

Rozhen Observatory wide-field plate archives

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Abstract: This paper provides an overview of the wide-field ($>1^{\circ}$) plate archives at disposal in the Institute of Astronomy and National Astronomical Observatory Rozhen of the Bulgarian Academy of Sciences. The plates with total number 10093 are obtained in the period November 1978 – February 1998 with the 2 m RCC telescope and 50/70/172 cm Schmidt telescope. The available plate catalogues are upgraded with new information, as well as with link to the digitized logbooks (in JPEG file format). The digitization with high quality EPSON flatbed scanners of the available 2 m RCC telescope plates (with low resolution in JPEG, and with high resolution in standardized FITS file format) is accomplished. The digitization of the available 50/70/172 cm Schmidt telescope plates is running. The low resolution images of the scanned Rozhen plates are included in the Wide-Field Plate Database (<http://wfpdb.org>) and accessible online.

1. Introduction

Astronomical observations with photographic plates had been conducted since the first applications of photography. For this long period only the number of the wide-field plates, having a field of view larger than 1° , is about 2 475 600 (Tsvetkova et al. 2012a). The old photographic observations done on a long time interval with a medium astrometric and photometric accuracy are very needed for the time domain astronomy because the present astronomical observations having high accuracy comprise only a short period of time. On the other hand the present observations with their high accuracy will enable to reduce the old plate observations with higher accuracy having at disposal the plates and access to the raw data they contain. Nevertheless the astronomical photographic plates stayed a long time not used. The reason can be found in the lack of appropriate tools - hardware and software. The situation changed with the contemporary methods for plate digitization with high accurate scanners and with professional flatbed scanners, as well as with the development of computer sciences, information and communication technology, and, in particular, data and network management. The plate digitization enables to increase the measurements accuracy in comparison with the previous used methods of plate measurements.

The origin of the plates as information records for astronomical objects for long period of time motivated the work for their storage and organization of modern access to the plate information. Thus the Wide-Field Plate Database (WFPDB,

<http://www.wfpdb.org>, Tsvetkov 1991) was established and developed. The WFPDB includes up to May 2012 not only plate metadata for 563 612 plates (about 23% of all plates stored worldwide), but also plate digital images, as well as another plate archive attributes as observing logbooks, card catalogue or other affiliated paper file, images of the original plate envelopes, linkage between archival plates and the papers based on this material. The database can be accessed through appropriate web-based search interface. The object of search can be plate metadata, plate quick visualization scan, plate large resolution scans, image meta-data characteristics, other plates in the same field, etc.

2. Rozhen Observatory wide-field plate archives

Rozhen Observatory possesses two wide-field telescopes: the 2m Ritchey-Chretien-Coude (RCC) telescope, and 50/70/172cm Schmidt telescope*. The plate observations in the Ritchey-Chretien focus of the 2m RCC telescope began in November 1978. The plate observations with the Schmidt telescope began immediately after the installation and test observations in 1979. Thus when in 1981 the Rozhen observatory was officially opened, already a lot of plates there were obtained.

From the WFPDB-Sofia Search Page (<http://wfpdb.org/search/>) one can obtained full information about the two Rozhen Observatory wide-field plate archives. As an excerpt of the Catalogue of Wide-Field Plate Archives (last version from January 2012, <http://www.wfpdb.org/catalogue.html>) Table 1 and Table 2 present the essential information about the telescopes with the WFPDB instrument identifier consisting of the first three letters of the observatory name and the telescope aper-

Table 1. Rozhen Observatory wide-field telescopes

WFPDB identifier	Aperture (m)	Focal length (m)	Scale "/mm	Telescope type	Field size (deg)
ROZ200	2.00	16	13	Ritchey-Chretien	1.0
ROZ050	0.50/0.70	1.72	120	Schmidt	4.5

Table 2. Rozhen Observatory wide-field plate archives

WFPDB identifier	Years of operation	Number of plates	Size of plates (cm)	Astronomer in duty
ROZ200	1978-1995	2196	30×30, 16×16	N. Petrov
ROZ050	1979-1998	7897	9x12,13x13, 16x16	M.Tsvetkov

* Rozhen Observatory has had at the disposal since the beginning of its operation also 60cm Cassegrain telescope for photoelectric observations that has been used by Professor M. Contadakis for joint observations of flare stars since 1980. His activity for collaboration among the Balkan countries continues up to the present.

ture in cm - ROZ200 and ROZ050, as well as information about the plate archives of each telescope, respectively.

Computer-readable catalogues were prepared from the existed telescope logbooks for the both wide-field plate archives in the required WFPDB format (Stavrev and Barzova, 1994, Mutafov et al. 1994). This format on the base of all available plate information enables future plate identification, selection and processing. More details about the accepted format as standard for plate/archive description, the used software for data reduction applied to original plate catalogues, as well as the work of making the existed logbooks accessible online can be found in Tsvetkova et al. (2012b).

Both Rozhen Observatory plate catalogues were included in the WFPDB. A statistics and analysis of the catalogues using the data retrieval from the WFPDB were done in Tsvetkova et al. (2009). The results concern the all-sky distribution of the plate centres, the time distribution, distribution of the plate number according to the type of the observed objects (asteroids, planets, comets, variable stars, open or globular clusters, galaxies, etc.), the exposure duration influencing the plate limit, as well as the exposure multiplicity as a method of observation required by different programmes (for asteroids, search for flare stars, etc.), the used emulsion and filter combination for a certain broad band photometric system, the plate size when it concerns the plate digitization, etc.

