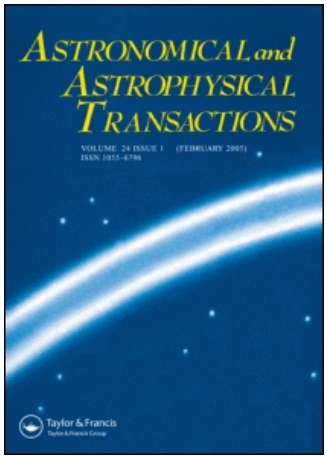


Astronomical & Astrophysical Transactions
The Journal of the Eurasian Astronomical Society
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713453505

# Catalogues of variable stars from Parenago to the present day

N. N. Samus [ab]
[a] Institute of Astronomy, Moscow, Russia
[b] Sternberg Astronomical Institute, Moscow, Russia

Online Publication Date: 01 April 2006
To cite this Article: Samus, N. N. (2006) 'Catalogues of variable stars from Parenago to the present day', Astronomical & Astrophysical Transactions, 25:2, 223 - 227
To link to this article: DOI: 10.1080/10556790600896016
URL: http://dx.doi.org/10.1080/10556790600896016

*Astronomical and Astrophysical Transactions*
Vol. 25, Nos. 2–3, April–June 2006, 223–227





# Catalogues of variable stars from Parenago to the present day

N. N. SAMUS*†‡

†Institute of Astronomy, Pyatnitskaya ul. 48, Moscow 110017, Russia
‡Sternberg Astronomical Institute, Universitetskij Prospekt 13, Moscow 119992, Russia

*(Received 5 July 2006)*

After World War II, the International Astronomical Union made Soviet astronomers responsible for variable-star catalogues. This work has been continued ever since the first edition of the General Catalogue of Variable Stars compiled by the team headed by P.P. Parenago and B.V. Kukarkin and published in 1948. Currently, the catalogue work is a joint project of the Institute of Astronomy (Russian Academy of Sciences) and the Sternberg Astronomical Institute (Moscow University). This paper is a brief review of recent trends in the field of variable-star catalogues. Problems as well as new prospects related to modern large-scale automatic photometric sky surveys are discussed.

*Keywords*: Variable stars; Catalogues

Variable-star catalogues have a long history. Probably the first list that can be called a variable-star catalogue was published by E. Pigott in 1786; it contained only 12 stars. The number of known variable stars increased very slowly until the advent of astronomical photography at the end of the nineteenth century (e.g. only 143 variables were catalogued by 1875), but then the number of known variable stars quickly reached several thousands. Between 1926 and 1942, the work on variable-star catalogues and ephemerides was organized by the Astronomische Gesellschaft; a new catalogue was published each year. The first of these [1] contained 2906 variable stars, and the last [2] contained 9476. The quality of the catalogues compiled by R. Prager, who had to emigrate from the Nazi Germany in the early 1930s, is especially good. After 1942, German astronomers were no longer able to publish their catalogues.

After World War II, the Executive Committee (EC) of the International Astronomical Union (IAU) decided to make other countries responsible for several projects earlier fulfilled in Germany and important for the world astronomical community. The Soviet Union were responsible for two of these projects, Ephemerides of Minor Planets and the General Catalogue of Variable Stars (GCVS). The EC decision concerning the GCVS was preceded by an inspection visit by one of the IAU officers to Moscow, who found a well-kept card catalogue of variable stars founded by P.P. Parenago and kept by Parenago, B.V. Kukarkin and their collaborators. Because of this new arrangement the yearly-published series of catalogues was discontinued;

*Email: samus@sai.msu.ru

*Astronomical and Astrophysical Transactions*
ISSN 1055-6796 print/ISSN 1476-3540 online © 2006 Taylor & Francis
http://www.tandf.co.uk/journals
DOI: 10.1080/10556790600896016

it was decided to issue a catalogue once every few years, with supplements, containing only new variable stars and stars with important changes in the catalogue data, printed between the major editions. Kukarkin and Parenago were able to publish the first one-volume edition of the GCVS already in 1948 [3]. In the style of Soviet scientific publications of that period, the title page of the book lists only two authors, although an author team (named in the Introduction, printed in Russian only) already existed. This catalogue contained 10 930 stars.

