

DIGITAL ARCHIVE OF THE ASTROGRAPH PLATES STORED AT THE INASAN ZVENIGOROD OBSERVATORY

S. V. Vereshchagin and N. V. Chupina

*Institute of Astronomy of the Russian Academy of Sciences,
48 Pyatnitskaya st., Moscow, Russia; svvs@ya.ru*

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Abstract. The plate collection of the Zvenigorod 40-cm Carl Zeiss astrograph, obtained in 1972–2003, contains direct photographs of star fields, comets, asteroids, Pluto, and Mars. The electronic library of images from photographic plates was created from scanning the astronomical negatives. We present information on programs scheduled at the telescope and the structure and maintenance of the plate stacks. We also list the plates with images of asteroids and comets. Access to all our plate lists is provided at the web sites of the Institute of Astronomy (INASAN) and WFPDB. It is possible to select plates by the date of observation, by the coordinates of the sky area, by the object type. Preview images can be inspected.

Key words: astronomical databases – techniques: digitizing – asteroids – comets

1. INTRODUCTION

The plate archive was created by observers of the Zvenigorod observatory during more than a quarter-century, till 2003. The Zvenigorod astrograph, shown in Figure 1, has the focal length $F = 200$ cm and a wide field: $8.5^\circ \times 8.5^\circ$. The largest possible plate size is 30×30 cm. Such features permit to photograph a long comet's tail positioning it along the plate diagonal. Exposure times of most plates result in a limiting magnitude about 16.5.

The observations were performed on several different programs. Basically, star fields were observed, but a considerable part of the archive are observations of asteroids, planets, and comets. Our archive contains a total of about 4500 glass photographic plates; however, only 3703 of them are listed in the logbooks.

2. BRIEF HISTORY OF THE TELESCOPE

The first program consisted in observations of nine bright quasars (to 18 mag) whose images were quite point-like. It was necessary for construction of an inertial system of coordinates that would form a basis for a catalogue of star positions. Long exposure times were required. The plates were sent to Pulkovo observatory, to the program coordinator, and studied there. Then, the Zvenigorod observatory participated in the program on radio sources identified with optical objects (8% of all the plates). This program, coordinated by N. G. Rizvanov (Kazan Obser-

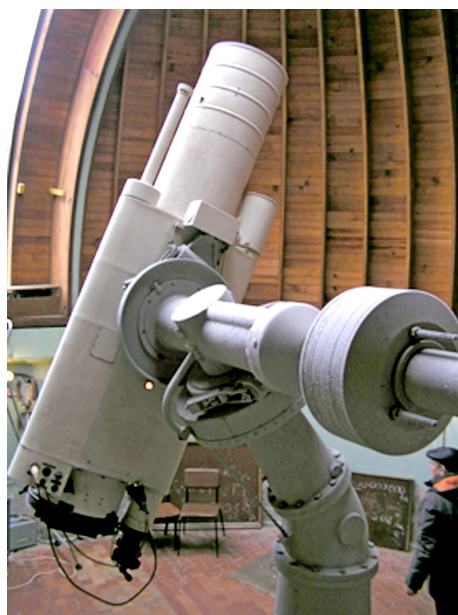


Fig. 1. The Carl Zeiss 40-cm astrograph on the broken mount.

vatory), was aimed at creating a catalogue of reference stars around 190 radio sources.

About one half of all plates were taken in the frame of the program “Photographic review of the sky” (FON) for building the astrometric Photographic Catalog of Proper Motions (FOKAT). The exposures were chosen so that stars to 16.5 mag were clearly visible. Six observatories having telescopes of the same type participated in this program. The work was coordinated by the Main Astronomical Observatory of Ukrainian Academy of Sciences (Goloseevo, Kiev). The program was performed between 1980 and 1992. Each plate had two exposures, with a small shift of the telescope: a long exposure, usually about 30 min, and a short exposure, one–two minutes. The range of declinations was from -2° to $+90^\circ$. The distribution of plate centers provided partial overlapping of the plate fields.

Observations of Pluto and Mars are 3% of all plates. The Pluto program was carried out by V. P. Osipenko in order to improve the orbit. The observations of Mars had to serve expeditions to Fobos planned for 1988–1989. These observations made use of a special filter provided by the Pulkovo Observatory that permitted to observe the satellite in the aureola of Mars. Our observatory was not able to obtain photographs of Fobos.

3. THE ASTEROID PROGRAM

The asteroid program gave 30% of the Zvenigorod plate collection. The program was started in 1980 on behalf of the IAU. It was a subprogram of photographic observation of selected asteroids. The target of the main program was to improve the position of the Spring Equinox point. Each plate had three or

Table 1. The list of asteroids.

