

Research Institute of Astronomy, Department of Astronomy and space informatics

V.N. Karazin Kharkiv National University, Kharkiv, Ukraine



Vadym Kaydash, Ivan Sliusarev, Sofiia Denyshchenko

V.N. Karazin Kharkiv National University

One of the oldest universities in Eastern Europe.
Founded in 1804, on the initiative of the prominent
scientist and enlightener Vasyl Karazin (1773-1842)

Astronomical observatory & Chair of astronomy



Grigory Levitskiy (1852–1917) Liudvig Struve (1858 -1920) Otto Struve (1897-1963) Nikolay Barabashov (1894–1971)

1808: The astronomical laboratory, systematic training and astronomical studies.

1824: Department of astronomy

1883: Permanent Astronomical Observatory

1918: N. Barabashov began studies of the Moon and planets



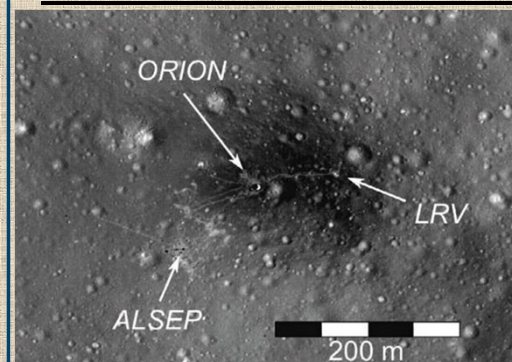
Kharkiv University is the only university in Ukraine where three Nobel Prize laureates studied and worked:

- biologist **Ilya Mechnikov**,
- economist **Semen Kuznets**,
- physicist **Lev Landau**.

Institute of Astronomy - Core areas of research

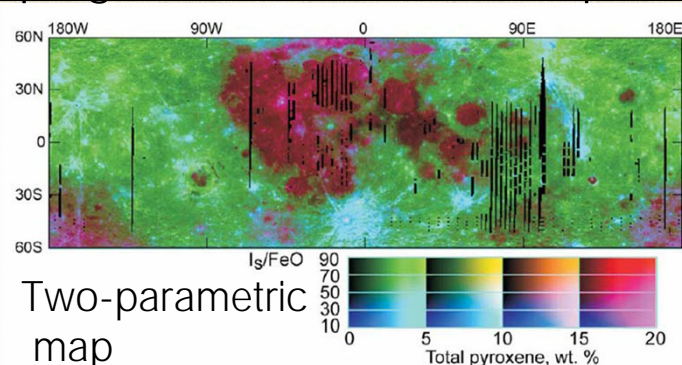
Composition and structure characteristics of the lunar and planetary surfaces and atmospheres (combining ground-based telescope and spacecraft observation data) [**Lunar and Planetary group**]

- Surface microstructure at the sites of
Spacecraft landings

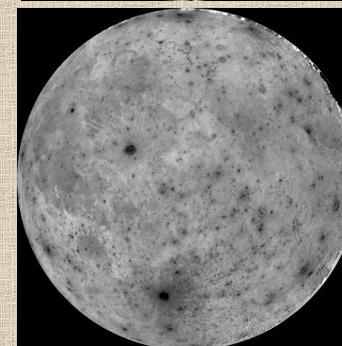
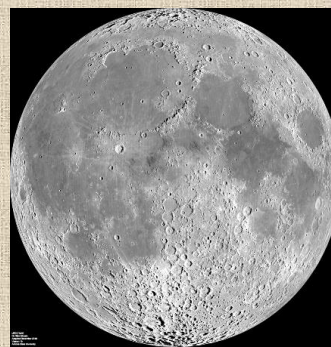


(Apollo-16
Landing Site).

- Mapping of lunar surface composition

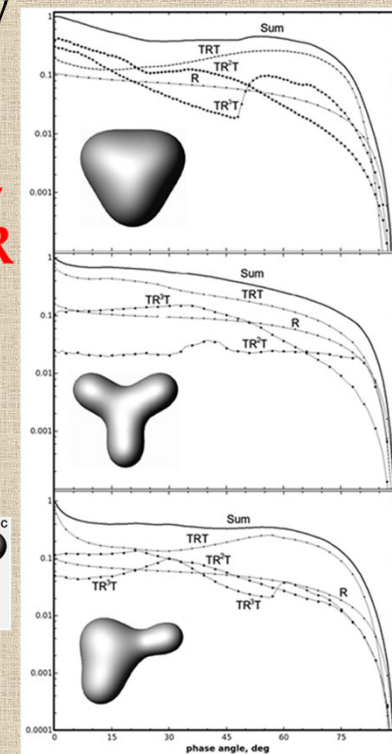
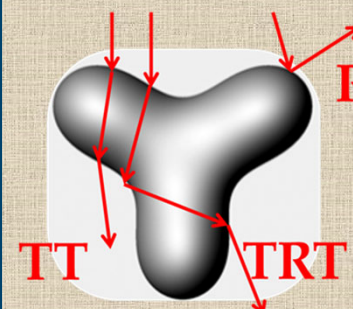


