VIRTUAL OBSERVATORY: Plate Content Digitization, Archive Mining & Image Sequence Processing
edited by M. Tsvetkov, V. Golev, F. Murtagh, and R. Molina, Heron Press, Sofia, 2005

Photographic archive of Crimean Astrophysical Observatory: status and perspective*

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Abstract.

Patrol photographic observations in Crimean Astrophysical Observatory were initiated by G.A. Shajn. Plate archive of the Observatory contains about 11000 plates from three collections obtained in 1935-1998. Photovisual and photographic magnitudes of direct plates are limited of $12^m.5$ - $16^m.5$ and 14^m - 18^m. Main characteristics of about 12% plates are described in the computer-readable form and in a list in the tabular form and submitted both to the Catalogue of WFPA. The created data base is added by information for other plates and in future the scanning plates will be integrated in the WFPDB. Briefly some results of the using of plate archive to astrophysical tasks are presented.

1 Common information

Photographic archive of the Crimean Astrophysical Observatory (CrAO) is based on 3 separate collections. Plates obtained before 1941 year are included in collection of Simeiz Observatory and at present they have stored in Odessa Astronomical Observatory. Plates with images of the Milky Way regions and a survey of asteroids are stored in CrAO. These collections involve about 11000 direct plates and 500 spectral plates obtained since 1935 to 1998.

The collection of the Milky Way regions consists from direct plates and spectral plates obtained with an objective prism with the dispersion of 280 Å/mm near Hγ. This collection is established due the long-term observational program proposed by G.A. Shajn to study the structure of diffuse nebulae in the Milky Way and hot stars connected with these nebulae [1].

*This work was supported by grant No. 02.07/00300 of SFFR in Ukraine.

Another tasks were a spectral classification of stars and a study of an interstellar extinction in nebulae regions. Standard fields in the areas of North Polar Sequence were photographed too. Location of the investigated nebulae and hot stars and characteristics of photographic areas are published in paper [1] and in review [2]. During 1948-1965 years photographic observations have been made on 40-cm Astrograph (Simeiz) and 2x40-cm Astrograph (Nauchny) by the camera "Dogmar". Sizes of plate fields are 10 by 10 deg. and 13 by 13 deg. Information in observational journals and on plates labels allow to take 839 direct plates and 509 spectral plates for including them in data base. Photovisual and photographic magnitudes are limited of $12^m.5$ - $16^m.5$ and 14^m - 18^m that depend on exposure and instrument. The program was finished in 1965, but some plates obtained on the twin Astrograph in 1984 were added to this collection.

The collection of photographical survey of asteroids contains about 10000 plates obtained since 1963 to 1998 on 2x40-cm Astrograph. Each plate covers of 100 deg. sq. on the hemisphere. Using these observations about 1300 new minor planets were discovered in the last decades in CrAO.

2 On the way to data base

Common information about archive of CrAO and main characteristics of individual plates from the Milky Way collection were performed in the united computer readable forms [3] in 1993. One form contains information about a telescopes (location and diameter) and the other form appears plate parameters - coordinates of its center, exposure, emulsion, filter, sensitive (pg, pv), size (deg.), storage, time of observation (date, Julian date, local and sidereal time) and name of astronomer who made this observation.

Data files for direct and spectral plates are saved in 'dBASEIII+' format and sorted in ascending of right ascension. Copies of these files submitted to the Wide-Field Plate Database (WFPDB). To request information about the plate it should be define coordinates of its center and size. Centers of plates for the epoch 1950.0 and description of the collection in detail are given in [4]. Distribution of plates are presented on Figure 1.

In addition to this data 52 direct plates and 137 spectral plates are stored in collection. The needed information for these plates was not found fully or partly and they were not included in the catalogue of Wide-Field Plate Archives (WFPA). The most of these plates were obtained in 1935-1948.

Table 1 shows the total number of direct and spectral plates which are stored in CrAO and information of each instrument. Columns under the table header "Telescopes" indicate following: CA - Clear Aperture (m); FL - Focal Length (m); Sc - Scale in "/mm.

Description of plates from collection of survey of asteroids is in preparation. The standard form of the WFPA was added by a few fields contained data specific to observations of minor planets. Full completion of this work allows to create in future the database suitable in operation.