Asteroid No.	Name	No. of plates	Asteroid No.	Name	No. of plates
1	Ceres	56	53	Kalypso	1
2	Pallas	87	148	Gallia	71
3	Juno	88	150	Nuwa	2
4	Vesta	82	189	Phthia	1
5	Astraea	1	389	Industria	54
6	Hebe	104	432	Pythia	1
7	Iris	44	480	Hansa	11
11	Parthenope	76	532	Herculina	56
16	Psyche	1	568	Cheruskia	8
18	Melpomene	86	582	Olympia	16
25	Phocaea	58	594	Mireille	2
36	Atalante	1	704	Interamnia	19
38	Leda	1	1301	Yvonne	7
39	Laetitia	81	1303	Luthera	1
40	Harmonia	93	4179	Toutatis	3

four exposures, with the camera shifted by declination between them. Thus, the sequence of images of a minor planet is inclined to image sequences of stars, and it is easy to find the asteroid. Equatorial coordinates were calculated and sent to the Minor Planet Center.

Asteroid 4179 Toutatis is of particular interest as an object closely approaching the Earth. However, our astrograph was found not suitable for observations of such objects: its limiting magnitude is about 17 mag, whereas asteroids approaching the Earth have magnitudes in the range from 19 mag to 26 mag. The list of asteroids observed in Zvenigorod is given in Table 1.

4. OBSERVATIONS OF COMETS

Comets were observed with two aims in mind: (1) studies of cometary tails (resolving tails into details, search for condensations in the tail image, traces of turbulence, etc.), see Figure 2, and (2) determinations of precise coordinates.

To study the tail, the plate was placed so that the tail crossed it along its diagonal and the guide star was near the comet head. We were thus able to obtain images of tails as long as 7° (25 cm). Our images of comets are interesting for studies of their morphology and its variations during the period covered with observations.

To find coordinates of a cometary nucleus with an uncertainty of 3–5'', chains of five exposures were photographed. Of the five images, the optimal star-like image was chosen for measurements of the nucleus.

Table 2 lists the comets verified in the JPL Small-Body Database. It contains identifications (comet names, according to the JPL database) and the number of plates in the Zvenigorod Observatory plate archive for each comet. When searching for physical parameters of comets and their orbital data, the resource <http://ssd.jpl.nasa.gov/sbdb.cgi> is helpful.

5. DIGITAL ARCHIVE

We are currently digitizing our plate archive according to requirements of the



Fig. 2. Comet Hyakutake (1996 April 8). Photo by V. P. Osipenko. The tail length is 5° . Long narrow threads are the ionic tail. The wide tail consists of dust.

Table 2. List of the comets of the Zvenigorod Observatory plate archive.

Name	No. of plates
108P/Ciffreo (1985p)	3
C/1983 H1 (IRAS–Araki–Alcock = 1983d)	7
1P/Halley (1982i)	20
9P/Tempel 1 (1982j)	2
161P/Hartley–IRAS (1983v)	10
146P/Shoemaker–LINEAR (1984u)	4
21P/Giacobini–Zinner (1984e)	41
C/1996 B2 (Hyakutake)	30
C/1995 O1 (Hale–Bopp)	18
27P/Crommelin	18
81P/Wild 2	3

Data Center in Sofia. The process of scanning and archiving all astrograph negatives was started in 2004. Like many other observatories, we apply the standard scanner EPSON Expression 1640XL. The oldest negatives were scanned first. The database with the results of our scanning will be placed at the INASAN, in the USB- and DVD-disk archive.

Certainly, a scan is not identical to the original plate, the accuracy of a scan is considerably poorer. However, if someone requires improved information on an object from any plate, it is possible to use the original plate directly.

The information about our group, tools, the size and characteristics of the Zvenigorod Observatory plate archive is presented at the INASAN web site: <http://www.inasan.ru/rus/scan/>. This site has the list of plates with equatorial

coordinates of plate centers, observation dates, and exposure times. It is possible to search for needed plates by coordinates and/or by date.

The Bulgarian Wide-Field Plate Data Base (WFPDB, <http://draco.skyarchive.org/>) provides much better possibilities for search and image viewing. The WFPDB search by coordinates or plate number permits not only to obtain complete information about the plate and observatory but also to see a preview image, a photo of the original log of observations, and the plate distribution on the sky.

6. CONCLUDING REMARKS

Information about the Zvenigorod plate collection was published in Samus et al. (2006). Later, a general description of our archive and its maintenance was presented in Vereshchagin et al. (2010) and Dluzhnevskaya et al. (2010). See also http://aquila.skyarchive.org/7_BSAC/index.html

In this paper, we have tried to draw special attention to the data available on asteroids and comets. Attention to near-earth objects is growing, and we encourage those interested in using our archive for their work on these problems.

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