

WIDE-FIELD PLATE DATABASE: DEVELOPMENT AND ACCESS VIA INTERNET IN THE PERIOD JANUARY 2009 - JUNE 2010

MILCHO TSVETKOV

*Institute of Astronomy and National Astronomical Observatory,
Tsarigradsko Shosee Blvd. 72, Sofia-1784
E-mail: milcho@skyarchive.org*

Abstract. Here we describe the motivations and results from the 1.5 year period of the project Wide-Field Plate Database: Development and Access via Internet (DO-02-273/18.12.2008), dedicated to preservation, digitization, development and web access mainly of the astronomical plate archives of the 200 cm RCC and partly of the 50/70 cm Schmidt telescopes of the National Astronomical Observatory Rozhen received in the period of the first 20 years of operation 1979-1998. The basis of the work is set out in the following two publications of Tsvetkov (2006) and Tsvetkova and Tsvetkov (2006) motivating the project over the past 10 years. The WFPDB (www.wfpdb.org) represents a unique virtual instrument in astronomical research, which allows obtaining information on existing astronomical observations of celestial objects over the past 130 years with the professional astronomical telescopes at observatories worldwide.

1. INTRODUCTION

The Wide-Filed Plate Database (WFPDB) project practically presents an unique virtual telescope working as a "Time Machine" for obtaining information on historical observations of minor planets, comets, stars and galaxies. The project also aims to continue and expand the successful work initiated during the past 15 years by extending the provision of technical work on the base, and improving and extending the internal LAN (www.skyarchive.org), which ensures rapid online access to data, based on international standards of the International Virtual Observatory Alliance (IVOA) and the European Virtual Observatory (EURO-VO). The astronomical plate digitization and the web access to the large amount of the digitized data sets require maintaining the standard relational database and expanding the opportunities for search and retrieval of data (see www.skyarchive.org/search). It was also necessary to expand the volume of the database and to create new computer-readable versions of catalogues of photographic observations with their inclusion in the WFPDB.

The main directions of this project can be listed as: (1) to expand the WFPDB - reaching and exceeding the total number of observations involved to 600000 (i.e. more than 25% completeness), (2) improving WFPDB in terms of opportunities for search and retrieval of data from the database - data for original catalogues and "previews" - digital images of archived photographic plates for rapid visualization of observations made online and photometric studies, (3) establishing a numerical procedure for photometric calibration of photographic surveys as a tool for efficient photometric studies, (4) to make available the archive of the photographic observations with 2 m RCC telescope of NAO Rozhen producing inventory and including the plates obtained with the 50/70 cm Schmidt telescope with digitisation of selected samples, (5) to study the evolution of non-stationary stars by photometry of digitized photographic observations.

2. TECHNICAL SUPPORT AND INTERNAL LOCAL NETWORK DEVELOPMENT

To achieve the objectives of the project was necessary to improve the local computer network service of the WFPDB. This is related to one of the most important tasks of the project - digitization of photographic plates – it is connected with the need for very large capacity for storage of the digitized plate images. It is known that the volume of a separate digitized plate is of several hundred MB to 1 GB ~ depending on the size of the plate and the selected resolution of the scanning. For this purpose LAN is equipped with a storage platform with high capacity up to 16 TB. In the Sofia Sky Archive Data Center (SSADC) the device PROMIS VTRAC M610p with capacity of 6 TB at present was purchased and installed. It is expected to be expanded to 16 TB in the next contract period. Furthermore, the computer system of the project used for the plate digitization and processing with specialized software packages, was renovated. LAN has been expanded with three new computers to scan the plates in Sofia and NAO Rozhen. For the purpose the SSADC network was improved and renovated with the necessary routers, collectors and devices to stabilize the voltage – UPSs. Fig.1 shows the block diagram of the SSADC and the laboratory of astro-plate digitization, the network with the main servers, the Perkin-Elmer microdensitometer PDS1010^{Plus}, and the integrated data storage system PROMISE-Vtrac M610p.

3. MAINTENANCE OF THE DATABASE AND ORGANIZATION OF DATABASES OF IMAGES

The WFPDB management system is based on Firebird SQL Server platform to Linux.(<http://draco.wfpdb.org/search/>) developed in previous period. Now a new enhanced search page is introduced. New choices in WFPDB are extended with parameters of observations - the original logbooks and previews - compressed images of the original plates. Figs. 2-4 show samples of search in the WFPDB with copy of the original logbook of observations and an example of plate preview

- the all sky plate distribution in this case is for the updated catalog ROZ200 of the 2 m RCC telescope of the NAO Rozhen.

Under the construction is a website home page of the WFPDB in form as Wiki platform. A prototype of the page can be seen at:

<http://trillian.magrathea.bg:2500/home/published/>

New WFPDB mirror in the Institute of Mathematics and Informatics, Bulgarian Academy of Sciences, was established and maintained. An important part of the WFPDB is the StarGazer version 3.0, which can display and link existing catalogues with the region of observation obtained by the plate search in the database at:

<http://wfpdb.org:8080/stargazer/>.

