CVSGC in each of them).



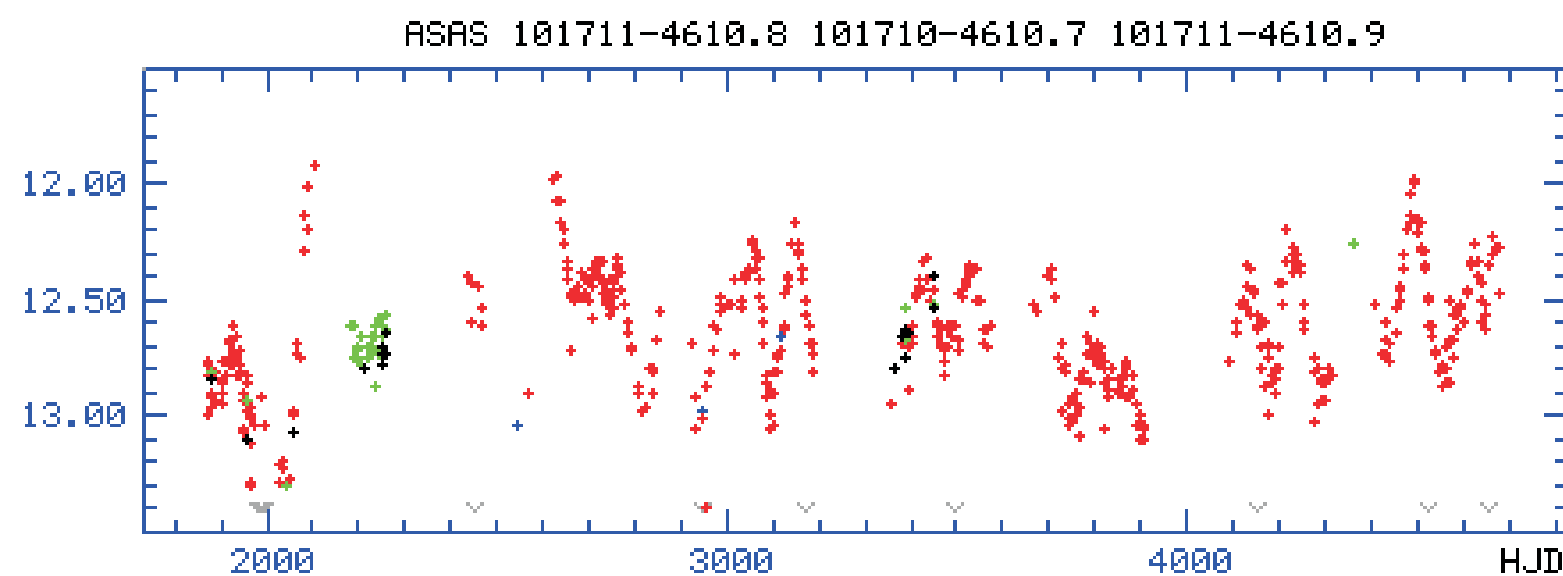
A 1°×1° field around NGC 6638. Red circles are positions of several variable stars from the CVSGC, based on their equatorial coordinates from Rutily & Terzan (1977). All 37 stars with equatorial coordinates from the cited paper have wrong catalogued positions, with errors from 13 to 49 arcminutes (more than half a degree in 18 cases). Green circles are correct positions. Double GCVS identifications for two NGC 6638 variables (V13, V63) in the following Table are due to their bad coordinates in the literature.

