Large surveys with small telescopes:
Past, Present, and Future
(Astroplate III)

2019 March 11 – 13, Bamberg, Germany

MONITORING OF SPACE OBJECTS USING ODESSA OBSERVATORY NETWORK OF TELESCOPES

S. M. Andrievsky[1], N. V. Bazyey[1], V. V. Zhukov[2], N. I. Koshkin[1], V. I. Kashuba[1], S. G. Kashuba[1], Yu. M. Gorbanev[1], P. P. Sukhov[1], S. V. Podlesnyak[1], S. N. Udovichenko[1], L. E. Keir[1]

[1] Astronomical Observatory of Odessa National University, Odessa, Ukraine, smandrievsky@onu.edu.ua
[2] Skyline Electronics Ltd. Co., Odessa, Ukraine, vadim@skyline.od.ua

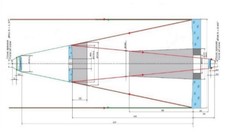
Abstract

In this paper we are presenting optical telescopes of Astronomical Observatory of I. I. Mechnikov Odessa National University. We are describing technical characteristics and scientific program for each telescope. Here we also present a description of the tools with which the unique collections of astroplates were obtained under the program "The Sky Service". Odessa Observatory (46°.28 N, 30°.45 E, altitude 64 m, observation code 086) it has several observational stations. Among them: Mayaki (46.39° N, 30°.27 E, altitude 25 m, observation code 583) and Kryzhanovka (46°.37 N, 30°.48 E, altitude 40 m, observation code A85). Both stations have a good geographical location, as well as good astroclimate (up to 200 clear nights or part of the night). Telescopes are equipped with modern CCDs and photometric light detectors. Odessa Observatory has its own mechanical and optical workshops that are used for construction the new telescopes and manufacture and repair other astronomical equipment.

OMT-800 (Odessa Multifunctional Telescope)

Location: Mayaki

Main mirror diameter: 800 mm
Telescope effective focal length: 2138 mm
Focal ratio: F/2.67
CCD camera: FLI ML09000
Field-of-view: 59' x 59'
Limiting magnitude: ~ 19.5^m



The optical layout: catadioptric plananastigmat (modif. of N. Fashchevsky)

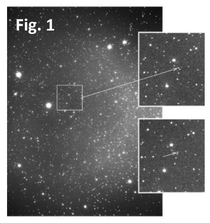


Fig.1. The shot is made with OMT-800 March 3, 2013, 0:00UT (exp. 10 sec). The arrow shows the image of comet C/2012 S1 ISON. The next fragment of the shot was made 25 minutes later (is shown at the bottom right).

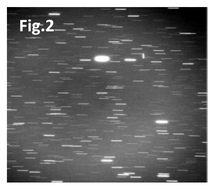
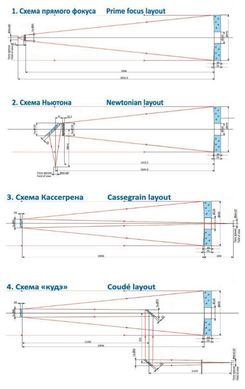


Fig.2. The figure shows a typical image of the sky with the object being tracked

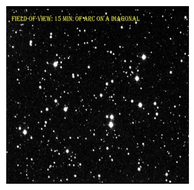
Observation program:
Positional observations of artificial satellites in the geostationary orbits.
Observations of the near-Earth approaching objects.
Observations of the Solar system small bodies (Fig.1, as an example).
In addition, this telescope can be used for the high precision photometric observations of faint objects up to 19 mag.

AZT-3



Location: Mayaki

Main mirror diameter: 480 mm
Telescope effective focal length: 2024 mm
Focal ratio: F/4.5
Camera: UAI CCD ICX429ALL
Field-of-view: 12.0’ x 8.5'
Limiting magnitude: 17^m



CCD image of variable stars

The optical layout: Prime focus, Newtonian (used now), Cassegrain and Coudé

Observation program:
Photometric studies of short-period variable stars of various types are conducted:
RR Lyr, δ Sct, SX Phe, β Cep etc.

Archive of astronomical negatives obtained with AZT-3
Number of plates (1969-1992): about 1,000
Plate size: 40 x 40 mm
Field-of-view: 60’ x 60'
Emulsions: Agfa Astro, ORWO (ZU1, ZU-2, ZU21, ZP-1, ZP-3)
Studied objects: variable stars, comets, asteroids and satellites

20” Cassegrain Reflector

Location: Mayaki

Main mirror diameter: 480 mm
Telescope effective focal length: 11047 mm
Focal ratio: F/23.0

Photo of GEO

Additional Wide-field lens: «Tair-19», F=500 mm, D = 16,7 mm

Limiting magnitude: ~ 13.5^m

The optical layout: Cassegrain

Light sensor: High speed photometer based on PMT FEU-79 with Johnson-Cousins UBVRI color filters system

Wide-field lens "Tair-19"

Observation program:
Multicolor photometry of GEO in pulse counting mode.
From 2003 to 2019, the largest in Europe standardized photometric database for geostationary satellites was accumulated. The database includes: photometric, dynamic, and optical-geometric characteristics of the GEO. At the beginning of 2019, it contained about 1900 light curves of 170 GEO.