- Lunar polarimetry



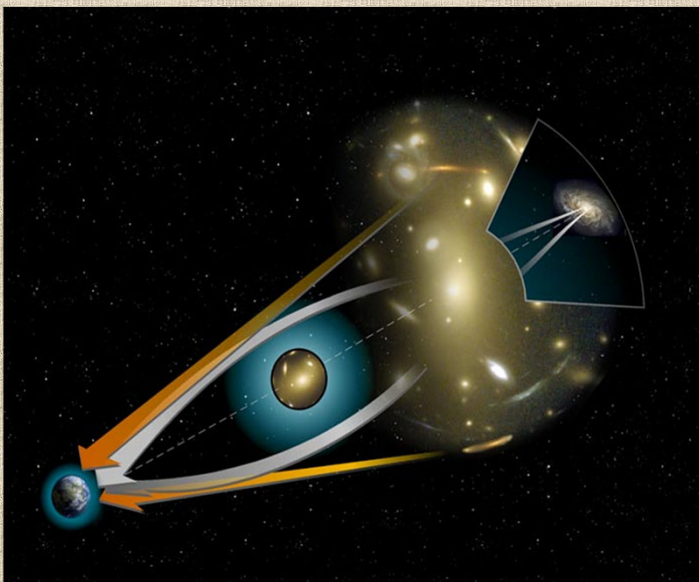
Polarization degree
 P_{min} ($=0.52 \mu\text{m}$)

- Modeling of light scattering
from irregularly
shaped surfaces



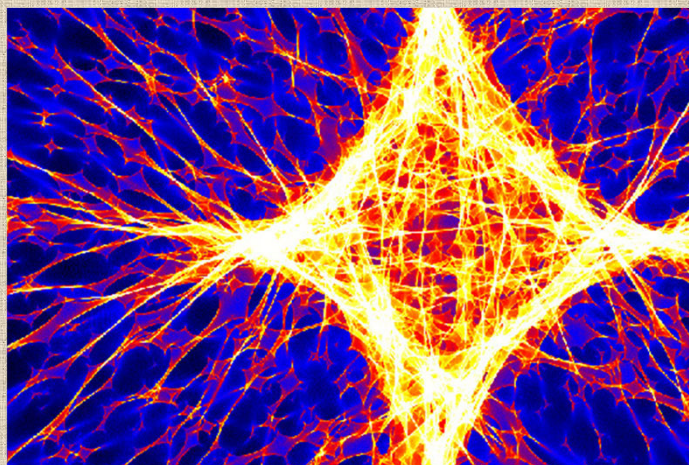
Institute of Astronomy - Core areas of research

Investigation of gravitational lensing phenomena. Computer simulation of Active Galactic Nucleus [**Department of Astrophysics**]

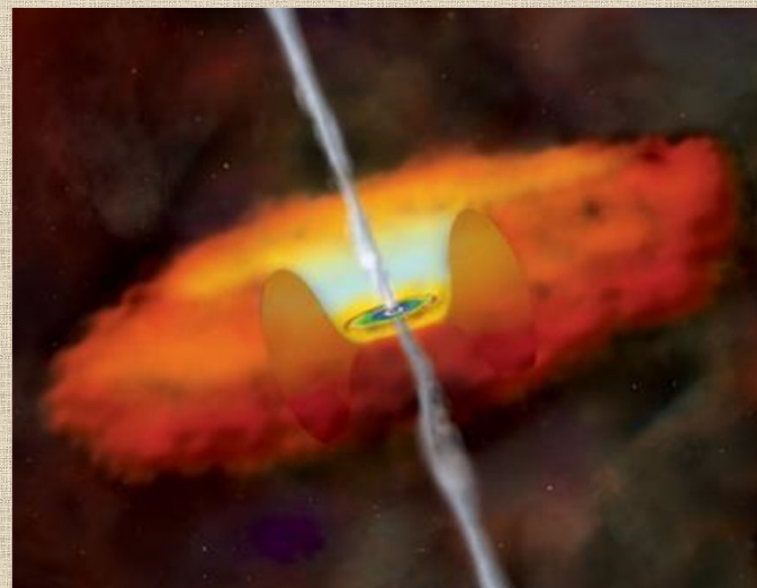


Gravitational lens in space

Gravitational microlensing modeling



Caustic pattern
(Building of lensing galaxy model using GPU CUDA technology)

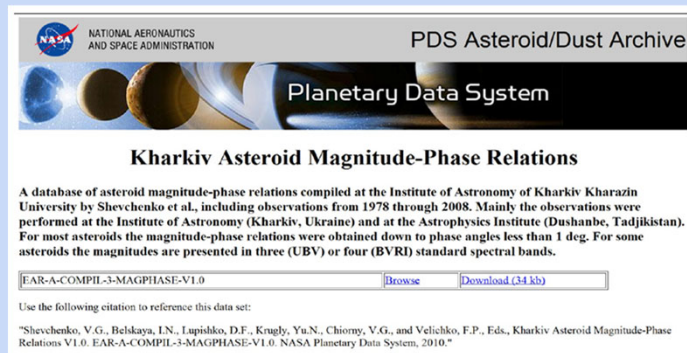


Modeling of active galactic nucleus. Computer simulation of accretion disks in AGNs. Explanation of specific rotation of galaxies

Institute of Astronomy – Core Areas of Research

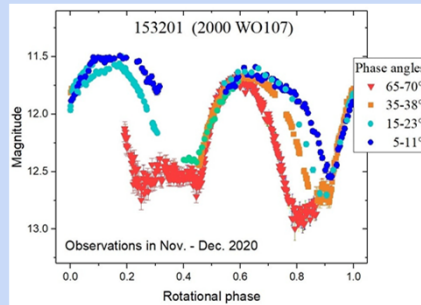
Physical and Dynamical Properties of Asteroids: Observations & Modeling [Department of Physics of Asteroids and Comets]

Photometry of asteroids (optical properties, rotation, sizes, shapes)