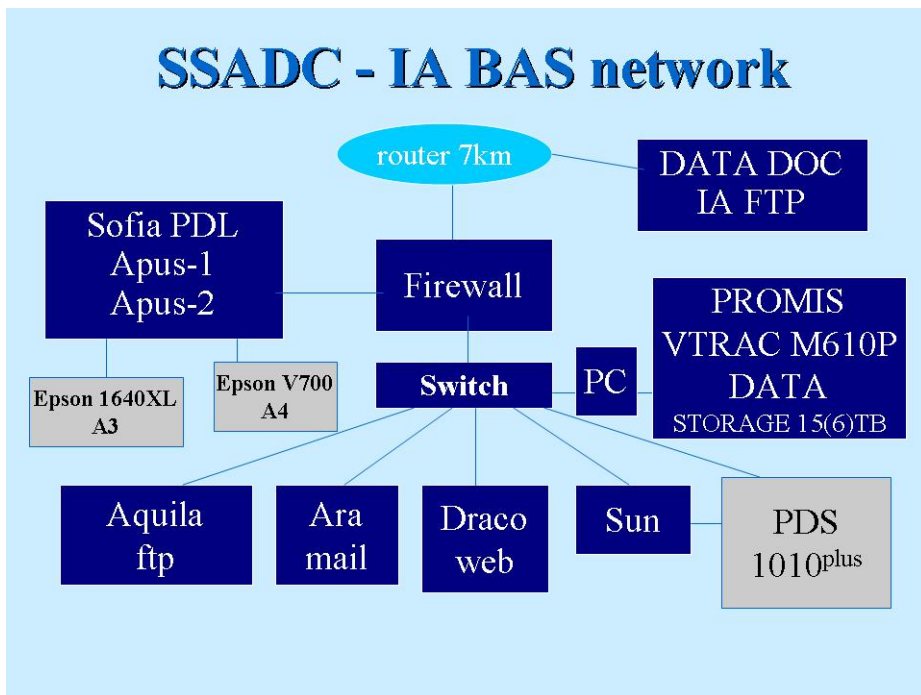


Figure 1. Block diagram of the network of the Sofia Plate Digitization Laboratory (SPDL) of the Sofia Sky Archive Data Centre with the main servers, Perkin-Elmer microdensitometer PDS 1010^{plus} and flatbed scanners EPSON 1640 XL and EPSON V700.

4. PROGRAM PACKAGE FOR DATA REDUCTION OF THE ORIGINAL PLATE CATALOGUES

New advanced packages were developed for:

- Data reduction from the original plate catalogues to the accepted WFPDB standards;
- Optical Character Recognition (OCR) tool for converting the typed original plate catalogues in table form to electronic form applied to the plate catalogue of the Brashear astrograph of the Tokyo Astronomical Observatory (see Kirov, Tsvetkov, Tsvetkova and Kalagrarskiy at http://aquila.skyarchive.org/DATABASE_NFNI273/publications/Chepelare_Kirov_KTS_DKG.pdf);
- Inclusion of images from original catalogues and previews. (See (published Kirov and Tsvetkov, http://aquila.skyarchive.org/DATABASE_NFNI273/publications/Ohrid_mil_nik_slides.pdf);
- Reading FITS and row TIF files and converting row TIF -> FITS (using standard packages, as well as own software packages);
- Data conversion and creation of tables in the WFPDB format (Package CuneiForm);
- Connection of the astronomical photographic plates scanned images from the WFPDB and the page images from the original astronomical journals;
- Segmentation of the images from the logbooks (experimental version of the software);
- Linking records of astronomical photographic plates from WFPDB and images of original pages of astronomical journals.

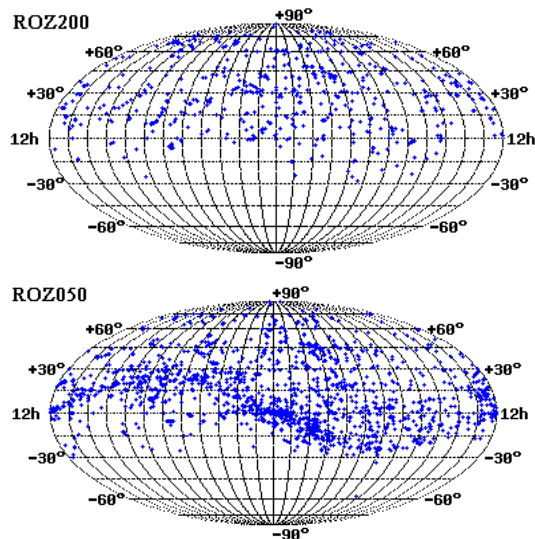


Figure 2. All sky distribution of the plate centres for the listed in the WFPDB plate collection of the Rozhen wide-field telescopes: the 2 m RCC (ROZ200 with 1984 plates) and 50/70/172 cm Schmidt (ROZ050 with 7359 plates).

From the given access to the plate logbooks from the site of the Harvard Observatory (<http://hea-www.harvard.edu/DASCH/ExposureData/LogJpeg/>) a mirror was made to all astronomical logbooks of the Harvard Observatory -the whole amount of data is 47GB, (see:

http://aquila.skyarchive.org/Astroinformatics/2_IA/1_IMI/Ohrid_mil_nik_slides.pdf).

WIDE-FIELD PLATE DATABASE - Google Chrome
trillian.magrathea.bg:8080/search/search.cgi?service=details&mainID=73839

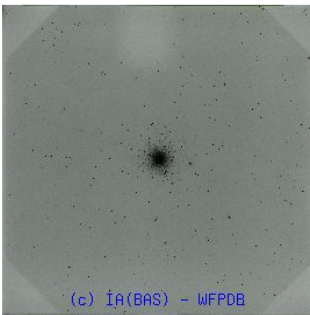
Wide-Field Plate Database - Sofia

[WFPDB](#) [WFPDB@VizieR](#) [Aladin](#) [Other Plate Catalogues](#) [Access Log](#) [Help](#)

Details for: **ROZ200 000023**

IDobs: ROZ	OBJNAM: M92
IDins: 200	OBJTYP:
IDSuf1:	METHOD: 1
IDno: 000023	MULTEX: 1
IDSuf2:	EXP: 60.0
RAJ2000: 17 17 42	EMULS: ZU21
DEC2000: 43 09 48	FILT: GG385
CCOD:	SPEC: B
DATE: 1980 06 18	DIMx: 30
UT: 16 03 49	DIMy: 30
TCOD: E	

QUALITY:
NOTES:
OBSERVER: **M. POPOVA**
AVAILABILITY:
DIGITIZATION:
Original Log-book scan: [logbooks/ROZ200_000020-24.jpg](#)

PREVIEW:  SCAN: N/A

(c) IA(BAS) - WFPDB

Figure 3. An example of the plate search in the WFPDB giving plate preview.