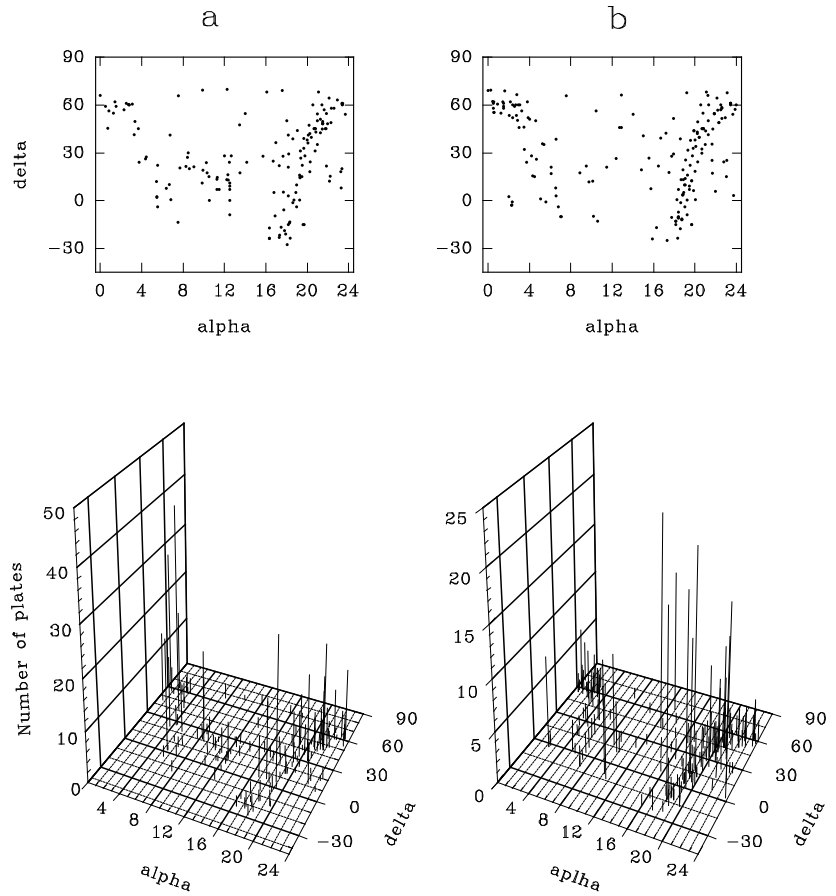

Figure 1. Distribution of plates from collection of the Milky Way images: a) direct plates; b) spectral plates.

Table 1. Information about telescopes and plates in archive of CrAO.

Location	Telescopes			Type	Field	Years of	Direct	Spectral
	CA	FL	Sc		(deg.)	operation	Plates	Plates
Simeiz	0.4	1.6	129	Astr.	10.0	1947-1948	59	159
Simeiz	0.17	0.75	276	Cam.	13.0	1948-1951	516	54
Nauchny	0.17	0.75	276	Cam.	13.0	1951-1953	49	-
Nauchny	2x0.4	1.6	129	Astr.	10.0	1951-1965	215	296
Nauchny	2x0.4	1.6	129	Astr.	10.0	1963-1998	10000	-

Location of observatories: Simeiz $+33^o59'.8$ $+44^o24'.2$, height (sea level) - 300 m and Nauchny $+34^o01'.0$ $+44^o43'.7$, 600 m.

A digitization of collection plates from the asteroids survey allow to repeat astrometry measurements, find a new asteroids, and determine their orbits and distance from Earth.

3 Digitizing of plates

Idea to create the Center of astronomical archive data for storage and an extensive using of worlds resources of wide-field photographic plates collections was declared in 1980 and since 1990 it started practically. This Center was organized in Sofia. The following stages are needed for a realizing of this project.

At first it should collect information about archives in different observatories in the united standard form, then performing data for individual plates to the computer readable form and submit these data to the catalogue of WFPA.

The last stage is a digitizing of plates and creation the bank of plate images. Digitizing of plates requires a many time and a vast financial resources that is a cause why more observatories do not start this work yet.

