

# Oleksii Sokoliuk

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## RESEARCH INTERESTS

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I'm a cosmologist, mainly interested in the complicated, high resolution simulations of the Large Scale Structure of the Universe within the non-standard theories of modified gravitation or dark matter. As well, I'm trying to alleviate  $H_0$ ,  $\sigma_8$  and other cosmological tensions using MG theories, find new physics in higher order weak lensing statistics.

## WORK EXPERIENCE

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**Research Scholar - Main Astronomical Observatory, NAS of Ukraine** 2021 - Present  
– Laboratory for the Large Scale Structure of the Universe

**Research Scholar - Taras Shevchenko National University of Kyiv** 2019 - Present  
– Kyiv Astronomical Observatory, Lisnyky Observational Station

## EDUCATION

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**BSc (Honours) Physics - University of Aberdeen, UK** Sept 2023 - Jun 2027  
– Supervisor: Prof. Charles Wang

## TALKS & POSTER PRESENTATIONS

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- [1] **Faculty of Physics, Taras Shevchenko National University of Kyiv** 26 Apr - 30 Apr 2021  
27-th Young Scientists' Conference on Astronomy and Space Physics (contributed talk)
- [2] **Faculty of Physics, Odesa I.I. Mechnikov National University** 16 Aug - 20 Aug 2021  
XXI Gamow International Astronomical Conference-School (contributed talk)
- [3] **Faculdade de Ciências da Universidade de Lisboa** 30 May - 1 Jun 2023  
CosmoVerse@Lisbon, First Annual Conference (poster)
- [4] **Kobe International Conference Center, Kobe Port Island** 4 Aug - 8 Aug 2023  
CCP2023 - 34th IUPAP Conference on Computational Physics (contributed talk)
- [5] **Institute for Computational Cosmology, Durham University** 14 Jun 2024  
Friday Lunchtime Astrophysics Talks (FLAT) (invited talk)
- [6] **Institute of Cosmology and Gravitation, University of Portsmouth** Sept 2024  
Theoretical Cosmology seminar (planning to attend) (invited talk)
- [7] **Mullard Space Science Laboratory, University College London** 19 Sept 2024  
UCL Astrophysics seminar (planning to attend) (invited talk)



## SELECTED PUBLICATIONS

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As of June 2024, 20 papers were published in international, peer reviewed journals with 13 papers published as a first author, 2 as a second author. In total, those papers have  $> 230$  citations and  $h$ -index of 10 according to [Google Scholar](#)<sup>g</sup>. Here are some selected publications:

- [1] [Oleksii Sokoliuk](#) and Alexander Baransky. "On the existence and stability of traversable wormhole solutions in modified theories of gravity". In: *Eur. Phys. J. C* 81.8 (2021), p. 781.