WFPDB currently provides information on 563,612 plates from 133 photographic archives (http://www.skyarchive.org/images/wfpdb_new.png) with different observing instruments. It represents about a quarter of the total number of photographic plates in the world.

We plan to include into the WFPDB within the 3-year period of the project about 50,000 plates, and the database to reach 600,000 complete observations. It has to be reported, however, that the most important activity in the expansion of WFPDB is particularly labor intensive and involves a number of difficulties. Still a significant part of the catalogues has no computer-readable versions and in these cases the team that supports WFPDB has to produce similar versions. In some cases, there are even no diaries of observations and then the only option is taking the information directly from the photographic plates or envelopes in which they are stored.

НАЦИОНАЛНА АСТРОНОМИЧКА ОБСЕРВАТОРИЈА "ПОЛЯН"
 2-И ЛИК ТЕЛЕСКОП - КК 300/6

	163	164	165	166	167
1. ДАТА	4/15/62 21	4/15/62 21	5/16/62 21	5/16/62 21	5/16/62 21
2. ОБЈЕКТ (ИМЕ)	446	506	Pal 5	M 10	M 10
3. ВРЕМ. УП. ОБЈЕКТА					
4. V			15° 15' 11"	16° 56' 11"	←
5. R.A.	14 55 13	17 12 52	00° 01' 21"	03° 57' 11"	←
6. D	24° 39' 52"	59° 19' 34"			
7. КАСЕТА			1	2	3
8. ЕКСПОЗИЦИЈА	2u 21	2u 21	2u 21	2u 21	2u 21
9. ФОРМАТ	13x13	13x13	30x30	30x30	30x30
10. ФОРМАТ	—	—	W/L 38 ₂ mm	W/L 38 ₂ mm	W/L 38 ₂ mm
11. ФОРМАТ (ПРЕМ. НАПРАВ.)	33x31	33x31	33x48/115	33x48	33x48
12. ИСТОРИЈА НА ОБЈЕКТА	3"	3"	4-6"	4-6"	4-6"
13. СТАТУС НА ОБЈЕКТА	new	new	new	new	new
14. ФОРМА	—	—	—	—	—
15. R.A. - ЗНАК	26 34.5	22 29			
16. ВРЕМ. НА ОБЈЕКТА			21° 07"	22° 26"	23° 28"
17. ПОСРЕДСТВО					
18. ОБЈЕКТА НА ОБЈЕКТА	90"	F0	45"	30"	30"
19. ПОСРЕДСТВО НА ОБЈЕКТА	01° 39"	01° 30.5"	6° 02"	23° 48"	23° 07"
20. ПОСРЕДСТВО НА ОБЈЕКТА					
21. ПОСРЕДСТВО НА ОБЈЕКТА					
22. ПОСРЕДСТВО НА ОБЈЕКТА					
23. ПОСРЕДСТВО НА ОБЈЕКТА					
24. ПОСРЕДСТВО НА ОБЈЕКТА					
25. ПОСРЕДСТВО НА ОБЈЕКТА					
26. ПОСРЕДСТВО НА ОБЈЕКТА					
27. ПОСРЕДСТВО НА ОБЈЕКТА					
28. ПОСРЕДСТВО НА ОБЈЕКТА					
29. ПОСРЕДСТВО НА ОБЈЕКТА					
30. ПОСРЕДСТВО НА ОБЈЕКТА					
31. ПОСРЕДСТВО НА ОБЈЕКТА					
32. ПОСРЕДСТВО НА ОБЈЕКТА					
33. ПОСРЕДСТВО НА ОБЈЕКТА					
34. ПОСРЕДСТВО НА ОБЈЕКТА					
35. ПОСРЕДСТВО НА ОБЈЕКТА					
36. ПОСРЕДСТВО НА ОБЈЕКТА					
37. ПОСРЕДСТВО НА ОБЈЕКТА					
38. ПОСРЕДСТВО НА ОБЈЕКТА					
39. ПОСРЕДСТВО НА ОБЈЕКТА					
40. ПОСРЕДСТВО НА ОБЈЕКТА					
41. ПОСРЕДСТВО НА ОБЈЕКТА					
42. ПОСРЕДСТВО НА ОБЈЕКТА					
43. ПОСРЕДСТВО НА ОБЈЕКТА					
44. ПОСРЕДСТВО НА ОБЈЕКТА					
45. ПОСРЕДСТВО НА ОБЈЕКТА					
46. ПОСРЕДСТВО НА ОБЈЕКТА					
47. ПОСРЕДСТВО НА ОБЈЕКТА					
48. ПОСРЕДСТВО НА ОБЈЕКТА					
49. ПОСРЕДСТВО НА ОБЈЕКТА					
50. ПОСРЕДСТВО НА ОБЈЕКТА					
51. ПОСРЕДСТВО НА ОБЈЕКТА					
52. ПОСРЕДСТВО НА ОБЈЕКТА					
53. ПОСРЕДСТВО НА ОБЈЕКТА					
54. ПОСРЕДСТВО НА ОБЈЕКТА					
55. ПОСРЕДСТВО НА ОБЈЕКТА					
56. ПОСРЕДСТВО НА ОБЈЕКТА					
57. ПОСРЕДСТВО НА ОБЈЕКТА					
58. ПОСРЕДСТВО НА ОБЈЕКТА					
59. ПОСРЕДСТВО НА ОБЈЕКТА					
60. ПОСРЕДСТВО НА ОБЈЕКТА					
61. ПОСРЕДСТВО НА ОБЈЕКТА					
62. ПОСРЕДСТВО НА ОБЈЕКТА					
63. ПОСРЕДСТВО НА ОБЈЕКТА					
64. ПОСРЕДСТВО НА ОБЈЕКТА					
65. ПОСРЕДСТВО НА ОБЈЕКТА					
66. ПОСРЕДСТВО НА ОБЈЕКТА					
67. ПОСРЕДСТВО НА ОБЈЕКТА					
68. ПОСРЕДСТВО НА ОБЈЕКТА					
69. ПОСРЕДСТВО НА ОБЈЕКТА					
70. ПОСРЕДСТВО НА ОБЈЕКТА					
71. ПОСРЕДСТВО НА ОБЈЕКТА					
72. ПОСРЕДСТВО НА ОБЈЕКТА					
73. ПОСРЕДСТВО НА ОБЈЕКТА					
74. ПОСРЕДСТВО НА ОБЈЕКТА					
75. ПОСРЕДСТВО НА ОБЈЕКТА					
76. ПОСРЕДСТВО НА ОБЈЕКТА					
77. ПОСРЕДСТВО НА ОБЈЕКТА					
78. ПОСРЕДСТВО НА ОБЈЕКТА					
79. ПОСРЕДСТВО НА ОБЈЕКТА					
80. ПОСРЕДСТВО НА ОБЈЕКТА					
81. ПОСРЕДСТВО НА ОБЈЕКТА					
82. ПОСРЕДСТВО НА ОБЈЕКТА					
83. ПОСРЕДСТВО НА ОБЈЕКТА					
84. ПОСРЕДСТВО НА ОБЈЕКТА					
85. ПОСРЕДСТВО НА ОБЈЕКТА					
86. ПОСРЕДСТВО НА ОБЈЕКТА					
87. ПОСРЕДСТВО НА ОБЈЕКТА					
88. ПОСРЕДСТВО НА ОБЈЕКТА					
89. ПОСРЕДСТВО НА ОБЈЕКТА					
90. ПОСРЕДСТВО НА ОБЈЕКТА					
91. ПОСРЕДСТВО НА ОБЈЕКТА					
92. ПОСРЕДСТВО НА ОБЈЕКТА					
93. ПОСРЕДСТВО НА ОБЈЕКТА					
94. ПОСРЕДСТВО НА ОБЈЕКТА					
95. ПОСРЕДСТВО НА ОБЈЕКТА					
96. ПОСРЕДСТВО НА ОБЈЕКТА					
97. ПОСРЕДСТВО НА ОБЈЕКТА					
98. ПОСРЕДСТВО НА ОБЈЕКТА					
99. ПОСРЕДСТВО НА ОБЈЕКТА					
100. ПОСРЕДСТВО НА ОБЈЕКТА					