Despite the name, the GCVS actually never was a 'general' catalogue. First of all, originally it did not contain galactic novae or supernovae, with several exceptions owing to tradition. In astronomy of the first half of the twentieth century, people tried to distinguish between variable stars and novae. By 1950, it was clear that novae and supernovae were a class of variable stars. Soon after the start of the Soviet GCVS project, historical galactic novae and supernovae were added to the catalogue. Also, as a rule, extragalactic variable stars were not included (and are not included, with the exception of a special list in the 4th edition of the GCVS). Currently, there are no comprehensive catalogues of extragalactic variable stars; the situation is good only for catalogues of extragalactic supernovae (see http://www.sai.msu.su/sn/sncat/).

The most strange tradition limiting the scope of the GCVS is not to include variable stars in the globular star clusters of our Galaxy (variable stars in open clusters are included). The number of globular-cluster variable stars is not too large and the GCVS team is quite able to add them but, since there is a special Canadian project of variable-star catalogues in globular clusters (see the last printed edition [4] and the online catalogue [5]), we are not going to duplicate effort. Circumstances now adding to the fact that the GCVS is not a genuine 'general' catalogue will be mentioned below.

In 1958, the second two-volume (14 708 stars) edition of the GCVS was published [6], the last with P.P. Parenago's coauthorship. The 3rd edition [7] (20 437 stars) already consisted of three volumes.

The GCVS is intended to contain only proven and more or less well-studied variable stars. Currently, the criterion that the star has been studied sufficiently well is that it must be possible to ascribe to it at least a tentative variability type or to decide that the star is 'unique' (possibly belongs to a type not yet introduced). Variable stars not meeting the GCVS criteria are called 'suspected variable stars' and listed in special catalogues. Until GCVS III, the system of the GCVS included two catalogues of suspects, supplementing each other [8, 9]. They contained a total of 12 041 stars.

The 4th edition of the GCVS, most probably the last to consist of printed books, started with *The New Catalogue of Suspected Variable Stars* (NSV catalogue) (14 810 entries) [10]. It replaced the two earlier catalogues of suspects (a supplement to the NSV catalogue, with 11 206 additional entries, was published in 1998 [11]). Then, five GCVS volumes appeared in 1985–1995. The first three of these [12] are the catalogue of galactic variables proper, containing 28 435 stars. After these, two more books [13, 14] appeared. The most important part of the first of these books contains cross-identification tables that permit a user to find the GCVS name for an object of interest if its name in one of the major astronomical catalogues is known. The second is the GCVS team's only attempt, initiated by P.N. Kholopov, to add extragalactic variable stars to the GCVS and thus to make the catalogue more 'general'. This book contains some 12 000 entries for extragalactic variable stars, including supernovae. Immediately after its publication, the flow of new discoveries of extragalactic variable stars became too extensive to permit the GCVS team, with its limited human power and funds, to continue this direction of work.

Until 1994, the IAU provided some financial support to the GCVS project. It almost never reached the GCVS team directly but permitted it to rely on the better attitude of local administrative bodies. Unfortunately, the support was discontinued just at the time of a serious financial crisis in Russian science and just when it became possible to make the funds available to the

scientific group engaged in the work. IAU Commissions 27 and 42 (now Division V) never discontinued their moral support of our effort.

Currently, it is too expensive for us to continue the GCVS in the form of printed books, and the role of printed catalogues also became secondary compared with electronic catalogues. The 4th edition of the GCVS, with corrections, is available at the Strasbourg data centre. The most recent version of the GCVS can be found at our website (http://www.sai.msu.su/groups/cluster/gcvs/gcvs/); it also has a search engine permitting GCVS information to be retrieved by name (in the GCVS or in other catalogues), coordinates, type and other parameters.