Shevchenko+ 2022, A&A

- Monitoring of **potentially hazardous asteroids**

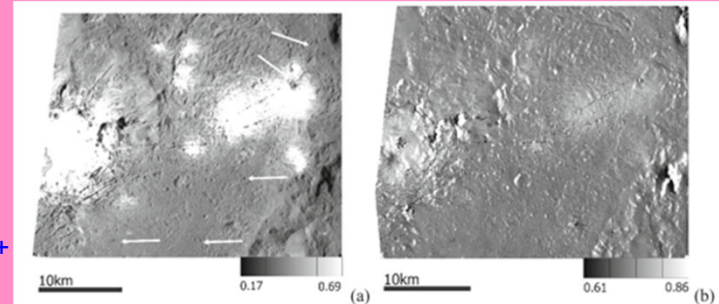


Krugly+ 2025, A&A

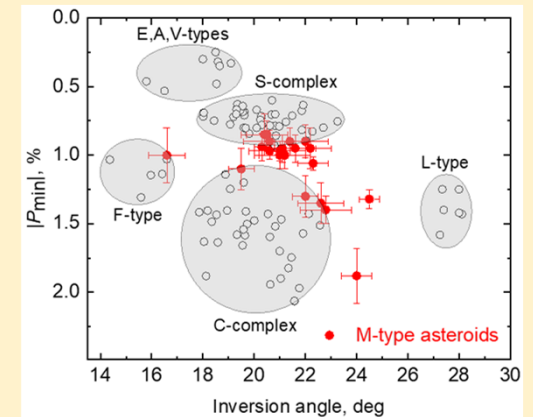


Identification of regolith structure anomalies on atmosphereless Solar System bodies

Slyusarev+ 2025

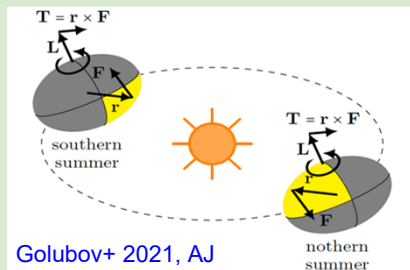


Polarimetry of asteroids (albedos, regolith properties, taxonomy)

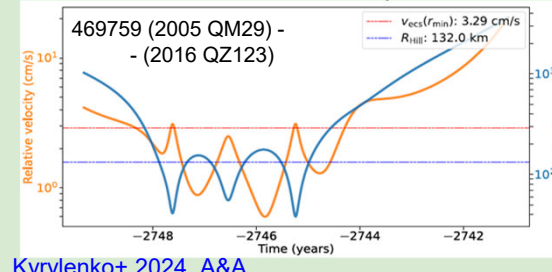
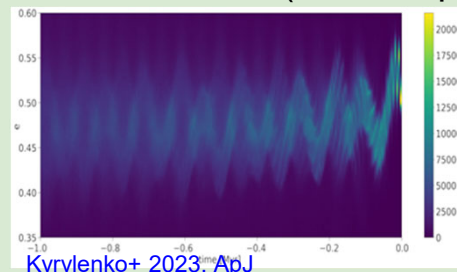


Belskaya+ 2022, A&A

- Theoretical and numerical modeling of the **Yarkovsky & YORP effects**



- Modeling of **orbital evolution** (asteroid pairs, links with meteorites)

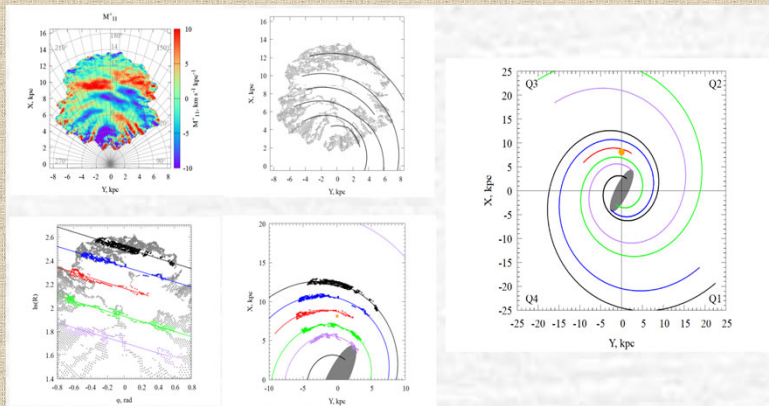


Institute of Astronomy - Core areas of research

[Laboratory of Astrometry]

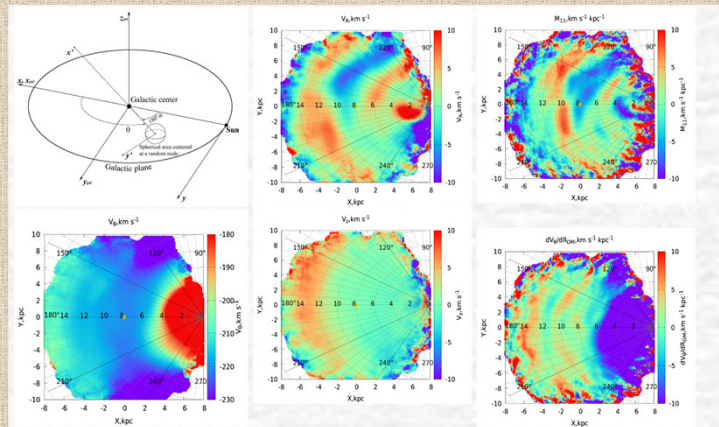
- Creation of high-precision astrometric catalogues
- Astrometry after ESA's Gaia astrometric satellite
- Studying kinematical properties of our Galaxy