47 Tuc	V12	CO Tuc	NGC 6356	V6	V1995 Oph	NGC 6638	V15	V4055 Sgr
NGC 1851	V1	Z Cvd	NGC 6352	V6	V819 Ara	V16	NSV 10948	
NGC 3201	V2	Y Cvd	HP 1	V1	NSV 8084	V17	NSV 10951	
	V15	NSV 4813		V2	NSV 8089	V18	NSV 10952	
	V68	KP Vsd		V3	NSV 8073	V19	NSV 10956	
	V98	NSV 4810		V4	NSV 8082	V46	NSV 24458	
	V2	V887 Cen		V5	NSV 8011	V47	NSV 24460	
NGC 4833	V1	BY Mus		V6	NSV 8016	V48	NSV 24460	
	V2	BZ Mus		V7	NSV 8067	V49	NSV 24461	
	V11	NSV 8078		V8	NSV 8078	V50	NSV 24463	
NGC 5272	V113	XX CVn		V9	NSV 8083	V51	NSV 24462	
	V141	BY CVn		V10	NSV 8088	V52	NSV 24465	
	V206	WY CVn		V11	NSV 8087	V53	NSV 24466	
	V206	WZ CVn		V12	NSV 8087	V54	NSV 24472	
NGC 5286	V1	GI Cen		V13	NSV 8012	V55	NSV 24471	
NGC 6093	V6	S Sco		V14	NSV 8021	V56	NSV 24475	
	V7	R Sco		V15	NSV 8023	V57	V4054 Sgr	
NGC 6191	V7	T Sco	Terzan 1	V4	NSV 22828	V58	NSV 24476	
	V12	NSV 20592		V4	NSV 22828	V59	NSV 24479	
	V13	NSV 20597		V20	V1164 Sco	V60	NSV 24481	
	V14	NSV 20591		V1	NSV 8335	V61	V3845 Sgr	
	V15	NSV 20594		V1	V638 Ara	V62	NSV 24485	
NGC 6144	V1	BP Sco		V2	V825 Ara	V63	IL Sgr	
NGC 6171	V1	D0 Sco		V9	V928 Ara	V64	V4056 Sgr	
NGC 6235	V1	V720 Oph	NGC 6426	V11	V979 Oph	NGC 6642	V1	V2578 Sgr
NGC 6266	V3	V2249 Oph	NGC 6441	V36	V1165 Sco	NGC 6637	V2	V3484 Sgr
	V2	V2249 Oph		V47	V1168 Sco	V4	V1894 Sgr	
NGC 6284	V29	PU Oph		V48	V1170 Sco	NGC 6652	V7	V3636 Sgr
	V70	OH Oph		V49	V1169 Sco	V9	V3641 Sgr	
NGC 6273	V2	FK Oph		V50	V1167 Sco	NGC 6656	V14	V1311 Sgr
V6	NSV 20887			V68	V1166 Sco	V17	V4068 Sgr	
NGC 6284	V7	V2135 Oph	NGC 6622	V7	V3600 Sgr	V22	V3853 Sgr	
	V10	V2121 Oph		V8	V1437 Sgr	V26	V2607 Sgr	
	V11	V2121 Oph		V9	V1438 Sgr	V28	V2507 Sgr	
	V12	GM Oph	NGC 6535	V1	MO Ser	V29	NSV 11080	
NGC 6293	V2	V2137 Oph		V2	MO Ser	V30	NSV 11084	
	V7	V2145 Oph		V1	SS Cva	V31	V3855 Sgr	
	V9	NSV 21091	NGC 6511	V2	V1148 Sgr	V32	V4067 Sgr	
	V10	V2136 Oph	NGC 6513	Novae	V5	V4301 Sgr	V33	V4069 Sgr
	V11	V2192 Oph	NGC 6566	V8	V4001 Sgr	NGC 6681	V2	V4082 Sgr
NGC 6304	V12	BY Oph		V9	V4556 Sgr	V5	V4081 Sgr	
	V13	V2167 Oph	NGC 6560	V4	V2711 Sgr	NGC 6712	V1	MP Sct
	V14	NSV 21164		V6	NSV 10564	V2	AP Sct	
	V1	V2171 Oph		V15	V2608 Sgr	V7	CH Sct	
	V4	V2184 Oph	NGC 6584	V16	FX Tel	V8	MR Sct	
	V5	V2173 Oph		V24	PU Tel	V15	MR Sct	
	V6	NSV 21193		V27	PT Tel	V16	LZ Sct	
	V7	V2186 Oph		V30	PS Tel	V21	MR Sct	
	V8	V2177 Oph	NGC 6626	V7	V4137 Sgr	NGC 6728	V30	NSV 24641
	V9	V2191 Oph		V15	V4132 Sgr	NGC 6752	V6	V3045 Pav
	V10	V2155 Oph		V16	V4130 Sgr	V5	V305 Pav	
	V11	V2159 Oph		V17	V2312 Sgr	V6	V306 Pav	
	V12	V2160 Oph		V24	V4129 Sgr	V8	V307 Pav	
	NSV 08349			V1	NSV 10865	NGC 6779	V11	V308 Pav
	V14	V2163 Oph	NGC 6638	V2	NSV 10866	V7	V407 Lyr	
	V15	NSV 08361		V3	V4011 Sgr	V8	V406 Lyr	
	V16	V2169 Oph		V4	NSV 10868	V9	V406 Lyr	
	V17	NSV 08377		V5	NSV 10913	V10	V404 Lyr	
	V18	V2180 Oph		V6	NSV 10914	V11	V404 Lyr	
	V19	NSV 08367		V7	NSV 10916	V2	MZ Sgr	
	V20	NSV 08369		V8	NSV 10918	V3	MY Sgr	
	V21	NSV 08386		V9	NSV 10921	NGC 6838	V1	Z Sgr
NGC 6341	V14	V708 Her		V10	NSV 10928	V3	Q1 Sgr	
NGC 6333	V2	V1861 Oph		V11	NSV 10930	V4	NSV 24932	
	V7	V1845 Oph		V12	V4052 Sgr	V6	V345 Sgr	
	V12	V1848 Oph		V13	V1073 Sgr			
	V13	V2008 Oph		V13	V4053 Sgr			
NGC 6356	V5	V2009 Oph		V14	NSV 10942			

