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Stars from the GTSh10 catalogue in the Shajn's Plan

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ABSTRACT

We examine objects from the GTSh10 catalogue among the studied stars as a part of implementing the Plan of Academician G.A. Shajn in order to replenish the database of photometric and spectral observations of red dwarfs. We consider a question concerning the cross-identification of data from the GTSh10 interactive version and the Shajn's Plan catalogues, as well as an access to the archive of photographic observations. The article is illustrated with examples of working with the obtained list by means of the Virtual Observatory in order to analyze the state of objects and/or to refine their photometric and spectral characteristics in the middle of the past century.

Key words: catalogues, archive observations

1 Introduction

The creation of the integrated structure of the database that constitutes the basis for the Crimean Astronomical Virtual Observatory (Shlyapnikov, 2007, 2013) implies the detection of relations in the accumulated observatory data. This involves original observations maintained in the 'glass' library and derived in the digital format, and the published results of studies, including those presented as catalogues.

In 2010 the GTSh10 catalogue was compiled containing 5535 objects, mostly red dwarfs of the lower part of the main sequence. A detailed description of this catalogue was given in Issue 1, Vol. 107 of the *Izvestiya Krymskoi Astrofizicheskoi Observatorii* (Gershberg et al., 2011).

Fourteen catalogues that contain information on magnitudes, color indices and spectral types of ~ 35000 stars have been obtained when implementing the project Plan of Academician G.A. Shajn (hereafter Shajn's Plan) on a study of the Galaxy structure. These were published in 9 volumes of the *Izvestiya Krymskoi Astrofizicheskoi Observatorii* between 1953 and 1963, in Vol. 7 of the *Trudy Rizhskoi Astronomicheskoi Laboratorii* in 1963 and in Vol. 136 of the *Soobschenia GAISH* in 1964 (Pronik, 2005). In 2007 there was started a converting of catalogues into the computer-readable format (Gorbunov, Shlyapnikov, 2017a, 2017b). Figure 1 shows the distribution on the celestial sphere in the galactic system of objects coordinates from the GTSh10 catalogue and the area of coverage by the catalogued objects from the Shajn's Plan. Note that in some cases the creation of catalogues was oriented on the identification of early spectral-type stars which affect the clusters illumination. However, the most part of catalogues includes almost all the objects available for investigations in the selected regions.

Observations carried out at the Crimean Astrophysical Observatory became the basis for the creation of the Shajn's Plan catalogues. There were derived 800 direct images and 500 negatives with an objective prism. Taking into account a significant area of coverage on the celestial sphere along the Milky Way (more than 1300 square degrees), of special interest are variable stars, particularly those with irregular brightness variations, flare activity manifestations, as well as other peculiar objects. More detailed information on the observational archive, perspectives of its digitization and application to solve astrophysical tasks may be found in a series of publications (Bondar', 2002; Bondar' et al., 2006; Bondar', Shlyapnikov, 2006; Bondar', Shlyapnikov, 2009; Gorbunov, Shlyapnikov, 2013; Pakuliak et al., 2014).

2 Identification of stars from GTSh10 in the Shajn's Plan catalogues

Fig. 1 and Fig. 2 show that a significant number of stars from GTSh10 should be present both in catalogues and in the Shajn's Plan negatives. Note that these catalogues commonly include photometry carried out in two bands and stellar spectral classification. Data of catalogues and possibility of independent brightness determination of stars from GTSh10 based on negatives allow us to estimate the object state at the moment of data acquisition.

The problems of interactive usage of catalogues developed based on Shajn's Plan are considered in detail in one of the articles devoted to its converting into the digital format (Gorbunov, Shlyapnikov, 2017b).

To make a cross-identification of objects from GTSh10 and stars from the Shajn's Plan catalogues, the interactive Aladin Sky Atlas was applied (Bonnarel et al., 2000). Table

Table 1.

R.A GTSh10	Decl. GTSh10	No. GTSh10	Name SIMBAD	mag	Sp	OF	R.A. B58	Decl. B58	BD	Sp B58	B B58	B – V B58
02 14 44.40	+59 47 57.0	420	V* V603 Cas	11.18 B	M0.5	F	02 14 44.37	+59 47 56.6	+59 151	F0	11.29	–
02 13 31.60	+60 26 03.0	415	V* V601 Cas	11.71 B	–	F	02 13 31.62	+60 26 03.6	+60 77	G0	11.66	–
02 30 39.60	+61 00 25.0	467	V* V612 Cas	12.50 B	M2	F	02 30 39.63	+61 00 25.2	+60 192	K0	12.03	–
02 55 56.90	+61 31 16.0	552	HR 860	5.60	F4/8	–	02 55 56.75	+61 31 15.8	+61 430	F5	(6.0)	–
02 22 26.30	+61 35 35.0	457	V* V607 Cas	12.10 B	M	F	02 22 26.27	+61 35 34.9	+61 126	B5	12.18	0.52
02 24 52.90	+61 53 47.0	459	V* V609 Cas	12.30 B	M3	F	02 24 52.60	+61 53 46.0	+61 134	K5:	12.05	–