The present status of the Rozhen Observatory wide-field plate archives is given in Table 3 taking in view the increased number of plates for the both wide-field plate archives.

Table 3. Present status of the Rozhen Observatory wide-field plate archives

WFPDB identifier	Period of observations	Number of plates
ROZ200	May 1980 – Oct. 1992	1984 in WFPDB
	April 1993 – June 1995	212 plates not yet included
ROZ050	June 1979 – Feb. 1994	7348 in WFPDB
	Feb. 1994 – Feb. 1998	549 plates not yet included

2.1. The 2 m RCC telescope wide-field plate archive

The catalogue of the plates obtained with the 2m RCC telescope was updated with information for the plates obtained after the preparation of the first version in 1994. The updated catalogue now comprises exactly 2196 plates obtained in the period November 1978 – June 1995.

All sky distribution of the centres of the WFPDB ROZ200 plate catalogue in equatorial coordinates is shown in Fig. 3 and can be found in the WFPDB home page.

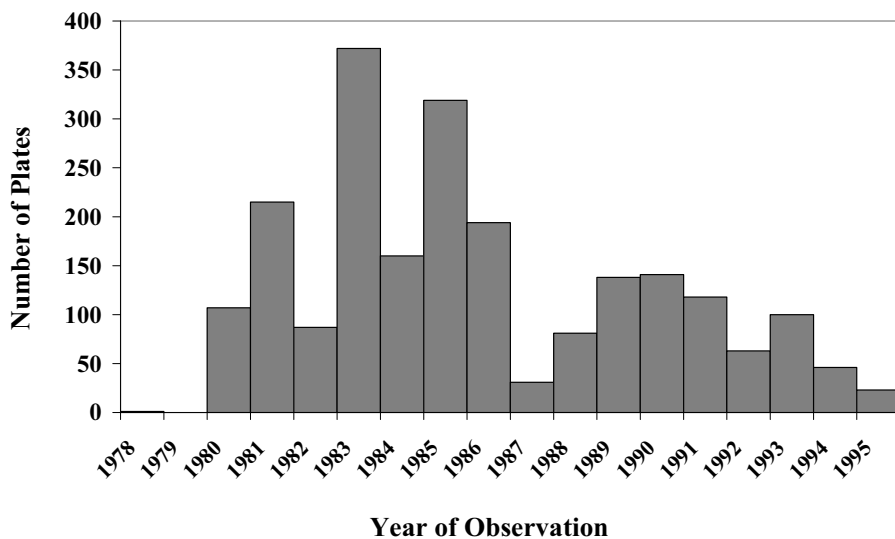


Figure 1. Time distribution for the Rozhen Observatory RCC telescope wide-field plates

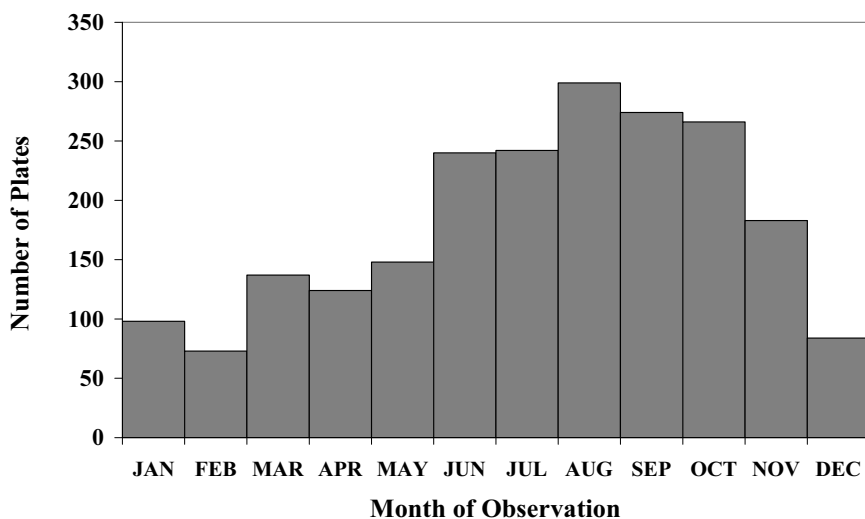


Figure 2. Month distribution for the Rozhen Observatory RCC telescope wide-field plates

Their time distribution is presented in Fig. 2. It is influenced by the astro-climatic conditions in Rozhen Observatory during the period of plate observations, as well as by such facts as the re-aluminization of the primary mirror of the telescope in 1987 and the declined activity of plate observations after 1990. The presented distribution of the plate number by month (Fig. 3) reveals the better conditions in Rozhen Observatory for observations in the second half of the year – especially in August, September and October.