- [2] [Oleksii Sokoliuk](#) and Alexander Baransky. “Cosmological constraints on bulk viscous  $f(Q,T)$  gravity”. In: *Astron. Nachr.* 343.5 (2022), e220003.
- [3] [Oleksii Sokoliuk](#), Alexander Baransky, Andrew Khorolskiy, et al. “An X-Ray and Optical Study of the UGSU-Type Dwarf Nova Gaia18awg”. In: *Journal of Physical Studies* 26.3 (Sept. 2022), pp. 3901–3909.
- [4] [Oleksii Sokoliuk](#), Alexander Baransky, and P. K. Sahoo. “Kuchowicz gravastars in the braneworld formalism”. In: *Phys. Lett. B* 829 (2022), p. 137048.
- [5] [Oleksii Sokoliuk](#), Alexander Baransky, and P. K. Sahoo. “Probing the existence of the ZTF Casimir wormholes in the framework of  $f(R)$  gravity”. In: *Nucl. Phys. B* 980 (2022), p. 115845.
- [6] [Oleksii Sokoliuk](#), Alexander Baransky, and Pradyumn Kumar Sahoo. “Non-singular T–K axion stars with/without the dynamical bosonic field in the presence of negative  $\Lambda$  term”. In: *Phys. Dark Univ.* 35 (2022), p. 100972.
- [7] [Oleksii Sokoliuk](#), Zinnat Hassan, et al. “Traversable wormholes with charge and non-commutative geometry in the  $f(Q)$  gravity”. In: *Annals Phys.* 443 (2022), p. 168968.
- [8] [Oleksii Sokoliuk](#), Sanjay Mandal, et al. “Generalised Ellis–Bronnikov wormholes in  $f(R)$  gravity”. In: *Eur. Phys. J. C* 82.4 (2022), p. 280.
- [9] [Oleksii Sokoliuk](#), Sneha Pradhan, et al. “Buchdahl quark stars within  $f(Q)$  theory”. In: *Eur. Phys. J. Plus* 137.9 (2022), p. 1077.
- [10] [Oleksii Sokoliuk](#), Subhrat Praharaj, et al. “Accretion flows around exotic tidal wormholes - I. Ray-tracing”. In: *Astron. Astrophys.* 665 (2022), A139.
- [11] Sanjay Mandal, [Oleksii Sokoliuk](#), et al. “ $H_0$  tension in torsion-based modified gravity”. In: *Nucl. Phys. B* 993 (2023), p. 116285.
- [12] [Oleksii Sokoliuk](#), Simran Arora, et al. “On the impact of  $f(Q)$  gravity on the large scale structure”. In: *Mon. Not. Roy. Astron. Soc.* 522.1 (2023), pp. 252–267.
- [13] [Oleksii Sokoliuk](#), Alexander Baransky, and P. K. Sahoo. “Compact stars admitting Finch-Skea symmetry in the presence of various matter fields”. In: *Chin. Phys. C* 47.1 (2023), p. 015104.
- [14] Fabiano F. Santos, [Oleksii Sokoliuk](#), and Alexander Baransky. “Holographic Complexity of Brane-world in Horndeski Gravity”. In: *Fortschritte der Physik* 71.2-3 (2023), p. 2200141.
- [15] Fabiano F. Santos (including [Oleksii Sokoliuk](#)) et al. “AdS/BCFT Correspondence and Horndeski Gravity in the Presence of Gauge Fields: Holographic Paramagnetism/ Ferromagnetism Phase Transition”. In: *Fortschritte der Physik* 71.12 (2023), p. 2300008.
- [16] [Oleksii Sokoliuk](#) et al. “AdS Black Hole Thermodynamics and Microstructures from  $f(Q)$  Gravitation”. In: *Fortschritte der Physik* 72.1 (2024), p. 2300043.

Observations of near-earth objects and comets were published in 12 Minor Planet Electronic Circulars (MPEC ) and observations of Gamma Ray Bursts in GRB Coordinates Network (GCN .

## COLLABORATIVE PAPERS

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Additionally, within the GRANDMA collaboration, I actively contributed to various publications, engaging in tasks such as observations, data analysis, figure/table creation, and text revision:

- [1] V. Aivazyan (including [Oleksii Sokoliuk](#)) et al. “GRANDMA observations of ZTF/Fink transients during summer 2021”. In: *Mon. Not. Roy. Astron. Soc.* 515.4 (2022), pp. 6007–6022.
- [2] D. A. Kann (including [Oleksii Sokoliuk](#)) et al. “GRANDMA and HXMT Observations of GRB 221009A: The Standard Luminosity Afterglow of a Hyperluminous Gamma-Ray Burst—In Gedenken an David Alexander Kann”. In: *Astrophys. J. Lett.* 948.2 (2023), p. L12.
- [3] T Hussenot-Desenonges (including [Oleksii Sokoliuk](#)) et al. “Multi-band analyses of the bright GRB 230812B and the associated SN2023pel”. In: *Mon. Not. Roy. Astron. Soc.* (2024), stae503.
- [4] I. Tosta e Melo (including [Oleksii Sokoliuk](#)) et al. “Ready for O4 II: GRANDMA observations of Swift GRBs over eight weeks in spring 2022”. In: *Astron. Astrophys.* 682 (2024), A141.