✓ Determining the parameters of the spiral arms of the Galaxy from kinematic tracers

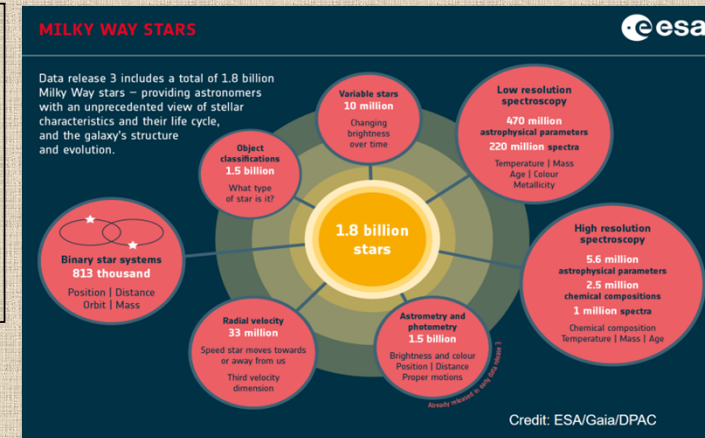


S. I. Denyshchenko, P. N. Fedorov, V. S. Akhmetov, A. B. Velichko and A. M. Dmytrenko Determining the parameters of the spiral arms of the Galaxy from kinematic tracers based on Gaia DR3 data, submit to MNRAS 2023.

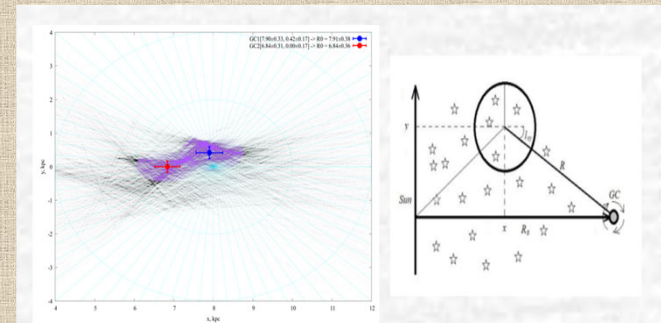
✓ Mapping the kinematic parameters of the Galaxy



P.N. Fedorov, V.S. Akhmetov, A.B. Velichko, A.M. Dmytrenko, S.I. Denyschenko Mapping the kinematic parameters of the Galaxy from the Gaia EDR3 red giants and sub-giants // Monthly Notices of the Royal Astronomical Society, 2023, Vol. 518, p. 2761



✓ The vertex coordinates of the Galaxy's stellar systems



A. M. Dmytrenko, P. N. Fedorov, V. S. Akhmetov, A. B. Velichko and S. I. Denyschenko The vertex coordinates of the Galaxy's stellar systems according to the Gaia DR3 catalogue // Monthly Notices of the Royal Astronomical Society, 2023, Vol. 521, P.4247.

Department of astronomy and space informatics: student involment in astronomical research

Presenting research
projects to students
(First semester)

Take part in NRFU, MESU
funded projects (MsC)

Attending
scientific
seminars

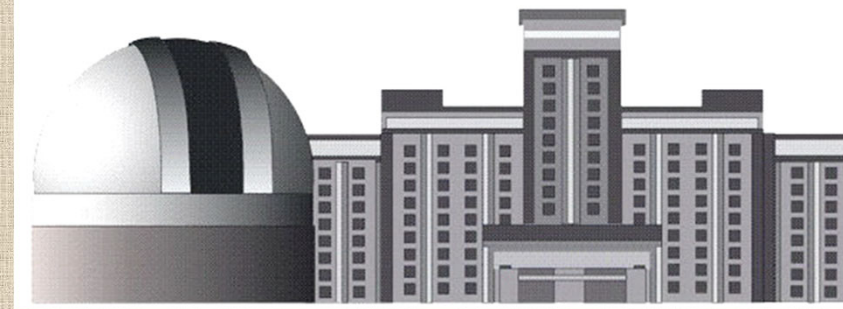
Annual Barabashov'
Readings, Young
scientists
conference...

Astrophysical practicum (hands-on
experience in data collection and
astronomical techniques)

Selecting scientific
supervisor



Institute of Astronomy - role in astronomy education in Ukraine & national research ecosystem



1. Participation in competitive selections of research and development projects:

- a) Competitions the Ministry of Education and Science of Ukraine (10 projects for last 5 years)
- b) Competitions of the National Research Foundation of Ukraine (1 project - as PI, 2 projects - Co-I for last 5 years)

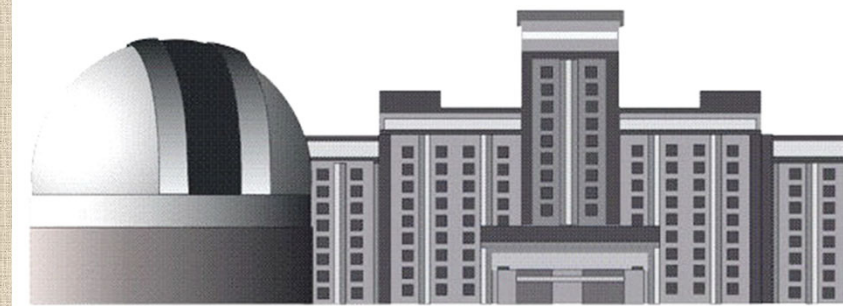


2. Expert activities

- a) Participation of employees in scientific expertise of projects of NRFU, MESU, Horizon 2020, NSF USA, Dutch Research Council
- b) Participation in expert groups and commissions of the Natl. Acad. Sci. of Ukraine
- c) Procedures for awarding scientific degree of Doctor of Philosophy or Doctor of Sciences