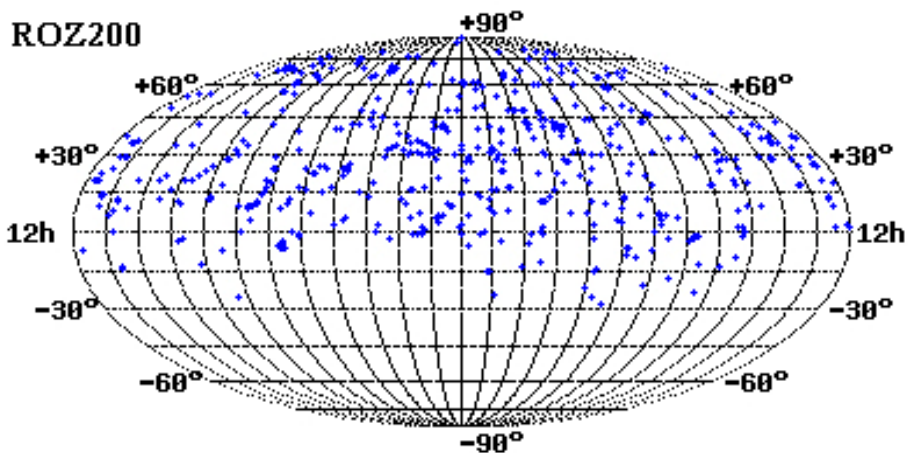


Figure 3. All sky distribution of the Rozhen Observatory RCC telescope wide-field plates

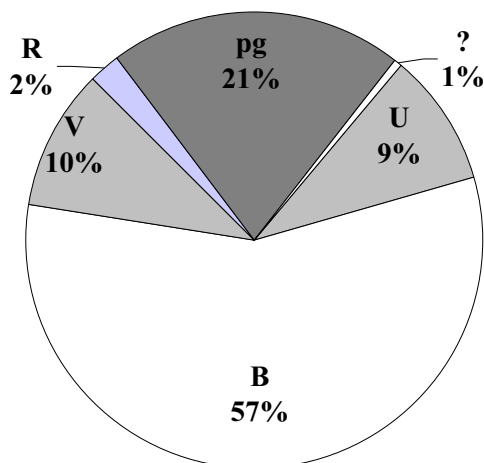


Figure 4. Broad band photometric system for the 2m RCC telescope wide-field plates

The used plate emulsions were Kodak (103aO, 103a D, 103aF, IIaO, IIaD, IIaF, IIIaF, IIIaJ, etc.) and ORWO (ZU 21, ZP3, RP1, etc). The observations were performed mainly in the Johnson broad band photometric system – UBV_R, or in pg (Fig. 4). From the presenting distribution of the exposure duration in Fig. 5 it is seen that mainly short exposures (up to 25 min) and exposures equal of 30 min and 60 min were used. Long exposure plates (more than 100 min) were used for observations of M31 and other galaxies.

The existed logbooks were scanned and after segmentation of the pages a linkage of the plate metadata information with the relevant logbook page was provided online through the WFPDB website. Examples of plate metadata and of scanned relevant logbook page are given in Fig. 7 and Fig. 8.

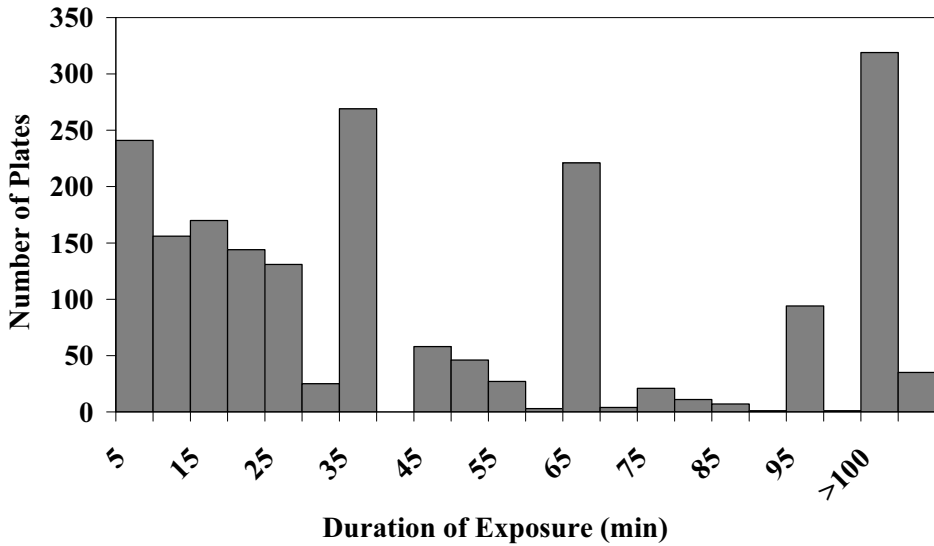


Figure 5. Used exposure duration for the 2m RCC telescope wide-field plates

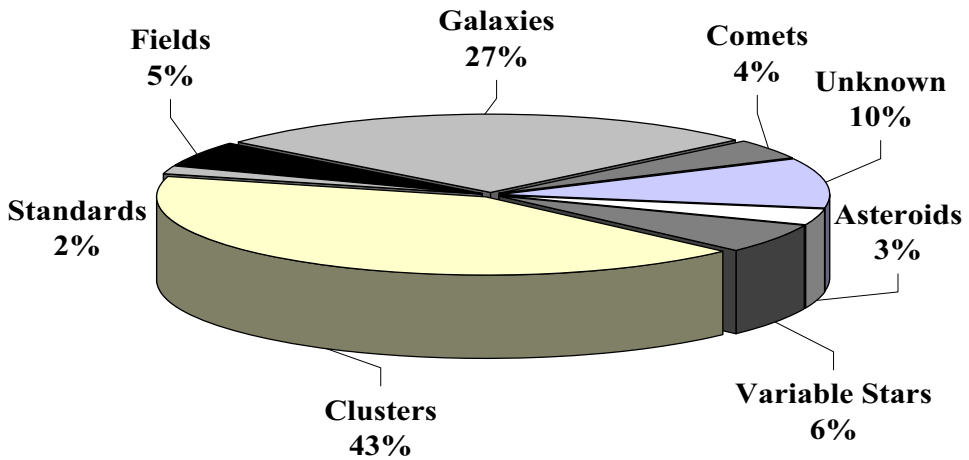


Figure 6. Observing programmes carried out with the 2m RCC telescope in RC focus

The observing programmes of the 2m RCC telescope (Fig. 6) include observations of stellar clusters (mainly globular clusters) – 43%, galaxies (type Seyfert, quasars, Markarian’s, Arakelian’s, interacting) – 27%, as well as variable stars, comets, asteroids, standards, etc.