Schmidt-type telescope

Location: Kryzhanovka

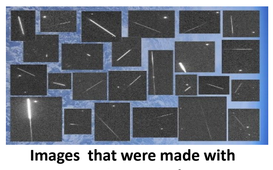
Main mirror diameter: 271.25 mm
Diameter of the correction plate: 219.2 mm

Telescope effective focal length: 0.44 m

C/2018 Y1 Iwamoto 13/14.02.2019

Focal ratio: F/2
Field-of-view: 49.5' x 37.4'
Limiting magnitude: ~ 19.2^m

CCD camera: Videoscan-415-2001

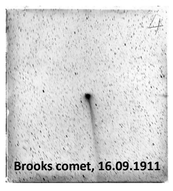


Images that were made with meteor patrol

Observation program:
From 2003 to 2015 Schmidt telescope was equipped with TV camera WATEC LCL-902K and it was used for the regular patrol observations of the meteor events. During that period 2345 meteor phenomena were observed. The time resolution of obtained data is 0.02 s and angular resolution is up to 1 arcsec.
In 2015 this telescope was modernized and equipped with the Videoscan-415-2001 camera (exposure time is 0.0029 - 40 s). Since that time the telescope is also used for the cometary tails observations.

The Odessa archive of astronegatives

Double astrograph with 120 mm Unar lenses

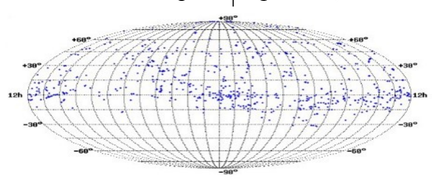


Brooks comet, 16.09.1911

SIMEIZ COLLECTION (1909 – 1953)

Location of Double astrographs: Simeiz (1909-1942, 1944-1953), Kitab (1942-1944)
Plate size: 130 x 180 mm
Emulsion: more than 10 varieties
Field-of-view: 11.9 x 16.2 deg

Limiting magnitude: m_{pg} ~ 15
Exposure time: up to 2 hours
Studied objects: small bodies of the Solar System
Number of plates: about 8,000
Digitized: 5,500



Distribution 887 plates SIM012A in the sky, the projection of the Molveide (http://www.wfpdb.org/ftp/WFPDB/archives/SIMEIZ/)

THE “OLD COLLECTION” (1951-1957)

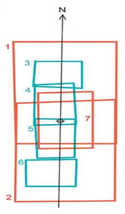
Obtained on three instruments: "Large" Astrograph ("Cook"), "Small 2-camera" Astrograph and 3-camera Astrograph "Hedgehog"

Location: Odessa
Plate size: 130×180, 180× 180 and 180×240 mm
Emulsions: Ilford, Agfa Astro, "Isoorto" with yellow, red filters and without filters
Field-of-view: 24 x 33 deg

Guide stars: 64 (+35 single stars)
Limiting magnitude: m_{pg} ~ 13.5
Exposure time: from 0.5 to 3 hours
Studied objects: variable stars, comets, asteroids
Number of plates: about 10,000

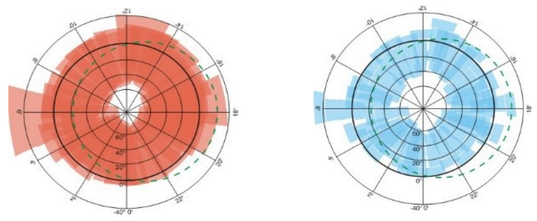
COLLECTION OF “THE 7-CAMERA ASTROGRAPH” (1957-1998)

The 7-camera astrograph



Location: Mayaki
Plate size: 130×180,180×240 mm
Field-of-view: 30 x 80 deg
Emulsion: Agfa Astro, ORWO, with yellow filters and without filters
Guide stars: 39 (+75 single stars)

Limiting magnitude: m_{pg} ~ 14.5, **m_{pv}** ~ 12
Exposure time: 30 min
Studied objects: variable stars («Sky service»)
Number of plates: about 84,000
Digitized: about 400