Institute of Astronomy - role in astronomy education in Ukraine & national research ecosystem



3. Participation in Ukrainian Astronomical Association

(admitted to the European Astronomical Society, acting as the Ukrainian National Committee of the International Astronomical Union)



4. Complete cycle of astronomy education:

1. *College*

- a) Junior Academy of Sciences of Ukraine (5-10 per year)
- b) Regional Astronomy Olympiad (50 per year)



2. *University*

- a) Bachelor (5-10 per year)
- b) Master (5-10 per year)
- c) PhD programs (1-2 per year)

Dept. of astronomy and space informatics

- **50** undergraduate students
- **3** PhD students
- 1 Bachelor Degree program
- 2 Master Degree program
- 1 PhD program

E5. Physics and Astronomy

Institute of Astronomy and Department of astronomy and space informatics : Pre-war teaching, research capacity and international role

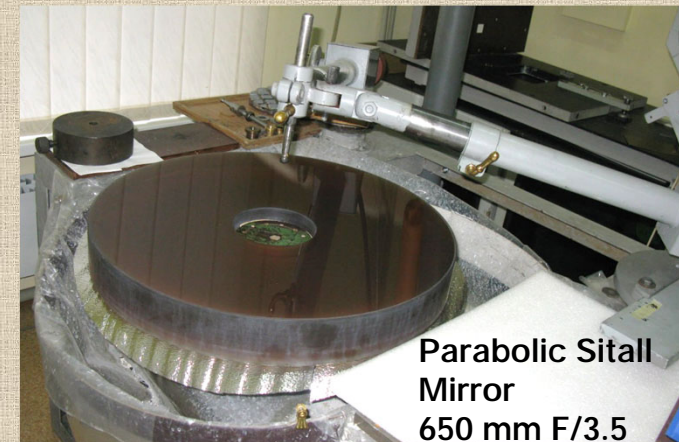
- 4 departments [22 scientific researchers in staff]
- Dept. of Astronomy [~50 students, 4 staff professors, 9 partially employed teachers]



Infrastructure:

- 0.7-m reflector AZT-8: observations of asteroids, space debris
- For educational purposes: the 30 cm Celestron reflector, the 20 cm reflector AZT-7, and the 20 cm Zeiss refractor are used.

Lab. of astronomical optics



Parabolic Sitall Mirror
650 mm F/3.5

Computer cluster:

- 5 graphic processors with support for CUDA technology (50480 CUDA cores) and multi-core central processors (60 cores). The cluster has been in use since 2021.
- Modeling of orbital evolution of asteroids

Astronomical research and education: Impact of the war

1. Relocation of students, teachers, researchers:
[2022] – 75 % researchers+teachers relocated, 50 % students relocated
[2025] – 15-20 % researchers+teachers relocated, 50 % students relocated
2. On-line educational process (due to proximity of battle line)
3. Shelling and power outages
4. The destruction and robbery of the observational stations and equipment have “blinded” astronomy, destroyed the research infrastructure
5. Need for using the astronomical equipment in joint projects/ observations
6. Study programs:
 - Need to restoring access to remote telescopes for student astronomers, enabling them to resume their observational astrophysics practice.
 - Loss of new student astronomers (25-50%)
 - Exchanging experiences in astronomy education.
7. Difficult tasks of restoring the operation of the equipment as war continues

Impact of the war: frontline at the territory of observatory



Combat cluster
unit of the Uragan
MLRS



MLRS combat unit in
front of the University,
02.03.2022



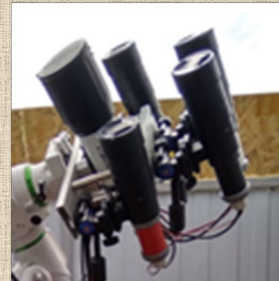
120 mm Tank shells

Shells and parts of
cluster missiles
were scattered on
the Station and
land around it

Destroyed instruments – light detectors

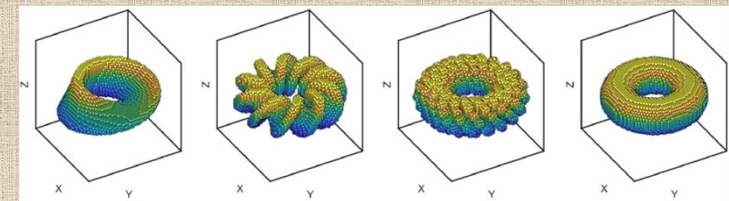
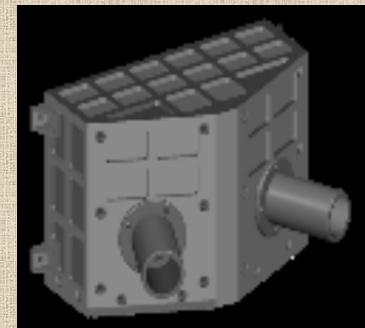
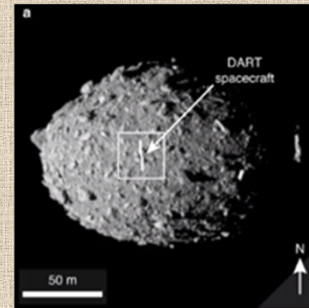


Broken CCD FLI cameras from the AZT-8 and Baker-Schmidt telescopes.
They served as targets in the shooting range of the occupiers.
Five Watec 902H TV cameras on meteor patrol were stolen.



