

GENERAL CATALOGUE OF VARIABLE STARS: CURRENT STATUS AND NEW NAME-LISTS

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ABSTRACT. A short history of variable-star catalogs is presented. After the second World War, the International Astronomical Union asked astronomers of the Soviet Union to become responsible for variable-star catalogs. Currently, the catalog is kept electronically and is a joint project of the Institute of Astronomy (Russian Academy of Sciences) and Sternberg Astronomical Institute (Moscow University). We review recent trends in the field of variable-star catalogs, discuss problems and new prospects related to modern large-scale automatic photometric sky surveys, outline the subject of discussions on the future of the variable-star catalogs in the profile commissions of the IAU, and call for suggestions from the astronomical community.

Key words: Stars: variable; stars: catalogs.

1. Introduction

Variable-star catalogs have a long history. Probably the first list that can be called a variable-star catalog was published by E. Pigott in 1786, though it contained only 12 stars. The number of variable stars being discovered each year considerably increased after the introduction of astronomical photography. Between 1926 and 1942, the work on variable-star catalogs and ephemerides was organized by the German society “Astronomische Gesellschaft”, and a new catalog was published each year. The first of them contained 2906 variable stars and the last of them, 9476. Since 1943, the situation in the country involved in the war made German astronomers unable to continue publishing their catalogs.

After the World War II, the Executive Committee of the International Astronomical Union (IAU) decided to make astronomers of other countries responsible for several projects earlier fulfilled in Germany and important for the world astronomical community. One of the projects suggested to the Soviet Union was the General

Catalogue of Variable Stars (GCVS). The Executive Committee’s decision was preceded with an IAU inspection in Moscow, where a well-kept card catalog of variable stars founded by P.P. Parenago (1906–1960) and maintained by Parenago, B.V. Kukarkin (1909–1977), and their collaborators was available. It was decided to issue a new catalog once in several years, with supplements, containing only new variables and stars with important changes in the catalog data, printed between the major editions.

The new Soviet compilers of variable-star catalogs were able to publish the first, one-volume edition of the GCVS already in 1948 (Kukarkin and Parenago, 1948). In the style of Soviet scientific publications of that period, the title page of the book mentions only two authors, though an author team (listed in the Russian version of the two-language Introduction) already existed. This catalog contained 10930 variable stars, only slightly more than the last German catalog.

2. The GCVS

The GCVS work is now continued by a joint team of researchers in the Institute of Astronomy of the Russian Academy of Sciences and in the Sternberg Astronomical Institute of Moscow University.

Despite the name, the GCVS actually never was a genuine “general” catalog. First of all, originally it was not intended to contain galactic Novae or Supernovae; there were several exceptions due to tradition. In astronomy of the first half of the 20th century, researchers tried to distinguish between variable stars and Novae. By 1950, it was clear that Novae and Supernovae were also variability types, like other numerous existing classes of variable stars. Soon after the start of the Soviet GCVS project, historical galactic Novae and Supernovae were added to the catalog, and after that, all further Novae of our Galaxy acquired GCVS names (we did not have a Supernova for centuries). Also, as a rule,

extragalactic variable stars were not included (and are not included, with the exception of several traditional cases, like S Dor, S And, or Z Cen, and a special list in Volume V of the 4th GCVS edition – see below). Currently, there are no comprehensive catalogs of all known extragalactic variable stars; only the situation with catalogs of extragalactic Supernovae is good (see <http://www.sai.msu.su/sn/sncat/>).

Probably the most strange tradition limiting the scope of the GCVS is not to include variable stars in the globular star clusters of our Galaxy (variables in open clusters are included). These stars are listed in special catalogs of variable stars in globular clusters, prepared and published in Canada, now only in electronic form (cf. Clement et al., 2001; Clement, 2010). We highly appreciate this work. Nevertheless, we have recently opened a possibility to add those stars that meet the GCVS criteria also to our catalog, having determined accurate equatorial coordinates for many variable stars in globular clusters earlier listed only with rectangular coordinates with respect of their cluster centers (Samus et al., 2009).