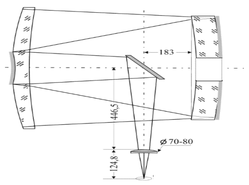


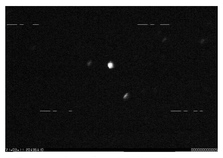
Scheme of covering the celestial sphere with and without filters (7-camera astrograph)

The total number of plates in the Odessa collections contains more than 100,000 wide-angle images of the sky (1909 – 1998)

Cinematic Theodolite KT-50

Location of KT-50: Odessa, Taras Shevchenko park
Main mirror diameter: 500 mm
Telescope effective focal length: 2000 mm
Light sensor: TV-CCD Watec-902H2 + TV tuner (since 2005) (pixels: 752×582, unit cell size 8.6μm×8.3μm).
Limiting magnitude: ~ 12^m
The optical layout: Catadioptrical
Field-of-view: 11.1’ x 8.3’
Photometry acquisition: the most active photometric telescope





Example of satellite image

Observation program:
Tracking of satellites in LEO (Low Earth Orbit in the altitude range of 350 ÷ 5000 km);
Imaging of satellites on the background of stars at 25 fps.
Photometry of satellites with magnitude up to 10-12 mag.
The standard deviation of astrometric measurements of satellites is ≈0.6 arcsec.
The database on the satellites orbital characteristics and the Atlas of their light curves have been created, which includes more than 8500 records for ≈500 objects.
(http://dspace.onu.edu.ua:8080/handle/123456789/8480)

Instruments of past years

Old meteor patrol (1957-1993)

(D=100 mm, F=250 mm)

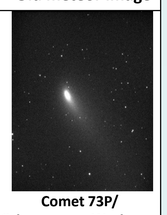
Location: Mayaki
Film frame size: 180 x 240 mm
Emulsion: for aerial photography
Cameras: 4 cameras of NAFA 3C/25 type + obturator
Field-of-view: 39x53 deg
Studied objects: basic and non-basic meteors
Number of images: up to 2000
Note: was stopped in 1993

Old meteor image

RC-600 (2005-2012)

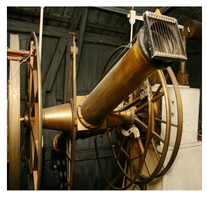
(D=600 mm, F=4800 mm)

Location: Mayaki
Focal ratio: 1:8
CCD camera: FLI ML1001E
Objects: space debris, GEO, comets and asteroids
Field-of-view: 17.67' x 17.67'
Limiting magnitude: ~ 17.5
The optical layout: Ritchey-Chretien system
Note: was stopped in 2012 for reconstruction



Comet 73P/ Schwassman-Wachman

Meridian circle (1871-2000)



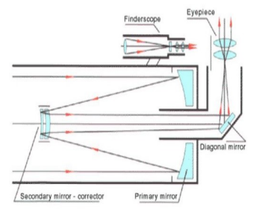
Lens diameter: 135 mm **Focal length:** 1980 mm
Diameter of reading circles: 988 mm

Observation program:
This telescope performed astrometric tasks. Over 80 years of observations, 10 catalogs were compiled, the most recent of which was the catalog of the giant planets (in 2000).

Telescopes under construction

TAL-250K

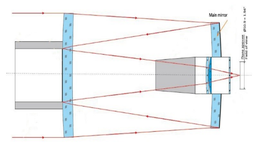
Location: Mayaki
Main mirror diameter: 250 mm
Focal length: 2130 mm
Focal ratio: F/8.5
Limiting magnitude: 14^m
Field-of-view: 33’ x 13’
Camera: FLI ML8300



The optical layout: Klevtsov system

Cinematic Theodolite Station (CTS)

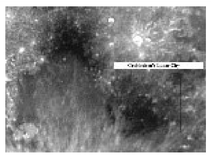
Location: Mayaki
Inlet diameter: 230 mm
Focal length: 1500 mm
Focal ratio: 1:6.5
Limiting magnitude: 16^m
Field-of-view (for sensor KAF-09000): 82.5’ x 82.5’



RC-400

Location: Mayaki
Main mirror diameter: 400 mm
Focal length: 3200 mm
The optical layout: Ritchey–Chrétien system

Program: Search for non-stationary phenomena on the Moon, excursions



A ring feature against the Gruithuisen's Lunar City background

Conclusions:

As can be seen from this presentation, the Odessa Observatory possesses sufficiently powerful scientific potential in observational astronomy with a small telescopes. The basis of this potential was laid down by several generations of Odessa astronomers. Even in our not easy time, when the government of our country is offering insufficient help to science (in particular, to astronomy), astronomers of the Odessa Observatory nevertheless try to keep those traditions. We are ready to consider proposals for international cooperation and participation in international observing programs and campaigns.