Figure 4. Sample of the original plate logbook (plates ROZ200_000163-167) included in the WFPDB as a new opportunity of the extended search.

Table 1. New WFPDB catalogues with a total of 23,358 new plates

WFPDB Catalogue Identifier	Number of the Plates
MYK012	7438
TOK016	868
TOK020	1577
GUA040A	8486
GUA040B	649
GUA040E	3656
GUA070A	570
QUI021A	66
QUI021B	48
Total number	23358

Data for added new catalogues during the first phase of the contract (exactly new 23 358 plates) is given in Table 1. These catalogues are available for user mode online via Internet.

A new updated version of the Catalogue of Wide-Field Plate Archives (CWFPAs) version June 2010 with a total of 473 archives was prepared. In the contract period the number of records has increased from 440 to 473, or 33 new archives were added. The increasing of the number of direct plates in the catalogues during the contract period is with 221,046 new plates.

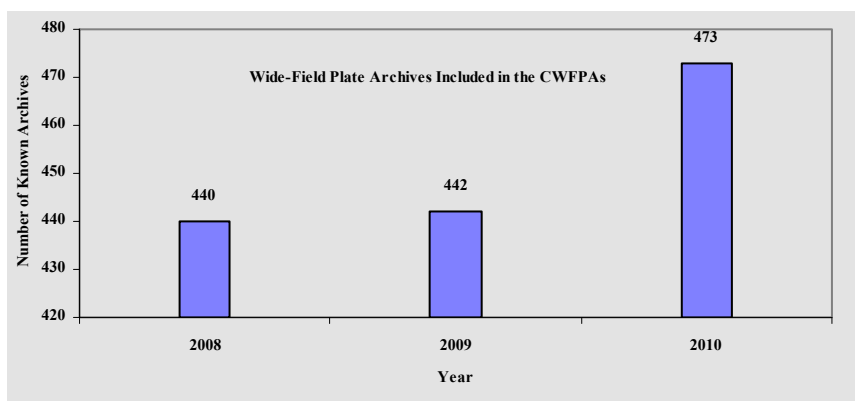


Figure 5. Status of the CWFPA version June 2010.

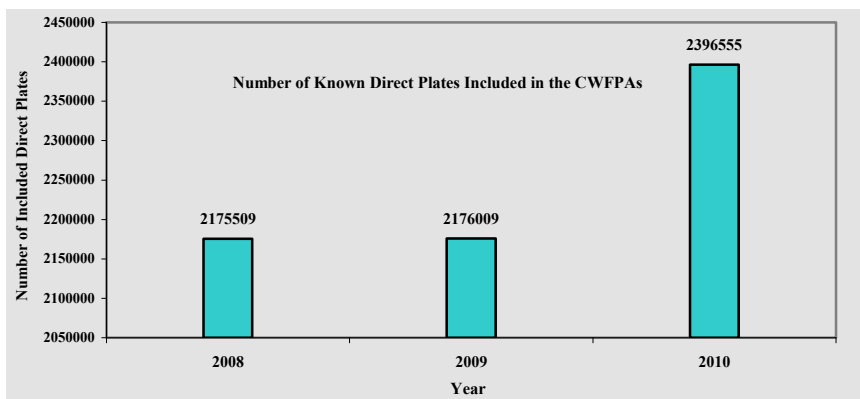


Figure 6. Increasing the number of direct plates in the CWFPA version June 2010.