Stars are added to the GCVS via Name Lists. The last list published was No. 77 [15]; the number of GCVS stars after its publication is about 38 500. More than 1700 stars have been selected for Name List No. 78, to appear this year (2006). Thus, the GCVS + NSV system now contains some 60 000 Galactic variable stars.

It should be noted that very many new variable stars are being discovered in modern automatic photometric sky surveys. Some of these surveys provide their own catalogues of variable stars. For several reasons, it is not easy to incorporate the stars of such catalogues into the GCVS.

First of all, most automatic sky surveys use wide-field small-focal-length instruments, and thus the variable-star coordinates in their catalogues are not precise enough. Note that the GCVS is ready for automatic identifications with newly discovered stars having accurate coordinates. In 2002–2006, we checked the identifications of all 'old' GCVS variable stars using published as well as unpublished finding charts and other sources of information and provided accurate coordinates (to about $1''$) for virtually all these stars [16–18]. In the process, we revealed many cases of highly incorrect coordinates, with errors as large as about $10^\circ$ in several exceptional instances. In typical automatic surveys, the angular resolution is $15 - 30''$ and, if a variable star is in a pair, its catalogued coordinates can be incorrect by dozens of arcseconds. We strongly prefer not to worsen the standard of coordinate accuracy now established in the GCVS.

Secondly, as a rule, variability types quoted in the variable-star catalogues of automatic surveys were determined automatically. They do give some idea of what is observed, but the GCVS classification is much more detailed and informative. The progress in developing algorithms for automatic variable-star classification is not fast enough. On the other hand, we admit that the GCVS classification system requires serious modification, taking into account the developments of astrophysics but not making the system too clumsy, and we are going to present our suggestions to IAU Division V at the 26th General Assembly of the IAU in Prague.

Some of the modern automatic photometric surveys are especially important for catalogues of variable stars. First of all, the excellent ASAS-3 survey of the sky to the south of $+28^\circ$ declination [19], made with small telescopes, should be mentioned. It is a continuing project; photometry has been regularly obtained, since mid-2000, for several millions of stars with $V$ magnitudes between 8.5 and 15.0 (this photometry is quite useable in variability studies of stars brighter than $V = 14$). The photometric data are in the standard $V$ band and they can be retrieved at http://www.astrouw.edu.pl/∼gp/asas/asas.html not only for the stars included in the ASAS-3 variable-star catalogue (some 50 000 variable stars, among which there are about 30 000 new variable stars) but for each observed star. Thus, it is possible to use these data for data mining, including discoveries of new variable stars and improving GCVS data for old variable stars. The ASAS-3 data have already been extensively used by the GCVS team for checking the catalogued information (see, for example, [20]).

In the very important ROTSE-I/NSVS project [21], the northern sky is covered, to declination $-38^\circ$ in the south, also with small telescopes. The photometric data available online at http://skydot.lanl.gov/nsvs/nsvs.php for some 14 000 000 stars are limited to a rather

short time interval between April 1999 and March 2000, making this survey less adequate for studies of long-period variables or slow phenomena. The number of variables announced by the project team (see, for example, [22, 23]) is still not very large, but the prospects of data mining are also very good. However, the NSVS survey is in an instrumental red photometric system, which is also a disadvantage compared with the ASAS-3 survey.

Of several other important surveys, the OGLE project should be mentioned. It consisted of several stages and is still under way. An important feature of the project is that it uses a rather large telescope (the 1.3 m Warsaw telescope at Las Campanas, Chile); so the scale problems discussed above are not important here. The project, aimed at studies of gravitational microlensing, resulted in the discovery of many variable stars in the Magellanic Clouds. The results most important for the GCVS are the catalogue of about 200 000 OGLE-II candidate variable stars in the galactic bulge [24] and the discovery of 177 OGLE-III objects with planetary or low-luminosity companion transits (see [25] and references therein); at least five of these have by now been confirmed as planetary transits by spectroscopy. The data from all OGLE observations can be retrieved, but, unlike ASAS-3 or ROTSE-I–NSVS, there is no user-friendly Web interface.