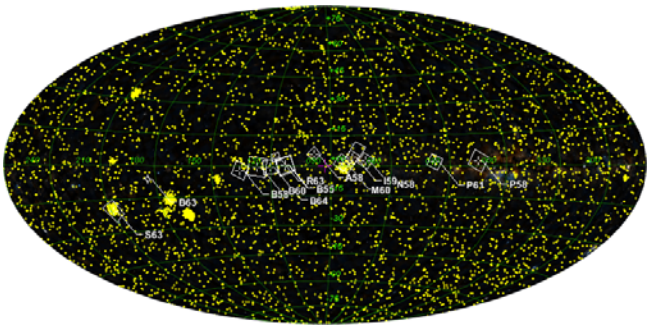

Fig. 1. Distribution on the celestial sphere of objects from the GTSh10 catalogue and the area of coverage by negatives acquired through the Shajn's Plan (in the galactic coordinate system)

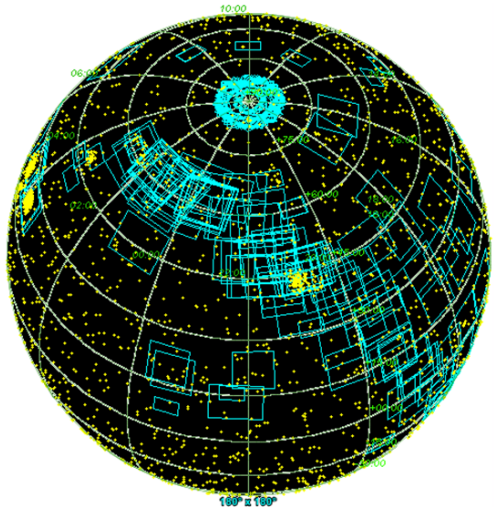

Fig. 2. Distribution on the celestial sphere of objects from the GTSh10 catalogue and the area of coverage by negatives acquired through the Shajn's Plan (in the equatorial coordinate system)

1 lists stars from the GTSh10 catalogue found among the objects from the B58 catalogue (Brodskaya, Shajn, 1958). Columns contain the following data: a) coordinates in both catalogues R.A.$_{GTSh10}$, Decl.$_{GTSh10}$ and R.A.$_{B58}$, Decl.$_{B58}$; b) the number based on the GTSh10 catalogue and notation in the SIMBAD database (No. GTSh10 and Name SIMBAD); c) magnitude in the corresponding band from GTSh10 and B58 (mag and B_{B58}); d) spectral types from GTSh10 and B58 (Sp and Sp_{B58}); e) the presence of optical flares OF; f) the number based on the BD catalogues and the color index B – V based on B58.

3 Stars from GTSh10 in the Shajn's Plan archive of negatives

As mentioned in Introduction, in the course of implementing the Shajn's Plan we acquired the observational data which of interest for analyzing the state of objects on large time intervals. As this work was carried out with the aim of working out the photometry procedure of stars from GTSh10 based on archive observations, for clarity we have chosen the region containing a significant number of objects per unit area of the captured sky. In this particular case it is a region of the open cluster M45 (Pleiades). Fig. 3 shows the Aladin interface with 472 stars from GTSh10 and negatives from the glass library in which this region was recorded. There appeared to be 14 negatives in the Shajn's Plan collection.

In what follows, we inspected negatives for their quality. For this aim consistently each out of 14 negatives was automatically transferred to a new window of Aladin via the hyperlink indicated in the lower part of the interface and de-

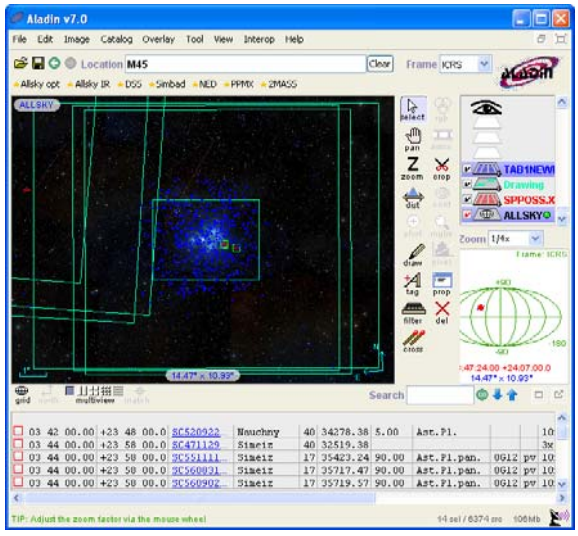

Fig. 3. Pleiades region with stars from the GTSh10 catalogue and negatives contours from the archive