5. DIGITIZATION OF THE PHOTOGRAPHIC PLATES - PREPARATION OF DIGITAL IMAGES WITH LOW AND HIGH RESOLUTION ACCORDING TO THE WFPDB REQUIREMENTS

About 3000 plate scans (preview images) of the Belgrade Astronomical Observatory and 1000 scan from Bucharest have been delivered to the WFPDB in order to be included into the database.

Substantial development work on creation of specialized digital archives of plates within the eScience and electronic connection between IBVS and WFPDB (Interlinking IBVS with WFPDB) was done with the new flatbed scanner of Konkoly observatory:

- 31 plates in Orion (with a total volume of data about 14.1GB) with EPSON PERFECTION V750 PHOTO scanner with scan parameters - 15x15 cm scanned field; 1200 dpi previews; 2400 dpi working scans. Source files in JPG format, have an average 1.5 MB in 52 MB TIF format in FITS format, 419 MB;
- 22 plates in the Pleiades ((total volume of data about 10.3 GB) with EPSON PERFECTION V750 PHOTO scanner with scanning parameters - 15x15 cm scanned field; 1200 dpi previews; 2400 dpi working scans. Source files in JPG format, have on average 1.5 MB in TIF format, 52 MB to 419 MB FITS format);
- 64 plates ((total volume of data about 26.2 GB) with EPSON PERFECTION V750 PHOTO scanner with scanning parameters - 15x15 cm scanned field; 2400 dpi working scans. Source files in FITS format are with a volume of about 419 MB.

Plate scanning laboratories were established with standard methods of scanning in astronomical institutes in Germany (Potsdam, Bamberg, Jena), Hungary (Konkoly), Romania (Bucharest), Belgrade, Ukraine (Kiev-Main Astronomical Observatory), Russia (Moscow- INASAN Zvenigorod) and others. Methodology (know-how) to digitise plates by flatbed scanners such as EPSON has been given also in Prague, Tatranska Lomnica, Cluj, Zvenigorod, etc.

Preparation of a new version of WFPDB, including new archives and catalogues is about to be published in the Astronomical Data Centre in Strasbourg. Within this task WFPDB was extended with digital images on photographic plates. The plates were scanned twice with precise commercial scanners (flatbed), type EPSON 10000XL, 1640XL and V700 - once a low-resolution colour and 8 bit, and a second time - with high-resolution 16 bit gray - FITS format. The purpose of scanning with low resolution, which is within the 600-1200 dpi ($> \sim 40\text{-}20\ \mu\text{m}$), is to prepare digital images for rapid visualization of observations included in WFPDB. This provides an opportunity for preliminary examination (preview) of the selected sky region (plate) and its evaluation in terms of area covered by the celestial sphere, the visibility of certain objects, the limit magnitude (related to duration of exposure), image quality and others. The developed technology for plate scanning is accepted in observatories in Europe as a standard. Images of plates with high resolution, typically 1200-2400 dpi ($< \sim 20\text{-}10\ \mu\text{m}$), are designed for photometry. These images are in greyscale and cleaned from possible dust and marks. Fig. 6 shows the Rozhen Digital Plate Laboratory equipped with flatbed scanner EPSON 10000XL.

The typical scan duration for one 30x30 cm plate with the cleaning, fitting on the scanner, setting scanning parameters, filling in the header file with the information and visual inspection of the resulting scan is about 30-40 minutes. The needed memory is about 0.7 GB. Only the scanning time of a plate with dimensions 30x30 cm (cleaned before scanning) with the EPSON 10000XL with 2400 dpi resolution is about 18 minutes. In some cases, for needed very high resolution (of a few μm), or for test and calibration measurements (densities to 5.0 D) the photographic plates were digitised by the high-precision microdensitometer PDS1010^{Plus} in SSADC (see

http://aquila.skyarchive.org/DATABASE_NFNI273/publications/reports/Nicola_Petrov_CHEPELARE.pdf).



Figure 7. Laboratory for scanning plates in NAO Rozhen, equipped with a scanner EPSON 10000XL (A3) and computer system APUS-3.

The technology of scanning plates with the same type of scanner is described in detail in the report of L. Schmadel from Heidelberg Astronomical Rechen Institute. In this project the digitization of a great amount of plates like Palomar sky surveys plates (POSS) with size 36x36 cm is described (http://aquila.skyarchive.org/DE_plate%20archives_pub/Heidelberg/Digitization_Stoss.ppt)

5.1. Digitization of Roz200 Plate Archive

The digitisation of the plates obtained in the RC focus of the 2 m telescope of NAO Rozhen is one of the most important tasks in this contract. That is why a special inventory and search for the plates, which were stored by the individual observers, were made.

According to the information existing in the WFPDB the ROZ200 catalogue contains information for 1984 plates obtained in the period 1978 - 1993, after it the photographic observations were de facto suspended by the CCD cameras. With additional plates obtained by this telescope, especially with short exposures, which were not included in WFPDB, the number of the plates reached 2115. The number of the available plates in Rozhen and Sofia is about 880 plates. The rest plates are still in the individual observers or astronomers at home or abroad. A request for their return back and for centralized storage in NAO Rozhen was made. The plates obtained in the RC focus of the 2m telescope are with scale 12.89"/mm, mostly with size 30x30 cm or 16x16 cm and they cover a sky region of one square degree.