International collaborations during the war

- Use of equipment in joint projects (Bulgaria, Georgia, Kazakhstan observatories)
- Participation in the Science team of NASA DART mission
- Participation in the first polarimetric lunar orbiter experiment (DANURI, Korea)
- Computer and theoretical modeling of lightscattering by particles and surfaces (U.S. Army Research Laboratory Contracts)



Impact of the war: Researchers Abroad, funding from alternative sources

- Grants to support Ukrainian researchers abroad (ex., ALLEA)
- Grants to support Ukrainian researchers in Ukraine (ex., EURIZON)
- PAUSE (Programme d'Aide en Urgence des Scientifiques et des Artistes en Exil), France



- **Problems:** low success rate

Current individual grants

- Italian National Institute of astrophysics
 1. INAF – Osservatorio Astrofisico di Torino, Turin, Italy
 2. INAF – Astronomical Observatory of Capodimonte, Naples, Italy
- Paris Observatory, France

Taking part in scientific bodies of the International Astronomical Union

IAU Working Group and Task Group Members



Iryna Belskaya - vice president of division *F* (*Planetary systems and astrobiology*) of IAU



Yuriy Shkuratov - Task Group for Lunar Nomenclature



Ivan Slyusarev - Task Group for Small Bodies Nomenclature

Scientific forums and conferences: pre-war and current situation

| Year | Conference |
|------|---|
| 2017 | The USERN (Universal Scientific Education and Research Network) Congress |
| 2018 | Atmosphereless Solar System Bodies in the Space Exploration Era |
| 2018 | Second Italy-Ukraine meeting in Astronomy / «Multiwavelength astrophysics from radio to gamma-rays» |
| 2019 | Mega Event «Leonardo and the Moon» |
| 2020 | «Are we alone in the Universe?» III Italy-Ukraine Scientific Meeting |



Astronomical outreach at the time of war

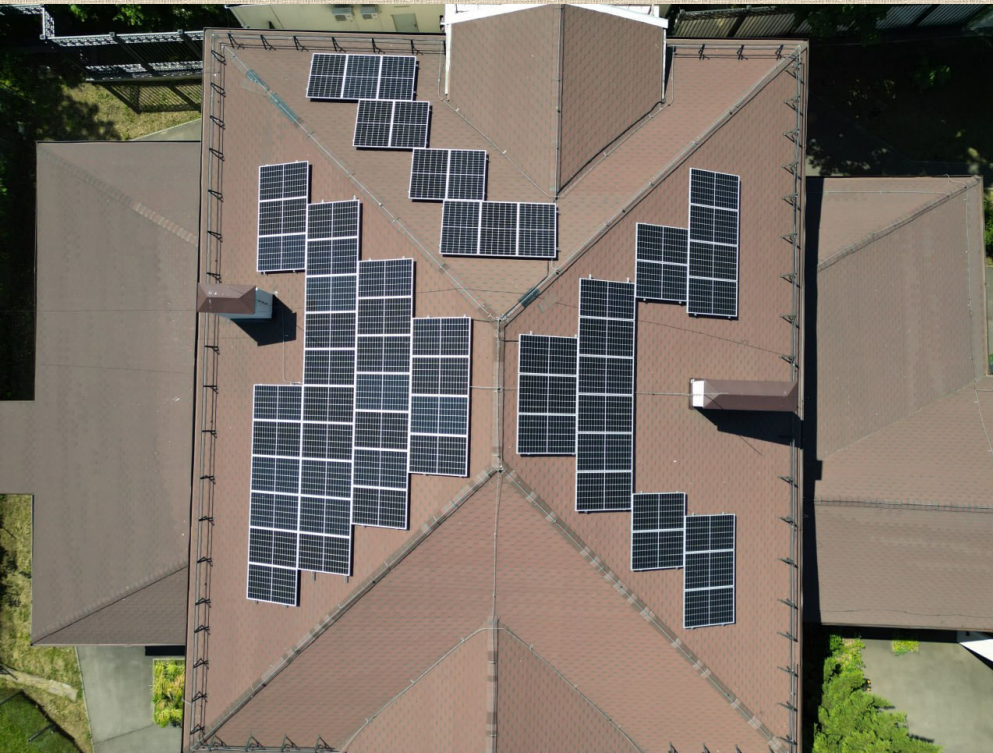


May, 1st 2025 Kharkiv

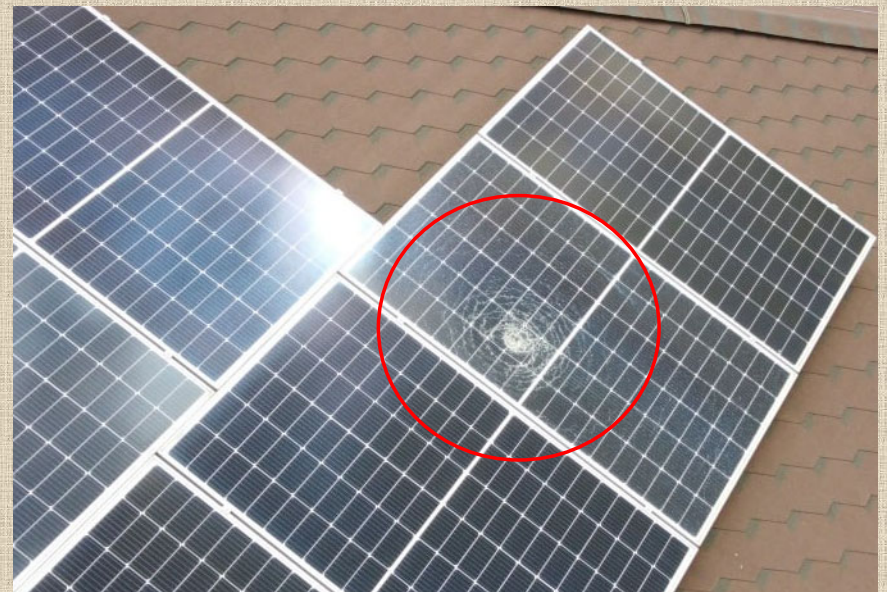
- Science day in Karazin university
- Museums night (May, 17 2025, >500 visitors)
- International Asteroid day (June, 30)