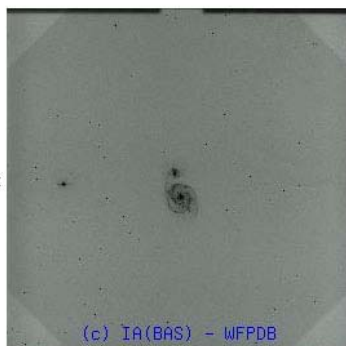
From 2196 obtained plates now 1100 plates (about 50% of all) are stored in the Rozhen Observatory plate library put in new envelopes. The rest of the plates are still kept by the individual observers.

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

Details for: ROZ200 000417

IDobs: ROZ	OBJNAM: M51
IDins: 200	OBJTYP:
IDSuf1:	METHOD: 1
IDno: 000417	MULTEX: 1
IDSuf2:	EXP: 60.0
RAJ2000: 13 29 54	EMULS: ZU21
DEC2000: 47 11 46	FILT: GG385
CCOD:	SPEC: B
DATE: 1983 01 14	DIMx: 30
UT: 02 33 00	DIMy: 30
TCOD:	
QUALITY:	
NOTES:	
OBSERVER: G.IVANOV	
AVAILABILITY:	
DIGITIZATION:	
Original Log-book scan: logbooks/ROZ200_000416-420.jpg	

PREVIEW:



SCAN: N/A

Figure 7. The search result for the WFPDB ROZ200 000417 plate

НАЦИОНАЛНА АСТРОНОМИЧЕСКА СЪВЕЩАНИЕ
2-ри ЯКО ТЕЛЕСКОП - "К. БОСОВО"

1	№ НА ПЛАКАТА	416	417	418	419	420
2	ДАТА	13/12/83	13/12/83	13/12/83	13/12/83	13/12/83
3	ОБЪЕКТИВЕ	M 51	M 51	Сатурн	Юпитер	Сатурн
4	№ НА ПЛАКАТА					
5	№ НА ПЛАКАТА					
6	№ НА ПЛАКАТА					
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49	№ НА ПЛАКАТА					
50	№ НА ПЛАКАТА					

Figure 8. Page from the 2m RCC telescope logbook containing the information for ROZ200 000417 plate (together for plates with original serial numbers 416-420).

2. 2. The 50/70/172 cm Schmidt telescope plate archive

The first version of the Rozhen Observatory Schmidt telescope plate catalogue containing metadata information for 7348 plates obtained in the period 1979-1994 was prepared by Mutafov et al. (1994). A statistics and analysis of this catalogue version done with the data retrieval from WFPDB and with corrected revealed mistakes can be found in Tsvetkova et al. (2010). The added in 2012 new information for 549 plates concerning the last plate observations done in the period 1994-1998 is analyzed in Tsvetkova et al. (2012c). As a result of this upgrading the catalogue of the Rozhen Observatory Schmidt telescope plates includes now exactly 7897 plates.

An example of plate information retrieval from the WFPDB website can be seen in Fig. 9 – in the case of the first plate taken with the Rozhen Schmidt telescope on June 5, 1979. Fig. 10 presents the all-sky distribution of the centres in equatorial coordinates of the ROZ050 plates retrieved from the WFPDB web page. The concentration of observations around the ecliptic due to the search for new asteroids is well seen. The time distribution of the plates shown in Fig. 11 reveals the maximum observational activity in the period 1982 - 1986. This maximum concerns the number of obtained plates, not the effective observing time. The month distribution of the plate number (Fig. 12) confirms the results from the 2m RCC plate observa-

Wide-Field Plate Database - Sofia

WFPDB@VizieR

[Aladin](#)

[Other Plate Catalogues](#)

Details for: ROZ050 000001

IDobs: ROZ	OBJNAM: ALPHA IYR
IDins: 50	OBJTYP:
IDSuf1:	METHOD: 10
IDno: 000001	MULTEX: 8
IDSuf2:	EXP: 0.3
RAJ2000: 18 36 41	EMULS: RP 1
DEC2000: 38 45 05	FILT: NONE
CCOD:	SPEC:
DATE: 1979 06 05	DIMx: 13
UT: 23 45 00	DIMy: 13
TCOD:	
QUALITY:	
NOTES:	
OBSERVER: M.TSVETKOV	
AVAILABILITY:	
DIGITIZATION:	
Original Log-book scan:	

Figure 9. WFPDB information for the first plate taken with the Rozhen Observatory Schmidt telescope