Data from automatic sky surveys do change our ideas on variable stars. For example, we did not expect so many stars to have chromospheric activity that determines their variability (RS CVn stars). Among periodic variables classified as Cepheids announced in ROTSE-I [22], 19% are X-ray sources and thus, most probably, RS CVn stars [26] (among real Cepheids, only the very brightest are detected as X-ray sources).

The possibilities of data mining opened by survey data accessible by the Internet unexpectedly led to a crisis in variable-star publication possibilities. The Information Bulletin on Variable Stars published by the IAU Commissions 27 and 42 is no longer able to accept all discovery announcements. However, it does not seem a correct decision to publish only 'astrophysically significant' discoveries; for example, no one could predict the astrophysical significance of HZ Her for decades after its variability had been announced, but after the discovery of the X-ray source Her X-1 it became one of the most 'significant' variable stars for many years. Thus, we decided to reopen the Peremennye Zvezdy (Variable Stars) journal, now a purely electronic English-language journal (for details, see http://www.astronet.ru/db/varstars/).

Some of the minor surveys and projects also have their own variable-star catalogues. As an example of the well-kept catalogue, the variable-star catalogue of the MISAO project (S. Yoshida, http://aerith.net/misao/data/misv.cgi?en) should be mentioned.

Returning to the problem of the GCVS variable-star classification, it should be noted that the GCVS team receives opposite suggestions from two categories of users. The general astronomical community wants to have an understandable system and, in their opinion, the existing system is too complex, with too many types. Those engaged in studies of particular variable-star classes suggest an increasing number of new types. One way out of this would be to simplify the GCVS classification system and to present more detailed classifications in specialized catalogues. The best example of such a catalogue, kept online in a very careful way and also containing excellent finding charts, was the catalogue of cataclysmic variables. However, the project is no longer being continued after the publication of the catalogue's final version [27].

Finally, I should mention the new important project of the American Association of Variable Star Observers, the Variable Star Index (http://www.aavso.org/vsx). It is a kind of a general variable-star catalogue, with extensive search possibilities, access to finding charts, and the possibilities of introducing users' additions and corrections. It can become a real competitor of the GCVS, and the interaction between the two projects should be discussed in detail.

Summarizing, it can be stated that the GCVS project started by P.P. Parenago is still important for the variable-star community, and the GCVS team is ready to continue it, in cooperation

with other interested teams. We recognize a number of problems that the GCVS project is facing: currently GCVS is not a really 'general' catalogue; no perfect software for automatic classification is available; the GCVS classification scheme should be simplified; it is very difficult to continue the individual approach to each star, with a human expert participating, that was used in the best variable-star catalogues of the past, but the experience with automatically updated catalogues demonstrates that the number of errors is too high; virtual sources of data possess unpleasant drawbacks, as access to them has been insufficiently standardized so far; software for light-curve analysis is not standardized, and the experience of automatic surveys shows that the accuracy of periods and other derived parameters is rather poor; variable-star catalogues should be completely incorporated into the developing projects of the International Virtual Observatory. All these problems need a serious discussion in IAU Division V.

## Acknowledgements

I would like to thank all the GCVS team for their work. The work of the GCVS team is supported, in part, by grants from the Russian Foundation for Basic Research (grant 05-02-16289), the program 'Origin and evolution of stars and galaxies' of the Presidium of Russian Academy of Sciences, and the Foundation for Support for Leading Scientific Schools of Russia (grant NSh-5290.2206.2).