War: shelling and frequent power outages

- Solution: Solar power station 21,6 kWatts.



- A donation from the New University in Exile Consortium to the Karazin Kharkiv University Foundation
- Enable scientists, faculty and students to continue their research and studies throughout the war



Roof of the main building of Astronomy institute

Bullet hit to the solar panel (April 2025)

Fund for the Restoration of the Chuhuiv Observation Station

- http://uk.astron.kharkov.ua/fond/index_u.html
- astrofund@astron.kharkov.ua
- Fundraising for two projects has been announced:
 - Purchase of astronomical instruments (1-1.5 m class telescope)
 - Restoration of the infrastructure of the observation station (~200 k)
- * Ukrainian Astronomical Association
 - Supporting the work of the foundation
 - Individual assistance to astronomers

Current status and strategic vision

Goal: • Overcome the consequences of the war • Preserve the scientific school • Boost observational astronomy in Ukraine •

Solution:

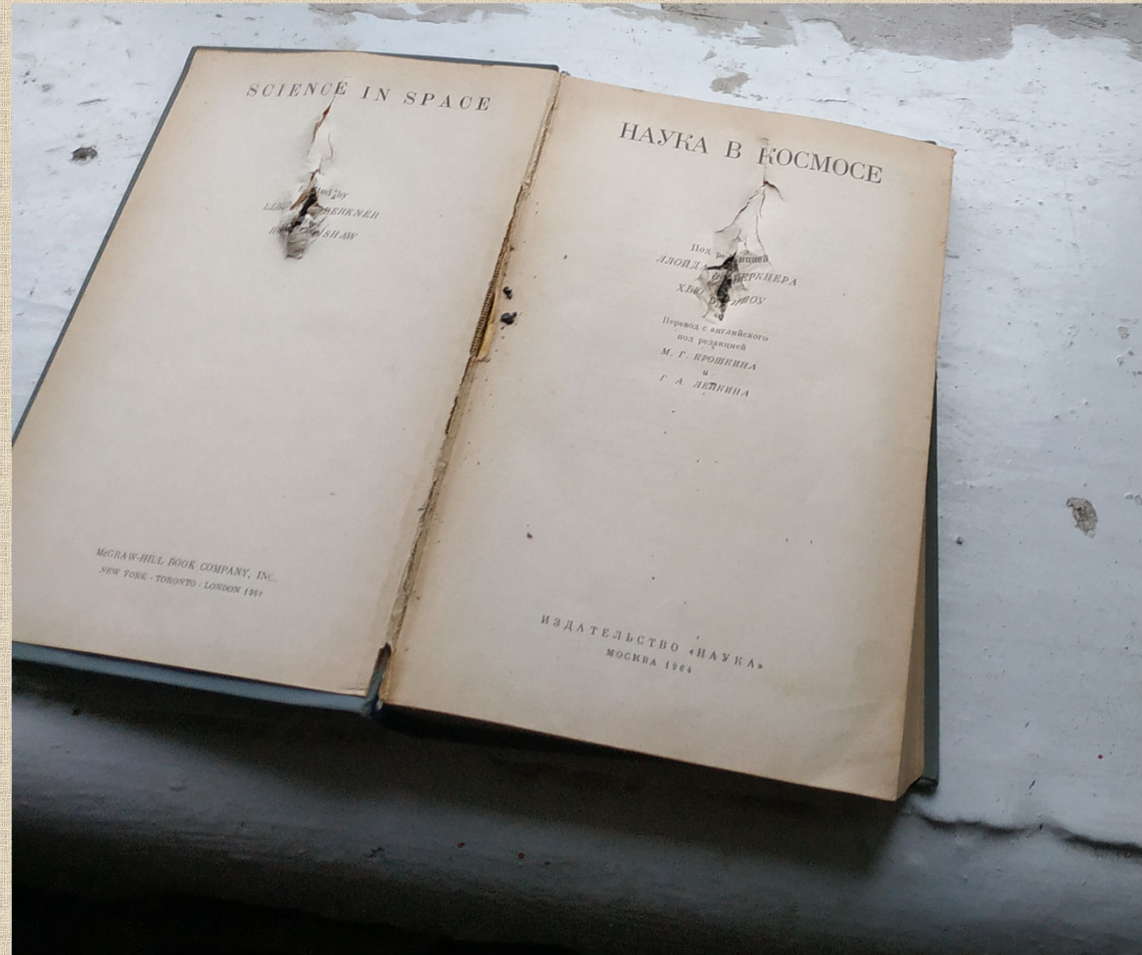
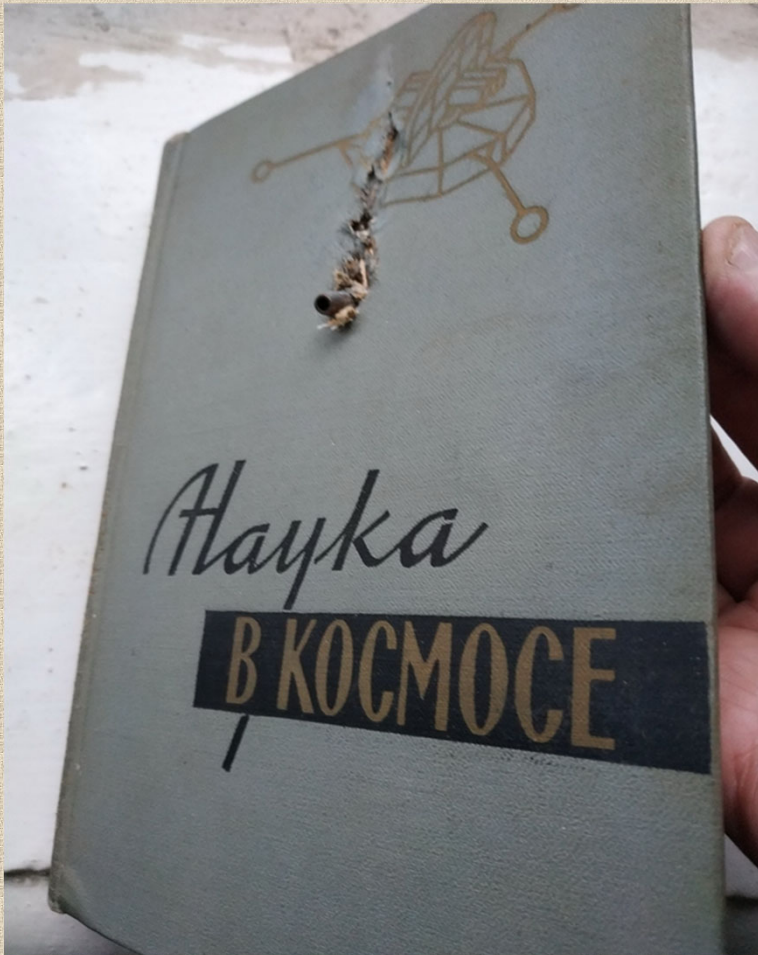
- Cooperation in multilateral projects EU-Ukraine (Horizon Europa, etc.)
- Using observational facilities in joint projects, granted observational time
- Using computing resources and equipment in joint projects
- Access to remote telescopes for student astronomers, enabling them to resume their observational astrophysics practice
- Co-supervising and co-teaching, connecting students via on-line teaching platforms
- Infrastructure recovery