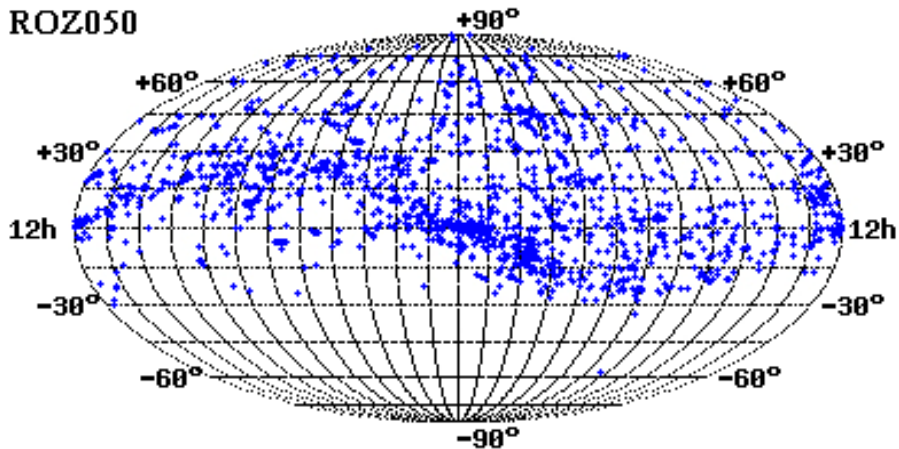


Figure 10. All sky distribution of the Rozhen Observatory Schmidt telescope plates

tions for better astro-climatic conditions in August, September and October in Rozhen Observatory.

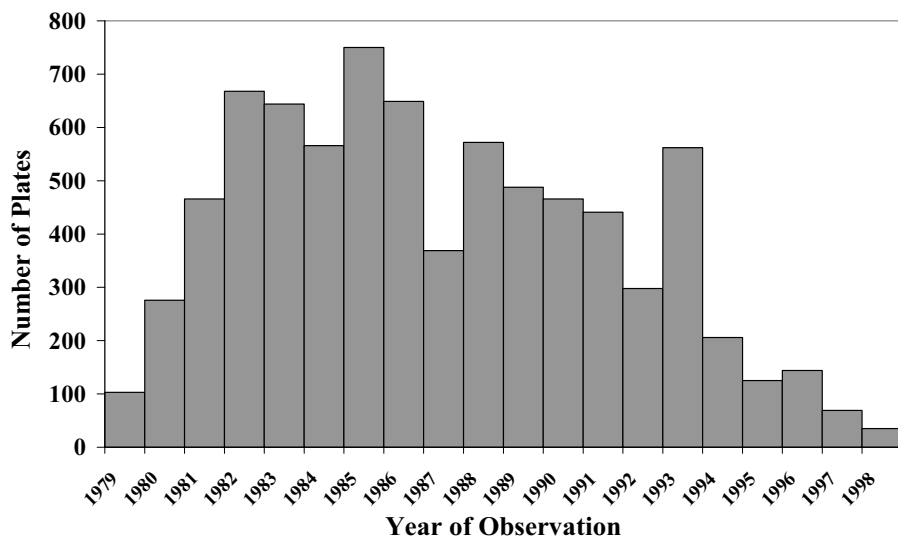


Figure 11. Time distribution of the Rozhen Observatory Schmidt telescope plates

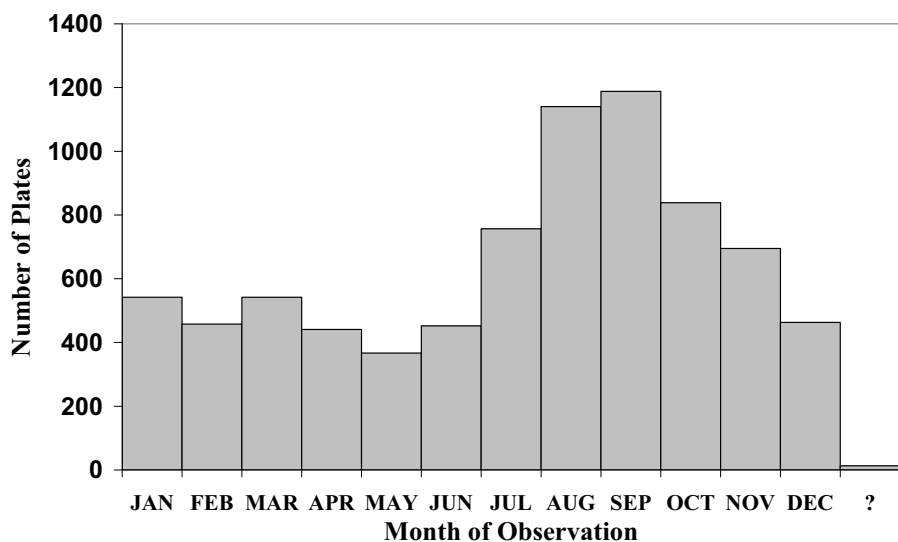


Figure 12. Month distribution of the Rozhen Observatory Schmidt telescope plates

The plate observations were performed mainly in pg or in the Johnson broad band photometric system – UBVRI (Fig. 13). The “pg” plates are about 52.6%, following by “B” plates (23.2%). The relatively large number of “U” plates is due of the patrol observations of flare stars in stellar clusters and associations done in Rozhen Observatory. The distribution of the exposure duration is shown in Fig. 14. Mainly