The photographic plates of the 2 m telescope were scanned at low (600 dpi) for previews and with high resolution (1600 dpi) for FITS scans. Resolution of 1600 dpi corresponds to 15.9 $\mu\text{m}/\text{pixel}$ and corresponds to the amount of - 0.20" per pixel. This value is comparable to the resolution of the CCD camera VersArray/1300B, which is currently used for observations with the 2-m telescope of NAO Rozhen pixel size of 0.26". Therefore it is suitable for efficient photometric image processing. With this resolution the volume of the scan of one plate is about 700 MB. Up to now according to the project programme for 2010 are scanned 496 plates from the Institute of Astronomy plate library: respectively - in Rozhen 424 plates and 72 in Sofia with size of 30x30 cm. Up to date (July 2010) from the catalogued 2115 plates from different observers 1100 plates were collected (not available 1015 plates present ~50%). The data from the scanned plates is available on the servers of the IA SSADC and NAO and a digital archive of photographic observations of the 2-m RCC telescope will be organized.

5.2. Digitization of Selected Photographic Plates from Roz050 Archive

The first step is the taken inventory of the available plates of this telescope. From those presented in the catalogue of the WFPDB for this telescope (ROZ050) for a period of about 20 years observations 7348 wide-field photographic plates mainly of small bodies of the Solar system, variable stars, star clusters and galaxies have been catalogued. The field of the telescope is 4.5 ° x 4.5

° at a scale of image 120 "/ mm and the dimensions of the plates are square 16x16 cm² and 13x13 cm² . Available in the plate library of IA with NAO are 1331 plates. The digitization of these photographic plates is also made in two steps - getting the "previews" with 1200 dpi (20 mic/mm) in TIF and JPG format and detailed scans in FITS format with 2400 dpi (10 mic/mm (1.2 "/pixel). So far with methods used 49 plates with the new EPSON Perfection V700 scanner in Sofia were preliminary digitized. Parallel with this goes digitization of selected samples to study different types of stellar objects: (a) eruptive stars, (b) minor planets, (c) before the main sequence stars and others. 200 Schmidt plates more are digitized and are available to the servers of NAO Rozhen and Sofia.

6. STUDY OF THE ACCURACY OF THE RESTORATION AND DEVELOPMENT OF NUMERICAL PROCEDURES FOR PHOTOMETRIC CALIBRATION

The important task was the testing the accuracy of the used methods especially with the available (commercial) flatbed EPSON scanners and with high accuracy microdensitometer PDS 1010 Plus. The task was divided into two stages: Investigation of the accuracy of digitization using the standard "driver" of the EPSON scanner (TWAIN-driver) and a new one of the commercial VueScan (VueScan - <http://www.hamrick.com>) and using the standard calibration procedure of de Vaucouleurs (1984). It was shown that the professional version of VueScan driver gives good results of scanning compared with the standard TWAIN EPSON driver is comparable with those of PDS1010^{Plus} (see Fig. 8 and http://aquila.skyarchive.org/DATABASE_NFNI273/publications/reports/budell-2010.pdf). In this connection we plan to prepare a special software package and to replace the currently used "FitsScan"-driver of S. Motola (Barbieri et al. 2003) based on the EPSON TWAIN-driver, which allows to receive data directly from the VueScan row-tiff format to a standard FITS format applied for astronomical images.

In case of absence of internal calibration (f.e. photometric wedges), which is the often case in photographic wide-field observations it was proposed and tested a method of passing in the relative intensities, using profiles of star images. The restoration of the characteristic curve by this method was first proposed by de Vaucouleurs (1984). In this case it is obtained that the method of stellar profiles allows to construct the characteristic curves of astronomical emulsion, which by its nature is comparable to that obtained from the photometric wedge. Since the method established ability to obtain internally consistent set of magnitudes with optimum accuracy – view at [http://aquila.skyarchive.org/DATABASE_NFNI273/publications/reports/Mapkov-atall-CHEP_2010% 20.pdf](http://aquila.skyarchive.org/DATABASE_NFNI273/publications/reports/Mapkov-atall-CHEP_2010%20.pdf) (see Fig. 9).

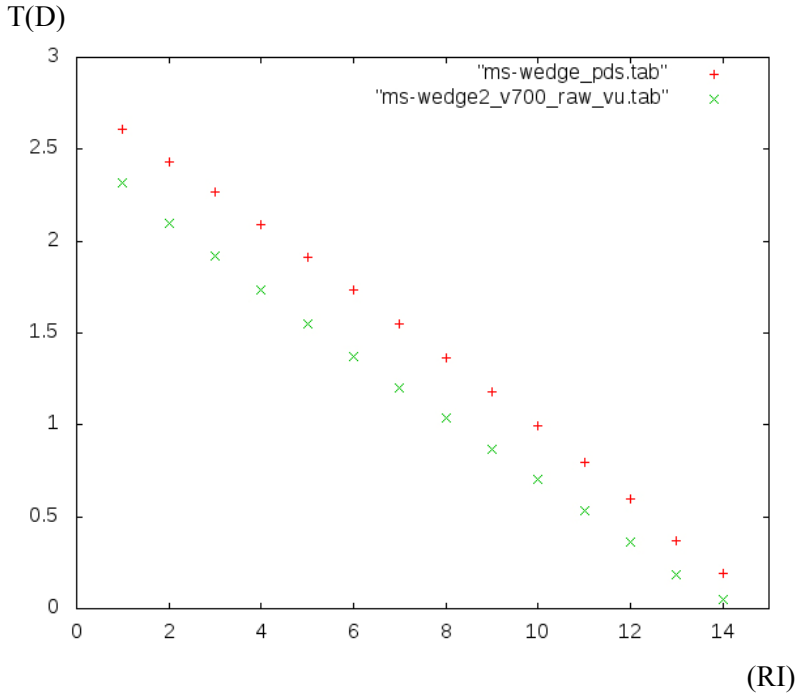


Figure 8. Comparative chart for photometric scan of EPSON V700 and PDS1010 Plus.