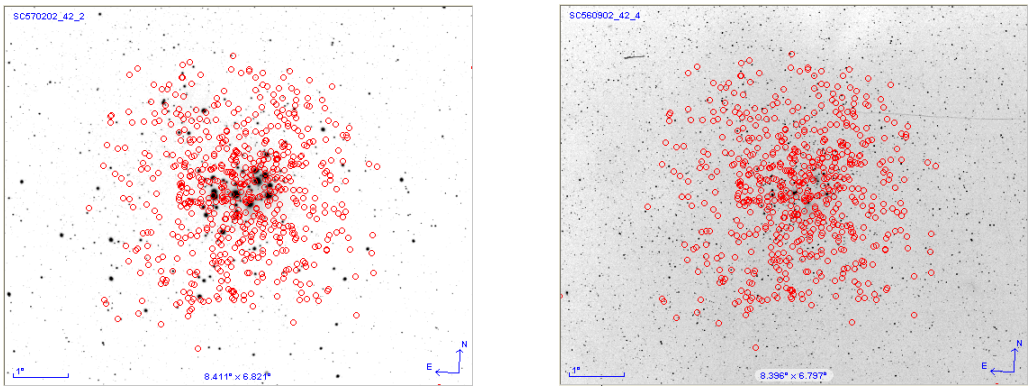

Fig. 4. Selected negatives with specified positions of stars from GTSh10

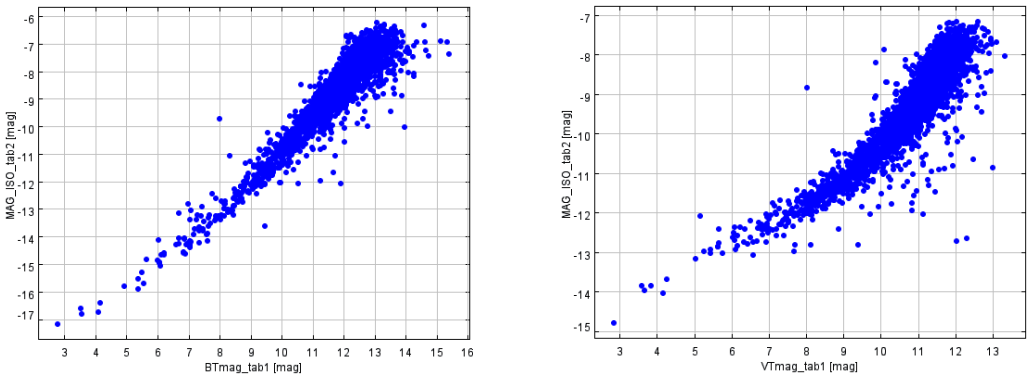

Fig. 5. Calibration curves of negatives

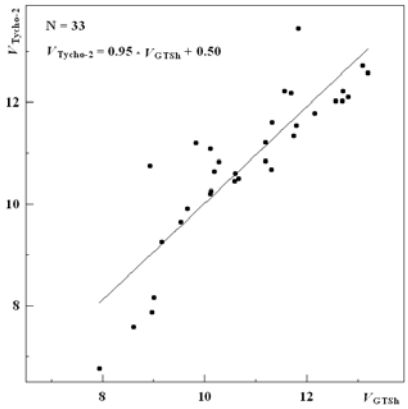

Fig. 6. Comparison of magnitudes V from GTSh10 and those determined from the negative SC560902_42_4

noting the image number in the archive. Hence, we selected negatives SC570202422 and SC560902424 (Fig. 4). The next step is a reduction of negatives with the program Sextractor (Bertin, Arnouts, 1996). The identified objects were calibrated in the system of the Tycho-2 catalogue (Hog et al., 2000) (Fig. 5). The linearization of characteristic curves has not been performed at this stage.

Note that during the reduction we used the zoomed-out images (a preview) available online. Therefore, it is irrational to make heavy demands on the photometric accuracy when estimating object brightness based on these negatives, above all since the size of stars in angular measure is about 1′; and in order to make a correct calibration of images it is required to perform a summation of object brightness near the calibrated one with such a diaphragm. Nonetheless, Fig. 6 shows good agreement between magnitudes V from GTSh10 and those determined from the negative SC560902_42_4.

4 Conclusions

The considered procedure of searching for the objects from the GTSh10 catalogue based on the Shajn's Plan data makes it possible to enlarge the CrAO database of photometric and spectral observations of red dwarfs. The possibility of operating with interactive applications of the International Virtual Observatory provides access to the world astronomical databases.

The Shajn's Plan data are available at the website[1] of the Crimean Astrophysical Observatory. To download the Shajn's Plan archive observations using the interactive Aladin Sky Atlas, it is required to copy a link[2] into Location of the program interface.

[1] http://www.craocrimea.ru/~aas/PROJECTs/SPPOSS/CrAVO_SPPOSS.html

[2] http://www.craocrimea.ru/~aas/PROJECTs/SPPOSS/Plates_Archive/SPPOSS.AJS

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