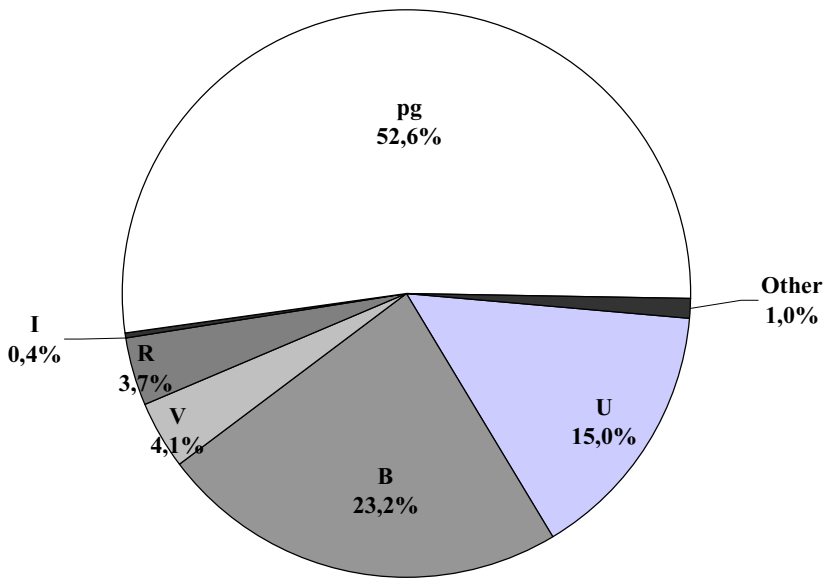


Figure 13. Broad band photometric system for the Rozhen Observatory Schmidt telescope plates

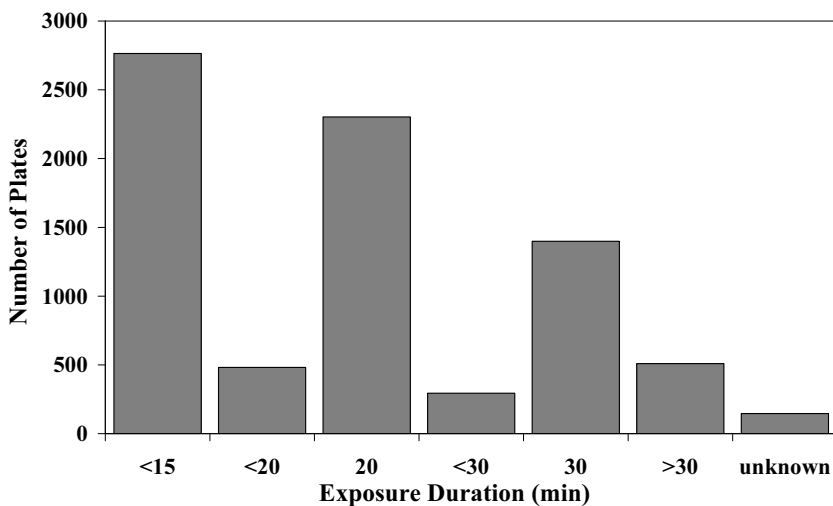


Figure 14. Exposure duration for the Rozhen Observatory Schmidt telescope plates

short exposures (up to 15 min) were used (for 35% of all observations) and exposures equal of 20 min (29%) and 30 min (18%).

Fig. 15 presents the results from the statistics concerning the used observing methods with the Schmidt telescope. For 74% of all obtained plates the most used method of observations was direct imaging. Multi-exposures method for 14.4% of plates was used mainly in the observations of flare stars in stellar clusters and asso-

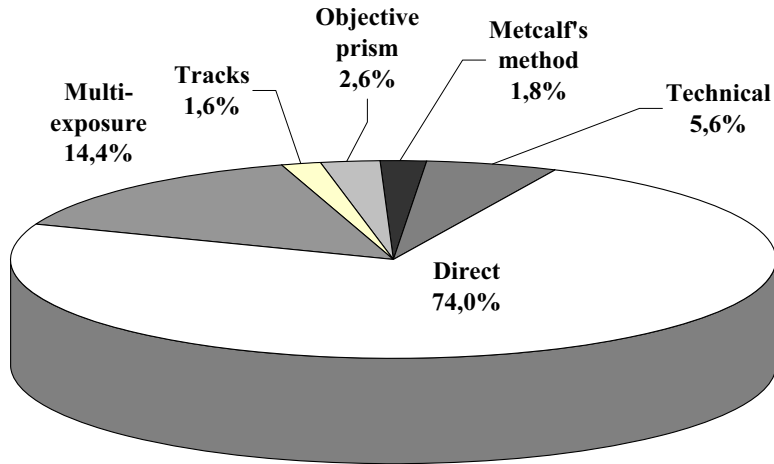


Figure 15. Observing methods used with the Rozhen Observatory Schmidt telescope

ciations, usually 6 exposures of 10 min each one. The technical plates (5.6%) comprise not only plates used for focusing, but also for Hartmann test, different experiments with emulsions, masks and some tests.