The Table presents 199 identifications of globular-cluster variables in the CVSGC with the GCVS and the NSV catalogue, made during the current study. Some of these stars are cluster non-members, others were discovered and announced without reference to globular clusters. Most of these identifications were already known in the complete GCVS data base. Only 9 of them are mentioned in the CVSGC (asterisks). Amazingly, even such stars as WY CVn (V205 in NGC 5272=M3) and WZ CVn (V206 in M3), identified with the GCVS in Bakos et al. (2000), the main source of CVSGC coordinates in M3, remain without GCVS identifications in the CVSGC.



A rare case of the ASAS-3 data and catalogue (Poimanski, 2002) being able to help both the GCVS and the CVSGC: V54 (NGC 6638) = NSV 24472 had no period in the GCVS data base or in Clement's catalog but had a Mira light curve and period in ASAS-3. The light curve shown is our solution of the ASAS-3 data. Unfortunately, most globular-cluster variable stars are too faint for the ASAS-3 survey.



The raw ASAS-3 *V*-band light curve of the red variable V68 (NGC 3201) = NSV 4810. No magnitudes at all are quoted for this star in the CVSGC. The star would be ready for adding it to the GCVS, were there no rule not to include globular-cluster variables (by its brightness, it quite can be a red-giant member of NGC 3201).

In the course of this study, we found about 80 errors in coordinates in the CVSGC (some of them already communicated to Dr. C.M. Clement and corrected), about 10 errors of different character in the same catalogue, and a number of errors in other sources (wrong charts, etc.).

In our opinion, both the CVSGC team and the GCVS team should continue their work on globular-cluster variables. After we finish checking the coordinates later this year, we will be able to include those variables that meet the strict GCVS naming criteria (the star should be sufficiently studied for it being possible to assign it at least a tentative type in the GCVS classification system) to the GCVS. This will be a logical step like that made in the 1940s, when Novae, earlier considered a class of objects different from classical variable stars, were added to the GCVS. A large fraction of globular-cluster stars will, however, remain “suspected” variables from the GCVS point of view, being genuine variable stars represented in the catalogue of variable stars in globular clusters but poorly studied yet.

In future, the catalogue of variable stars in globular clusters should contain only *verified equatorial coordinates* for all the stars. This will permit to avoid continuing confusion among catalogues, lists of new discoveries, variable-star inventories. We will provide the CVSGC team with the complete list of coordinates and identifications upon the completion of this study.

Our work is supported by grants from the Russian Foundation for Basic Research (08-02-00375), from the Program “Origin and Evolution of Stars and Galaxies” of the Presidium of Russian Academy of Sciences, and from the Program of Support for Leading Scientific Schools of Russia (NSH 433.2008.2). We wish to thank Dr. C.M. Clement for fruitful cooperation.

## References

- Bakos, G.Á., Benkő, J.M., Jursik, J., 2000, Acta Astron., **50**, 221
- Clement, C.M., Muzzin, A., Dufton, Q., et al., 2001, Astron. J., **122**, 2587
- Poimanski, G., 2002, Acta Astronomica, **52**, 397
- Rutily, B., Terzan, A., 1977, Astron. & Astrophys. Suppl., **30**, 315