Formation of a local database in CrAO intend in the frame of close cooperation and consultation with astronomical organizations in Ukraine, Russian and Bulgarian Academy of Science. At present the firs results are taken out together with the Sternberg Astronomical Institute (Russian). Some plates 30 by 30 cm were scanned completely by scanner "Creo" with a high resolution (color palette appears 16777216 hues in RGB scale).

The scanned information for each plate is very large (about 6 GB) and to the scanning a full field of plate was divided on 3 overlapping parts. Each of the scanned part was saved in TIFF-format file. Reductions of the received information are in progress.

Preliminary results shown that a quality of images is depend on a quality of plate and setting of scanner treatment. If background of plate is inhomogeneous it is more reasonable to set a non- automatic treatment of scanning. To correct a background inhomogeneity it should be chosen a needed method of digitizing or to use to calculation a small extracted fields when a background may be consider as homogeneous.

Figure 2 presents an original digitizing image compiled from three parts and reduced to a 40 times. Reduction of equatorial coordinates allow to identify of 70 variables from [5], [6]. The linear size on the figure is 777x749 elements, size of each elements is 48x48, the limited magnitude is 13^m. Symbols mark stars from GCVS - General Catalogue of Variable Stars, NSV - New Suspected Variables, GKL - the catalogue published in [5].

The other task is an extraction the photometric characteristics to use they for astrophysical researches. In particular CrAO leads about 15 years the study of long-term variations in active red dwarf stars. Using photographic archives the photometric behavior of 40 stars are described on time span of some decades. Samples of light curves are included in the new book by Gershberg [7]. Using digitizing plates this work will be continued on the higher level for a new group

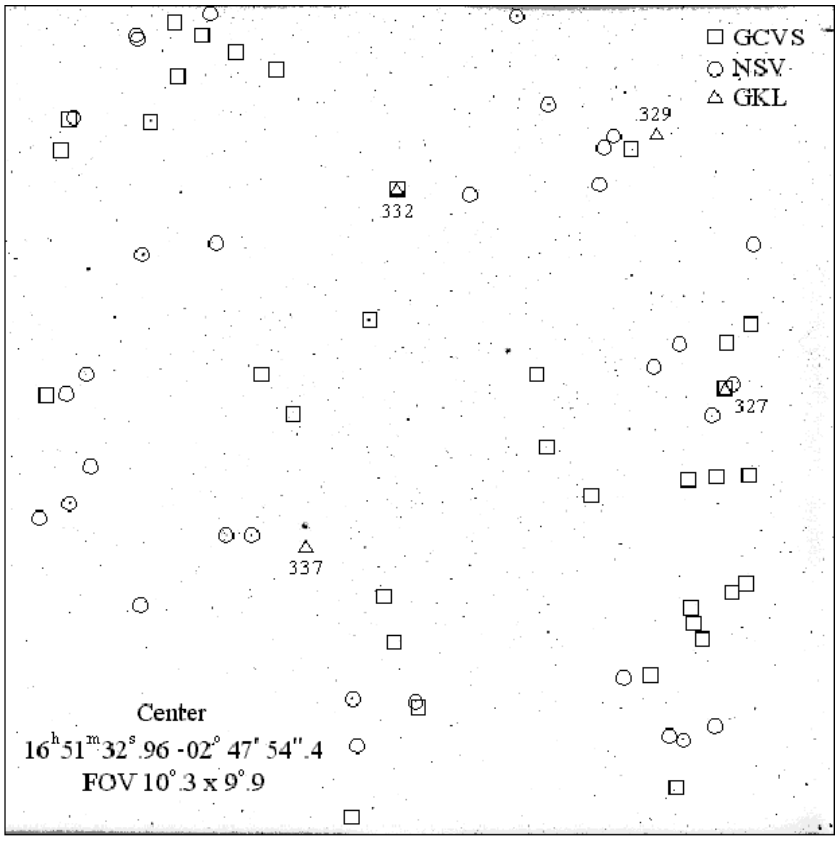

Figure 2. The reduced image of a digitized plate.