In the observing programmes of the Schmidt telescope (Fig. 13) the most observed objects were the asteroids (2659 plates), followed by the search for flare-ups of flare stars in stellar clusters and associations as the Pleiades, Gamma Cygni region, M42/43 in Orion, Praesepe, Alpha Per, Tauri Dark Clouds, the open cluster NGC 2264, the emission nebula NGC 7000 (with totally 1584 plates). More details about these flare star patrol plate observations can be found in Tsvetkova (2012d). Another observed objects were open stellar clusters - among them NGC 7129 (with 300 plates available), IC 4665 (265 plates), IC 5146 (with 85 plates), NGC 7092 (131 plates), M67 (47 plates). There is a good collection of observed globular clusters: M2, M3, M4, M5, M10, M12, M13, M 15, M 22, M 53, M 56, M68, M92, NGC 1904. Among the observed variable stars are the unusual nova-like star KR Aur (with 190 plates), the cataclysmic variable AM Her giving the name of this type variables (91 plates), the semi-regular pulsating star V 1319 Cyg (67 plates), the Nova star MV Lyr (76 plates), M dwarfs stars, Supernovae, etc. The observed galaxies are of different types as LINER-type Active Galaxy Nucleus, Interacting galaxies, Seyfert, etc. Andromeda Galaxy was observed with 183 plates, the group M81+M82 - with 34 plates. The list of observed comets includes: Halley, Shoemaker-Levy 9 (1993e), Hale-Bopp, Giacobini-Zinner (21P), P Tempel 1 93C, Tempel 2, Schaumasse, Panther, Metcalf-Brewington (1991a), Tanaka-Machholz (1992d), Austin, Bradfield (C/2004 F4), Encke, Helin (1977e), 22P Kopff, 65P/Gunn, Levy (1990 XX), Machholz (C/2004 Q2), 6P d'Arrest, Brorsen-Metcalf, C/1996 Hyakutake, Schwassmann-Wachmann-2, McNaught-Russell 93V, Takami-zawa-Levy 94, Kassini, Kowal, Faje, and Tabur. Another type observed objects are different fields, major planets, H II regions, planetary nebulae, etc.

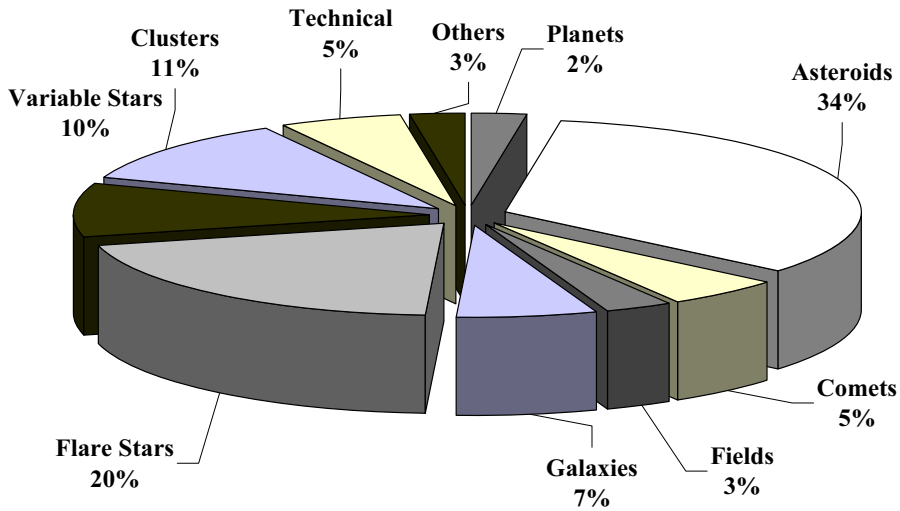


Figure 16. Observing programmes carried out with the Rozhen Observatory Schmidt telescope

Fig. 17 presents the observers who obtained more than 200 plates with the Schmidt telescope – A. Georgieva, V. Ivanova, A. Tsvetkova, E. Semkov, K. Tsvetkova, V. Radeva, V. Umlenski, Ts. Georgiev, M. Tsvetkov, V. Shkodrov, B. Bilkina. Interesting fact from the statistics is that these 11 observers obtained about 84% of all Rozhen Observatory Schmidt telescope plates. The existed logbooks are scanned but still are in process of accessibility online.

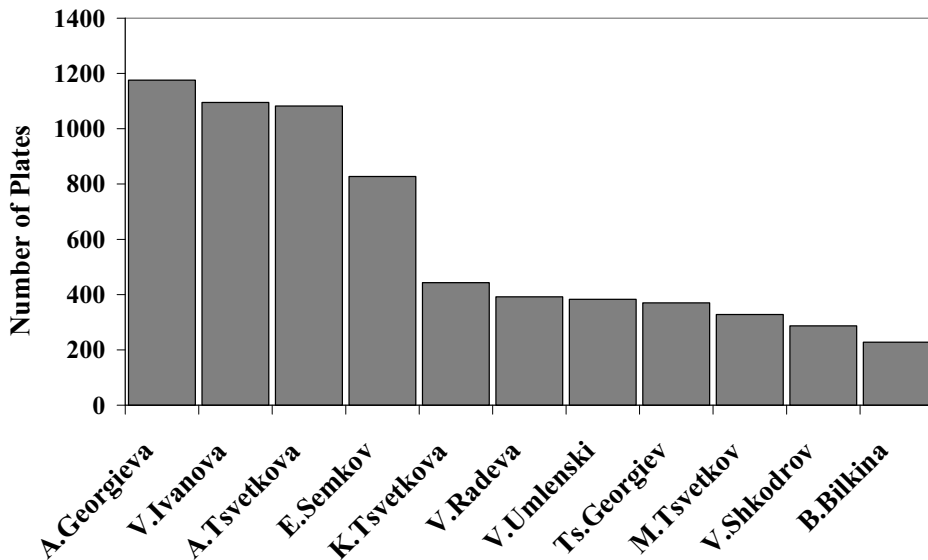


Figure 17. Observers with the Rozhen Schmidt telescope

3. Plate digitization

The total number of both Rozhen Observatory wide-field plate archives is 10093. For such large-scale plate digitization the EPSON flatbed scanners at disposal in the Institute of Astronomy in Sofia (EXPRESSION 1640XL and PERFECTION V700 PHOTO) and in the Rozhen Observatory (EXPRESSION 10000XL) were used. The scanners give good astrometric and photometric accuracies while generating archival quality digital data, and have fast scanning speeds.