## CONFERENCE PROCEEDINGS & OTHER

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- [1] S. Agayeva (including [Oleksii Sokoliuk](#)) et al. “The GRANDMA network in preparation for the fourth gravitational-wave observing run”. In: *Observatory Operations: Strategies, Processes, and Systems IX* 12186 (Aug. 2022), 121861H.

## IN PREPARATION & UNDER REVIEW

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- [1] Jialian Liu (including [Oleksii Sokoliuk](#)) et al. “Early-Time Observations of SN 2023wrk: A Luminous Type Ia Supernova with Significant Unburned Carbon in the Outer Ejecta”. In: *Astrophys. J.* (2024).
- [2] [Oleksii Sokoliuk](#). “Probing Physics beyond  $\Lambda$ CDM with JWST data up to  $z \sim 17$ ”. In: *Astron. Astrophys.* (2024).
- [3] [Oleksii Sokoliuk](#) et al. “The LANCELOT project: Cosmological simulations for Large Scale Structure in the modified theories of gravitation with massive neutrinos”. In: *Mon. Not. Roy. Astron. Soc.* (2024).

## PEER REVIEW

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|---------------------------------------|---|
| ➤ European Physical Journal C (2022)  | ➤ Indian Journal of Physics (2023)        |
| ➤ New Astronomy (2022)                | ➤ Physics of the Dark Universe (2023 (2)) |
| ➤ Foundations of Physics (2022, 2024) | ➤ Pramana (2024)                          |
| ➤ Scientific Reports (2023)           | ➤ Annals of Physics (2024 (2))            |
| ➤ Annalen der Physik (2023)           | ➤ Physics Letters B (2024) in the process |

## MEMBERSHIPS

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- International Society for Relativistic Quantum Information (ISRQI)
- International Society for Quantum Gravity (ISQG)
- Global Rapid Advanced Network Devoted to the Multi-messenger Addicts (GRANDMA)
- Assembling Galaxies Of Resolved Anatomy (AGORA)
- Insitute of Physics (IoP) Associate Member
- American Astronomical Society (AAS) Undergraduate Student Member

## AWARDS & GRANTS

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Monetary awards (5200\$ total):

- ◆ Scholarship of the President of Ukraine - 1000\$
- ◆ CA21136 ITC Conference Grant for CCP2023 - 2200\$
- ◆ CA21136 Conference Grant for CosmoVerse@Lisbon - 1000\$
- ◆ MAO NAS travel grant -  $2 \times 500$ \$

Computing time allocations (1.65M CPUh total):

- ◆ PI: 1.15M CPUh on IUCAA Pegasus, with Prof. Jiajun Zhang and Prof. P. K. Sahoo as Co-PIs (applied)
- ◆ Co-PI:  $\sim 200$ k CPUh on Australian NCI Gadi with Subhraj Praharaj as PI
- ◆ Co-PI:  $\sim 300$ k CPUh on IUCAA Pegasus with Prof. P. K. Sahoo as PI

Observational proposals:

- ◆ PI: Target of Opportunity (TOO) observation of Gaia18awg by SWIFT space telescope (ID: 13502,  $\sim 3$ k seconds)
- ◆ PI: Target of Opportunity (TOO) observation of Gaia18awg by XMM-Newton space telescope (ID: 08711910011,  $\sim 18$ k seconds)

## PUBLIC OUTREACH

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- Short article "*Is Modified Gravity an Illusion?*" for CosmoVerse COST action in a series of articles for general public "Learn about Cosmology"
- Interview for CosmoVerse COST action in a "*Meet our scientists*" dissemination activity
- Volunteer for Astronomy night under "Curiosity in Action" program (funded by STFC)
- STEM Ambassador Scotland, volunteering to promote science to the general public
- Demonstrator for the STEM Summer Showcase 2024 at UoA

## TEACHING

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ST1506 - *Understanding Data* [!\[\]\(dd161862f9164df98f62b726e9846241\_img.jpg\)](#)