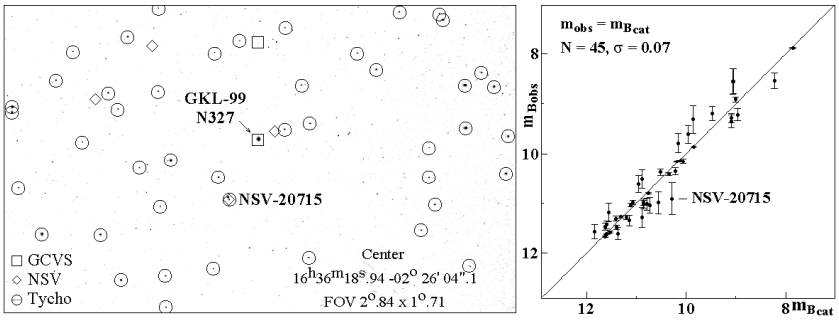

Figure 3. a) The area around of red dwarf star No. 327 (Left. Top is North) and b) The relation between measurement and catalogue stellar magnitudes in the field (Right).

of stars. Four program stars are located on plates with center that is given on Figure 2. Number of stars is taken from GKL catalogue.

Figure 3a shows segment around the star No.327. Size of area is $2^o.8$ x $1^o.7$, linear size is 788 x 474 elements, size of each element is 13" x 13". The limited magnitude is about 12^m. Analysis of the digitizing image of plate allows to identify of 834 stars from catalogue [8].

Figure 3b presents the measured magnitudes for 45 stars versus B magnitudes taken from this catalogue. Linear relation between values and accuracy of measurements (σ=$0^m.07$) allow to estimate magnitude for star No. 327 certainly while this star is the brightest among the surrounding objects.

The star No. 20715 (NSV) on Figure 3a is suspected in variation. Its magnitude on the given epoch can be estimated by equation m_{obs} = f(m_{cat}), where m_{obs} is approximate B. Field around the program star No. 337 (GKL catalogue) is shown on Figure 4a. Size of this field is 17' x 11', linear size is 784 x 506 elements and size of each elements are of 1".3 x 1".3, the limited magnitudes is up to 17^m.

Relation between observational magnitudes and B magnitudes taken from catalogue NOMAD [9] was found using data for 45 objects. Standard deviation for all data is about $0^m.07$. A scatter of data on Figure 4b grows towards fine stars. Magnitude of the investigated star lies in the range of small scatter and estimated with a higher accuracy. More higher accuracy can be achieved in future due using of 16 and 24 bits images in calculation and large number of stars to calibrate.

These preliminary results show perspective to extensive using a digitized images for a photometrical study of stars

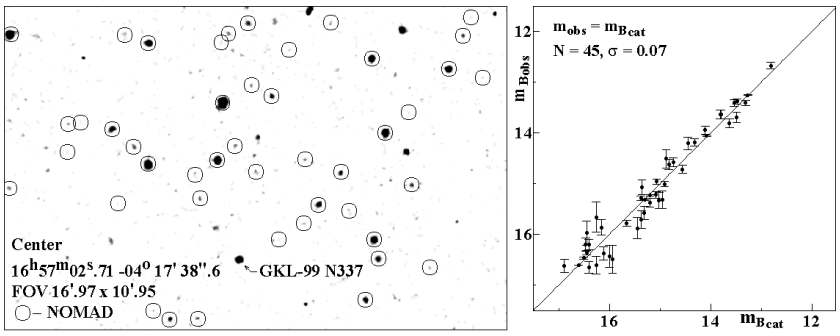

Figure 4. a) The area around of red dwarf star No. 337 (Left. Top is North) and b) The observational magnitudes versus magnitude in B from catalogue NOMAD (Right).

Acknowledgments

The authors are grateful to Dr. R. E. Gershberg for stimulating the work, useful discussions and comments, S.I. Plachinda for help in storage of digitized information. We wish to thank our colleagues from Sternberg Astronomical Institute Dr. N. N. Samus, A. Zharova and A. Belinskyi for collaboration and support in scanning the plates. This research was supported partial by grant No.02.07/00300 of SFFR in Ukraine. N.I.Bondar' also thank LOC of VOWS-2005 for making the interest in meeting available.

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