The GCVS is intended to contain only proven and more or less well-studied variable stars. Currently, the criterion for the star to be considered studied well enough for the GCVS is the possibility to ascribe it at least a tentative variability type or to decide that the star is “unique” (possibly belongs to a type not yet introduced). Earlier, the rules used to be even stricter, like, for a periodic variable, the requirement of the period being known. Variable stars not meeting the GCVS criteria are called “suspected variables”, even if their photometric variations are beyond doubt, and listed in special catalogs. After the World War II, such catalogs are also a responsibility of the GCVS team in Moscow.

The fourth edition of the GCVS, surely the last one to consist of printed books, started with the “New Catalogue of Suspected Variable Stars” (the NSV catalog) with 14810 entries (Kholopov, 1982). A supplement to the NSV catalog, with 11206 additional entries, was published by Kazarovets et al. (1998). After the NSV catalog, five GCVS volumes appeared in 1985–1995. The first three of them (Kholopov, 1985–1987) are the catalog of galactic variables proper, containing 28435 stars. After them, two more books (Samus, 1990, 1995) appeared. The most important part of the first of them, devoted to different auxiliary tables, are 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 catalogs is known. The second of them is the GCVS team’s first and only attempt, initiated by P.N. Kholopov, to add extragalactic variables to the GCVS and thus make the catalog more “general”. This book contains some 12000 entries for extragalactic variables, including Supernovae. Immediately after its publication, the flow of new discoveries

of extragalactic variables became too strong to permit the GCVS team, with its limited human power and funds, to further pursue this direction of work.

Till 1994, the IAU provided some financial support to the GCVS project. These funds did not reach the GCVS team but permitted it to rely on better attitude of local administrative bodies. Unfortunately, the support was discontinued, just at the time of a serious funding crisis and just when it became possible to make the IAU money available directly to the scientific group compiling the catalog. The IAU Commissions 27 and 42 (now Division V) continue to provide their moral support of our effort.

Currently, it is too expensive to continue the GCVS in the form of printed books, and the role of printed catalogs also has become secondary compared to electronic catalogs. The fourth GCVS edition, with corrections, is available electronically at the Strasbourg data center. The most recent electronic version of the GCVS can be found at our web site (<http://www.sai.msu.su/groups/cluster/gcvs/gcvs/>). The site also has a search engine permitting to retrieve GCVS information by the star’s name (in the GCVS or in other catalogs), coordinates, variability type, and other parameters.

Stars are added to the GCVS via Name-Lists. The last one published so far was No. 79 (Kazarovets et al., 2008), it makes the number of GCVS stars as high as about 41500. The GCVS+NSV system now contains more than 60000 Galactic variable stars. The GCVS data base contains stars from the fourth GCVS edition as well as stars from the subsequent Name-Lists, but, until recently, information provided in the data base for Name-List stars used to be incomplete. We have now started preparing catalogs of Name-List variables in the complete GCVS format. Recently, the first catalog of this kind (Kazarovets et al., 2009) has been published for the 79th Name-List.

We have now finished selecting stars for the Name-List No. 80. The number of stars selected is so large that we are forced to subdivide the list into several parts, to be published separately. The first part, for right ascensions (J2000) between 0 and 6 hours, will appear before the end of 2010. It will contain about 2000 variables.

For a number of constellations (it should be reminded that the traditional naming system of the GCVS relies on each star’s constellation), the web version of the GCVS now contains completely revised information on variability types, magnitude ranges, light elements, with new remarks. This revision will be continued.

3. Current GCVS Problems

These days, very many new variable stars are being discovered in modern automatic photometric sky sur-

veys. Some of the surveys provide their own catalogs of variable stars. In the near future, automatic surveys, especially those from space, will be able to discover millions of new variable stars each year.