MA1005 - *Calculus I* [!\[\]\(758ebdf4629c903da74c2e079717ae32\_img.jpg\)](#)

Teaching Assistant, 2024-2025

Teaching Assistant, 2024-2025

## SKILLS

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LANGUAGES	Ukrainian (native tongue), Russian (native tongue), English (C1, very fluent)
PROGRAMMING LANGUAGES	Python (advanced), $\LaTeX$ (advanced), Mathematica (advanced), C/C++ (intermediate), MATLAB (intermediate), Haskell (beginner)
SOFTWARE	<b>N-body/SPH/Lattice simulations:</b> Gadget-2/4, ME/MP/MG/Axion-Gadget, SWIFT, zwindstroom, NGenIC, 2LPTic, monofonIC, MUSIC, <i>CosmoLattice</i> <b>Approximate simulations, emulators:</b> COLA, MG-PICOLA, LPICOLA, forge. <b>Post-processing:</b> eht-imaging, UFalcon, DeepSphere, GLAMER, eMaNu, swift-simio, VELOCIRaptor/ROCKSTAR, SAGE/RSAGE/cifog, L-Galaxies. <b>GRMHD, ray-tracing:</b> iharnd3D, athena++, BHAC, RAPTOR, gyoto. <b>Cosmology, MCMC:</b> CAMB/MGCAMB, CLASS/MG-CLASS I/II, reps, pymc3, emcee, Cobaya/MGCobaya. <b>Parallel Computing:</b> MPI, OpenMP, Slurm, worked with Cray/ARM





## PROJECTS

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<b>CA21106 - COSMIC WISPerS in the Dark Universe</b> – Working Group 2: WISPerS Dark Matter and Cosmology	Oct 2022 - Oct 2026
<b>CA21136 - CosmoVerse</b> – Working Group 3: Fundamental Physics	Oct 2022 - Oct 2026
<b>Mathematical Modeling in Interdisciplinary Research of Processes and Systems Based on Intelligent Supercomputer, Grid and Cloud Technologies</b> – Grant for the Lab of LSS, MAO NAS of Ukraine	Jan 2021 - Jan 2025

## DEVELOPED SOFTWARE & SIMULATIONS

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RAMA	Code can be used with <code>reps</code> output to find $z$ , $l$ at which N-body simulation coincide with the desired cosmology in the presence of massive neutrinos. Available at <a href="#">RAMA</a>  .
MG-SWIFT	Modification of the standard N-body/SPH SWIFT code to include such cosmologies as $f(Q)/f(T)$ gravitation, Palatini- $f(R)$ gravitation with the help of linearly interpolated Hubble parameter and effective gravitational constant, which are updated every step using provided data from tables. Available at <a href="#">MG-SWIFT</a>  .
zwindstroom	With the help of Willem Elbers, modified initial conditions generator monofonIC to include massive neutrinos and non-standard cosmologies simultaneously. Available at <a href="#">MG-monofonic</a>  .
LANCELOT	A suite of 12 high resolution N-body simulations with more than 13.5 billion particles in total as well as 24TB of output. From the simulation snapshots, many quantities such as void/halo catalogues, power spectrum and HMF are being derived. Currently in development.
Condor	Emulator of non-linear $P(k)$ for Jordan-Brans-Dicke cosmology, based on 200 Comoving Lagrangian Approximation simulations of structure formation with Latin hypercube parameter sampler. Currently in development.
Anthology of Inflation	A project, aimed to study 27 single-parameter models of inflation using $N = 256$ lattice simulations of reheating, primordial power spectrum of curvature perturbations and gravitational waves. Currently in development, some of the code is available via the link <a href="#">ASPIC</a>  .

## REFERENCES

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**EMPLOYER**     Department of Mathematics  
                    BITS Pilani  
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**NAME**            **Dr. Alexander Baransky**  
**POSITION**      Senior Scholar  
**EMPLOYER**     Lisnyky Observational Station  
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