In this direction the research and development of technology and software for reading FITS and ROW TIF files were carried out and to convert them from ROW-TIF (product of the new program VueScan) in FITS.

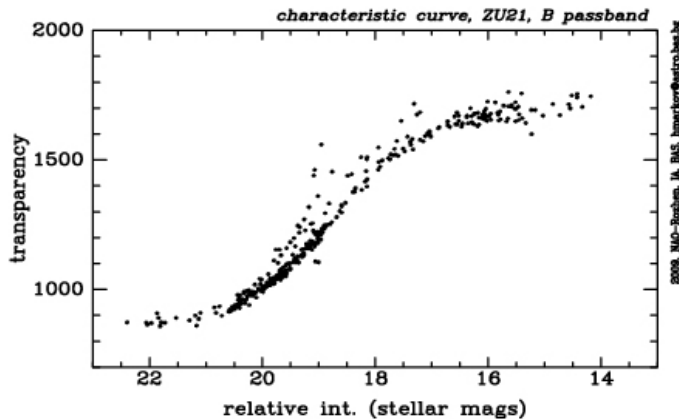


Figure 9. Chart of the photometric scan done by EPSON 10000XL of 30x30 cm² plate of the 2-m RCC telescope, emulsion ZU21 (B) in the star cluster M13 obtained in the calibration procedure applied to photometric plate processing. A test for digital aperture photometry of saturated star images was also performed.

7. RESEARCH AND RESULTS FROM THE USE OF ASTRONOMICAL PHOTOGRAPHIC PLATES IN THE WFPDB

Within the framework of research and application of WFPDB and photometric study of different types of variable stars a dissertation on the topic of the project was prepared http://aquila.skyarchive.org/Astroinformatics/DISERTATIONS_PhD_275/Ana_Borisova_disertatsia/

The main results of this work can be summarized:

- Creation of a database of wide-field photographic astronomical observations in the Pleiades as an annex and extension of WFPDB;
- Combining data observations in a period of 115 years, the photographic observations (about 4000 plates);
- Hosted is a web-access data available through the interface of the WFPDB.

The photometric studies of selected southern active variable stars were executed using the digitized the Bamberg Southern Sky Survey plates. The analysis of the rotation curves for long period of the stars investigated confirms the observed rotation periods of CF Oct, YY Men and indicates the presence of long-term and changes in brightness of the star BW 76 type FU Orionis and the long-scale changes of the YZ Men. The cyclical activity was proved using the method of Bayesian statistics. Conclusions are in agreement with the hypothesis of differential rotation of the star's photosphere. It was shown with a high probability of the existence of two cycles of approximately 7.13 and 9.81 years, and indications for the registration of three harmonics cycle with period 9.81 years, 6.66 years and 3.3 years.

Using the WFPDB and in particular the 2-m RCC and 50/70 cm Schmidt telescope plate collections for photometric variability survey of large intervals is of great importance for the study of stellar evolution and the study of no stationary processes were long requiring measurements of the brightness of stars. We scanned more than 220 plates as a special sample from the archives of 50/70 cm Schmidt telescope in combination with observations from observatories in Japan, Germany and others allowed to study of stellar evolution through the study of no stationary processes leading to change the brightness of stars.

In cases were studied FU Orionis (FUors) bursts of two stars located in a phase where not yet reached the main sequence. Physical causes are attributed to thermal changes caused changes of the nearby stellar disk. In the case was of star V1735 Cyg located in the nebula IC 5146 - a complex of active star formation. Based on the observed outburst and spectral properties, V 1735 Cyg is classified as an object FUOrioni and we are trying to build historically glow curve V1735 Cyg. Plates from the archive 50/70-cm Schmidt telescope of the observatory are 82 Rozhen received in the center of IC 5146. They were scanned with the Epson 1640XL scanner with 1600 DPI resolution, which corresponds to 16 μm /pixel. Aperture

photometry was applied using the package DAOPHOT. Analysis of existing photometric data shows a slow decline in star brightness - 1.8 mag (R) for 44 years, which is typical of stars and FU Ori-. The data from the search shows that V 1735 Cyg should be added to the group of long FU Orionis type and that the time scale of this phenomenon FUOR should be much longer than assumed in previous studies.

It is necessary to continue research done on the basis of other existing historical photographic observations of V 1735 Cyg collections of the following telescopes: the 67/92-cm and 40/50-cm Schmidt telescope at Asiago (Italy) on 105/150-cm Schmidt telescope at Kiso Observatory (Japan), the 60/90-cm Schmidt telescope at Roma Observatory at Campo Imperatore (Italy) on 134/200-cm Schmidt telescope in Tautenburg (Germany) and 40 cm in telescope of Sonneberg Observatory (Germany). View.:

[http://aquila.skyarchive.org/DATABASE_NFNI273/publications/T_Peneva_A &SS2009.pdf](http://aquila.skyarchive.org/DATABASE_NFNI273/publications/T_Peneva_A&SS2009.pdf)