## References

[1] R. Prager, Kleine Veröff. Universitätssternwarte Berlin-Babelsberg, No. 1 (1926).
[2] H. Schneller, Kleine Veröff. Universitätssternwarte Berlin-Babelsberg, No. 26 (1942).
[3] B.V. Kukarkin and P.P. Parenago, *General Catalogue of Variable Stars*, 1st edition (Izdatel'stvo Akademii Nauk SSSR, Moscow, 1948).
[4] H. Sawyer Hogg, Publs David Dunlap Obs. **3** (6) (1973).
[5] C.M. Clement, A. Muzzin, Q. Dufton *et al.*, Astron. J. **122** 2587 (2001).
[6] B.V. Kukarkin, P.P. Parenago, Yu.I. Efremov *et al.*, *General Catalogue of Variable Stars*, 2nd edition, Vols I and II (Izdatel'stvo Akademii Nauk SSSR, Moscow, 1958).
[7] B.V. Kukarkin, P.N. Kholopov, Yu.N. Efremov *et al.*, *General Catalogue of Variable Stars*, 3rd edition, Vols I–III (Nauka, Moscow, 1959–1971).
[8] B.V. Kukarkin, P.P. Parenago, Yu.I. Efremov *et al.*, *The First Catalogue of Stars Suspected in Variability* (Izdatel'stvo Akademii Nauk SSSR, Moscow, 1951).
[9] B.V. Kukarkin, P.N. Kholopov, Yu.N. Efremov *et al.*, *The Second Catalogue of Suspected Variable Stars* (Astrosovet, Moscow, 1965).
[10] P.N. Kholopov (ed.), *The New Catalogue of Suspected Variable Stars* (Nauka, Moscow, 1982).
[11] E.V. Kazarovets, N.N. Samus and O.V. Durlevich, Inform. Bull. Variable Stars, No. 4655 (1998).
[12] P.N. Kholopov (ed.), *General Catalogue of Variable Stars*, 4th edition, Vols I–III (Nauka, Moscow, 1985–1987).
[13] N.N. Samus (ed.), *General Catalogue of Variable Stars*, 4th edition, Vol. IV *(Reference Tables)* (Nauka, Moscow, 1990).
[14] N.N. Samus (ed.), *General Catalogue of Variable Stars*, 4th edition, Vol. V *(Catalogue of Extragalactic Variable Stars; Catalogue of Extragalactic Supernovae)* (Kosmosinform Moscow, 1995).
[15] E.V. Kazarovets, N.N. Kireeva, N.N. Samus *et al.*, Inform. Bull. Variable Stars, No. 5422 (2003).
[16] N.N. Samus, V.P. Goranskii, O.V. Durlevich *et al.*, Astron. Lett. **28** 174 (2002).
[17] N.N. Samus, V.P. Goranskii, O.V. Durlevich *et al.*, Astron. Lett. **29** 468 (2003).
[18] N.N. Samus, O.V. Durlevich, A.V. Zharova *et al.*, Astron. Lett. **32** 263 (2006).
[19] G. Pojmanski, Acta Astron. **52** 397 (2002).
[20] S.V. Antipin, E.N. Pastukhova and N.N. Samus, Inform. Bull. Variable Stars, No. 5613 (2005).
[21] P.R. Woźniak, W.T. Vestrand, C.W. Akerlof *et al.*, Astron. J. **127** 2436 (2004).
[22] C. Akerlof, S. Amrose, R. Balsano *et al.*, Astron. J. **119** 1901 (2000).
[23] S.J. Gettel, M.T. Geske and T.A. McKay, Astron. J. **131** 621 (2006).
[24] P.R. Woźniak, A. Udalski, M. Szymánski *et al.*, Acta Astron. **52** 129 (2002).
[25] A. Udalski, M.K. Szymánski, M. Kubiak *et al.*, Acta Astron. **54** 313 (2004).
[26] T. Ignatyeva, New methods to search for variable stars and to study them. MSci Thesis, Moscow University (2005–2006).
[27] R.A. Downes, R.F. Webbink, M.M. Shara *et al.*, J. Astron. Data **11** (2005).