Table 4 presents the main parameters of the available flatbed scanners: Optical density (Dmax), Colour depth (bit internal/bit external), Grayscale depth (bit internal/bit external), Maximum hardware resolution.

Table 4. Main parameters of the Rozhen Observatory available flatbed scanners

EPSON Scanner	Optical density (Dmax)	Colour depth (bit int/ bit ext)	Grayscale depth (bit int/ bit ext)	Resolution (dpi)
EXPRESSION 1640XL A3	3.6	42/42	14/14	1600x160
EXPRESSION 10000XL A3	3.8	42/42	16/16	2400x4800
PERFECTION V700/750 PHOTO	4.0	42/42	16/16	4800x9600

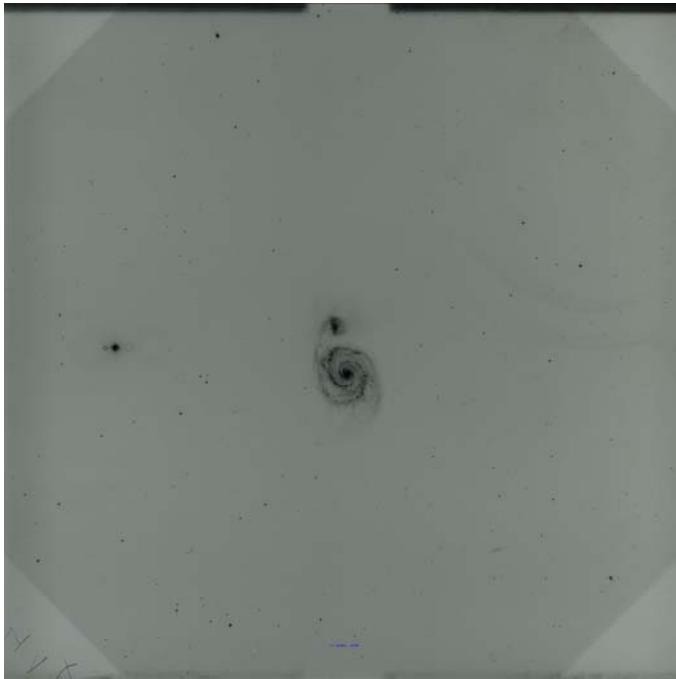


Figure 18. Preview image of the ROZ200_000417 plate retrieved from the WFPDB homepage

All available 1100 2m RCC telescope plates are scanned using the software Scanfits developed ad hoc by S. Mottola (Barbieri et al. 2003) with 1600 dpi (16 mic/pixel) high resolution. The output files are in FITS format. The scale of the 2m RCC telescope (13 arcsec/mm) is suitable for astrometric measurements and that is why a method for plate digitization with additional 90⁰ plate rotation was developed. Parallel with the high resolution scans a system for quick plate visualization – plate preview, was developed aiming easier web accessibility and to store the information from the observer marks on the plate (Fig. 18). The previews are made with 600 (or 1200) dpi in TIFF format and compressed 2000x2000 pxl JPEG format. An example for downloaded preview image is the given one in Fig. 18, which is obtained with click on the image shown in Fig. 7. Table 5 summarizes the data of the Rozhen Observatory plate digitization. The output files after scanning (in their original file format) of the 2m RCC plates (~0.7TB) are stored on the WFPDB servers and are available upon request.

Recently a new technology for plate scanning was developed using VUESCAN driver (Kirov et al. 2012) and grayscale wedge scanned together with the plate. The output VUESCAN files are in TIFF format. The developed software package converts these output files in FITS format taking the data needed for generation of FITS header from the WFPDB catalogues. The software includes also a possibility to divide both images – of the plate and of the wedge.

Table 5. Rozhen Observatory plate scanning data

WFPDB Telescope Identifier	EPSON Flatbed Scanner	Used Software	Plate Size (cm)	High Res. (dpi)	Low Res. (dpi)	Tel. Scale "/mm arcsec/	Scan Size FITS/TIF (MB)	Scan Size JPEG (MB)
ROZ200	Expression 10000 XL	Scanfits	30x30	1600	600	13	664 FITS	2
ROZ200	Expression 10000 XL	VueScan +rotation	30x30	1600	600	13	664 row TIFF	2
ROZ200	Expression 1640XL	Scanfits	30x30	1600	600	13	664 FITS	2
ROZ050	Perfection V700Photo	VueScan	16x16	2400	1200	120	430 row TIFF	2

The 2m RCC telescope original logbook (in two volumes with 260 pages) was scanned with the Zeutschel - OS1200 flatbed scanner in the Institute of Mathematics and Informatics of the Bulgarian Academy of Sciences (with data volume about 305 MB). The logbook and 1043 plate previews (about 1.6 GB) are visible online via search query in the WFPDB.

The work on the Rozhen Observatory wide-field plate archives is supported by the BG NSF DO-02-273.

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- Tsvetkova, K., Tsvetkov, M., Kirov, N., 2012b, *Publ. Astron. Soc. Rudjer Bošković*, accepted
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