Other similar star of FU Orionis candidate that was investigated - V733 Cep situated in the constellation Cepheus discovered by Persson in 2004. The star is located in the L1216 dark cloud near OB3 association Cepheus. As a result of scanning of 192 photographic plates found in the field of V733 Cep from different observatories selected on the bases of WFPDB search. The results of our photometric study from the digitized plates confirmed the affiliation of V733 Cep to no particular group of objects FU Orionis (Peneva et al. 2010 and Peneva et al.2010a). It is shown for the first time that in the optical band the star increase the brightness in the period 1971-1993. During the period 1993-2004 V733 Cep reaches its maximum brightness and the observed outburst amplitude exceeds 4.5 (R) magnitudes. In color BVRI photometric system data show that from February 2007 to October 2009, slowly the brightness of V733 Cep decreases. Development of the observed color index also suggest that V733 Cep currently is faint. Long time light curve of V733 is very similar to the usual curves of other objects FU Orionis.(see:

http://aquila.skyarchive.org/DATABASE_NFNI273/publications/Peneva_semkov1003.3744v1.pdf

8. CONCLUSIONS

The important results from the work program under contract DO-02-273 in the first period of the grant can be summed up as:

1. The SSADC local computer network was improved and it was equipped with a new data storage capacity (PROMIS VTRAC V610p) of 15 TB (at present only 6TB are ordered). The steps are made to integrate the network of the SSADC to the network of the Institute of Astronomy and National Astronomical Observatory, Bulgarian Academy of Sciences.

2. There are existing "Mirror" database WFPDB in IMI and IA:

<http://trillian.magrathea.bg:8080/>, (www.wfpdb.org)
<http://trillian.magrathea.bg:8080/search/>,
<http://trillian.magrathea.bg:8080/stargazer/>,
<http://trillian.magrathea.bg:8080/hyperleđa/>,
<http://docs.astro.bas.bg/~pi/Data/www/picindex.html>,
http://www.wfpdb.org/7_BSAC/

3. Catalogue records (CWFPFA) was updated as new version is made (5.5), which includes information about new American observatories possessing such observations. So during the project work during the first stage the number of records increased by 33 new archive containing 221.046 plates - the total number of records reached number 473, the database (WFPDB) grew by 23,358 plates.

4. 15 publications are published on the topic of the project, 4 of them are in journals with high impact factor. Exported more than 20 reports of some international conferences and present, of which 6 invited.

5. Organized an international conference on "Astroinformatics" with over 65 participants, with over 50% participation from abroad, http://aquila.skyarchive.org/7_BSAC/. Organized was an international Workshop in Potsdam(AIP) to discuss a project on digitization of European cultural heritage (historical astronomical plates) in frame of the 7th Framework Programme.

6. The project research team has had and continues to provide expert assistance to astronomical institutes and observatories in Europe (Bamberg, Potsdam, Bucharest, Budapest, Moscow, Belgrade etc.) for the organization, digitization and the use of their photographic archives.

7. A doctoral thesis was defended connected with the topic of the project.

"WFPDB(Database of Wide-Field Photographic astronomical observations: Application for long-photometric study of different types of variable stars" Borisova 2010

Acknowledgements

This work is supported by the BG NSF DO-02-273 and partly DO-02-275 grants of the MONM.

References

- Barbieri, C., Blanco, C., Bucciarelli, B., Coluzzi, R., Di Paola, A., Lanteri, L., Li Causi, G.-L., Marilli, E., Massimino, P., Mezzalira, V., Mottola, S., Nesci, R., Omizzolo, A., Pedichini, F., Rampazzi, F., Rossi, C., Stagni, R., Tsvetkov, M. Viotti, R.: 2003, *Experimental Astronomy*, **15** (1), 29.
- Borisova, A.: 2010, "WFPDB(Database of Wide-Field Photographic astronomical observations): Application for long-photometric study of different types of variable stars" (PhD Thesis) http://aquila.skyarchive.org/Astroinformatics/DISERTATIONS_PhD_275/Ana_Borisova_disetratsia/

- de Vaucouleurs, G.: 1984, in Capaccioli, D. (ed) Proc. Of the Confer., Astronomy with Schmidt-type Telescopes, Erice, Reidel, Dordrecht Astronomy with Schmidt-type Telescopes. Proceedings of the 78th. Colloquium of the International Astronomical Union, Asiago, Italy, August 30-September 2, 1983. Editor, Massimo Capaccioli; Publisher, D. Reidel Publishing Co., Dordrecht, Holland; Boston, A87. P. 367.
- Innis, J. L, Coates, D. W, Borisova, A. P, Tsvetkov, M. K.: 2010, Digital Aperture Photometry of Saturated Star Images, *Bulg. Astr. J.*, **13**, 108.
- Peneva, S. P., Semkov, E. H., Munari, U., Birkle, K.: 2010, "A long-term photometric study of the FU Orionis star V733 Cep", *A&A*, **515**, 24.
- Peneva, S. P., Semkov, E. H., Stavrev, K. Y.: 2010, "Long-term light curves of four young variable stars", *Bul. Astr. J.*, **14**, 79.
- Persson, R.: 2004, IAU Circ., 8441, 2 . Edited by Green, D. W. E.
- Tsvetkov, M.: 2005, "Virtual Observatory: Plate Content Digitization, Archive Mining and Image Sequence, Processing", iAstro workshop, Sofia, Bulgaria, Eds. M. Tsvetkov, F. Murtagh, R. Molina, p. 10, 2006 "Wide-Field Plate Database: a Decade of Development" (http://aquila.skyarchive.org/WFPDB/basic/10_YD_MKTS/MTS_WFPDB-10YD.pdf).
- Tsvetkova, K., Tsvetkov, M.: 2005, "Virtual Observatory: Plate Content Digitization, Archive Mining and Image Sequence, Processing", iAstro workshop, Sofia, Bulgaria, Eds. M. Tsvetkov, F. Murtagh, R. Molina, p. 45, 2006. "Catalogue of Wide-Field Plate Archives: Version 5.0" (http://aquila.skyarchive.org/WFPDB/basic/CWFPA50/KTS_MTS_CWFPA50.pdf)