For several reasons, it is not easy to incorporate the stars of variable-star catalogs of automatic surveys into the GCVS. First of all, most ground-based automatic sky surveys use wide-field, small-focal-length instruments, and thus the variable-star coordinates in their catalogs 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 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 of them (Samus et al., 2006 and references therein). In the process of identification, we revealed many cases of very wrong coordinates, with mistakes as large as about 10° in several exceptional instances. Only about 200 cataloged variable stars seem to be lost forever because of poor-quality coordinates in their discovery announcements and lacking finding charts.

In several important automatic surveys, like ASAS-3 (Pojmanski, 2002) or ROTSE-I/NSVS (Woźniak et al., 2004), the angular resolution is $15''$ – $30''$, and if a variable star is in a pair, its cataloged coordinates can be wrong by a dozen of arcseconds. Thus, in many cases, automatic-survey catalogs contain quite reliable variable stars at formal positions between two stars separated by $10''$ – $15''$, so that it is impossible to be sure which of the two stars varies. We strongly prefer not to worsen the standard of coordinate accuracy now established in the GCVS and not to add such stars to the GCVS till the true variable in the pair is reliably identified.

As a rule, variability types quoted in the variable-star catalogs of automatic surveys were determined also automatically. They do give some idea of what is observed, but the GCVS classification is much more detailed and informative. Algorithms for automatic variable-star classification still provide a large percentage of erroneous classifications. On the other hand, the GCVS classification system requires serious modification, taking into account current astrophysical ideas but not making it too complex and clumsy. We presented our suggestions to the IAU Division V (Variable Stars) at the General Assemblies of the IAU in 2006 and 2009. In 2006, the IAU Commission 26 established a working group to study the future of variable-star catalogs. We invite everyone interested in the problem to join the discussion on classification as well as on all other issues of future variable-star catalogs. Some materials of the working group can be found at our web site (<http://www.sai.msu.su/gcvs/future/future.html>).

Variable-star catalogs of large automatic surveys may be considered self-sufficient for the time being. Adding their stars to the GCVS will be very effort-consuming. So far, the GCVS team finds it more important not to miss variable stars announced individually or as a result of minor surveys. We use to add stars from large automatic surveys to the GCVS if they are studied in detail in subsequent publications.

Several years ago, the American Association of Variable Star Observers (AAVSO) started a new large-scale project, the Variable Star Index (<http://www.aavso.org/vsx>). It is a kind of a general list of variable stars, with extensive search possibilities, access to finding charts, possibilities to introduce users' additions and corrections. In the opinion of the AAVSO leadership, it can become a future main entry point to the GCVS system. In April 2009, prospects of interaction between the VSX project and the GCVS were discussed in detail between the two teams. After this discussion, the coordinates of GCVS variable stars in the two data bases were attentively compared, with a number of mistakes revealed and corrected in both of them. We invited the team of the SIMBAD data base (Strasbourg) to join our effort, and they have also started the mutually benefiting process of checking their coordinates of variable stars against those in the GCVS.

4. Conclusions

The GCVS project, initiated on behalf of the IAU in the second half of the 1940s, has a long and eventful history. The recent developments in astronomy have led to the necessity to solve a number of problems in order to enable future successful continuation of the project. The current GCVS problems can be summarized as follows.

- The GCVS is no longer (and actually never was) a true “general” catalog, even for variable stars in our Galaxy;
- no reliable software for automatic classification of variable stars exists;
- the GCVS classification scheme should be simplified but also improved according to the current state of variable-star astrophysics;
- individual approach of a human expert to each star, characteristic of the best catalogs in the past, will be impossible in future, but the experience of automatically updated catalogs shows that they contain too many mistakes;
- virtual data sources often have unpleasant imperfections, access to such sources is insufficiently standardized;
- light-curve-analysis software is not standardized, and the experience of automatic surveys evidences for low precision of periods and other derived parameters.

The discussion of these and other problems during the recent General Assemblies of the IAU shows that the astronomical community still wants quality variable-star catalogs. Thus, we need to seek solutions of the problems listed above most actively, with participation of variable-star experts worldwide.

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