Urgent needs:

- Fill the gaps in funding of fundamental science (**80 k per year** for the full staff of Research Institute of Astronomy)
- Erasmus+ mobility for student astronomers and researchers

**Thank you for your
attention**

Optimistic ending: Science can stop bullets



A book "Science from space" from the library with a 5.45 mm bullet stuck in it

OPTICS OF THE MOON

by YURIY SHKURATOV, GORDEN VIDEEN, VADYM KAYDASH

- Elsevier (2025)
- 890 p.
- 1st Edition,
- Paperback ISBN: 9780128179727
- eBook ISBN: 9780128179734.

38 CHAPTER 1 Lunar histories

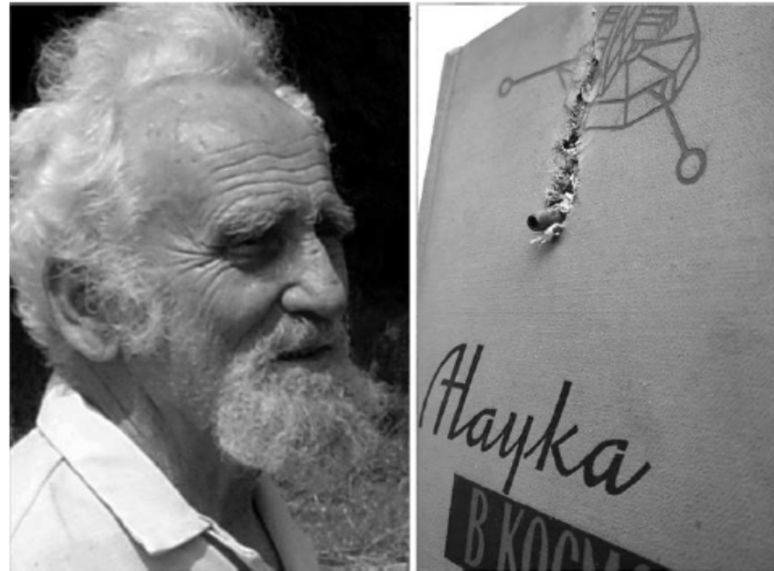


FIGURE 1.22

Leonid Akimov (1937–2016) and a bullet stuck in the Russian-language book *Science in Space*, which was found in 2022 after attacks on the house where Akimov lived and invented his astonishing formula (1.10).

following theoretical disk function that has no parameters besides the angles of illumination/observation geometry:

$$F(\alpha, i, e) = (\cos \beta)^{\frac{\pi}{\pi - \alpha}} \cos\left(\frac{\pi}{\pi - \alpha} \left(\gamma - \frac{\alpha}{2}\right)\right), \quad (1.10)$$

OPTICS OF THE MOON

YURIY SHKURATOV | GORDEN VIDEEN | VADYM KAYDASH

OPTICS
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MOON



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VIDEEN
KAYDASH

