Oleksii Sokoliuk

GitHub | iNSPIRE | oleksii.sokoliuk@mao.kiev.ua | 0000-0003-4503-7272

Research Interests

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, σ_8 and other cosmological tensions using MG theories, find new physics in higher order weak lensing statistics.

Work Experience

Visiting Student - KICC, University of Cambridge Aug - Sept 2024
– Supervisor: Prof. John Webb, Project: Direct detection of the cosmic web at $z = 2.48$

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

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

Talks & Poster Presentations

[1] **Astronomy Group, University of St. Andrews** 1 Apr 2025
Lunchtime Talks (planning to attend) (invited talk)

[2] **Mullard Space Science Laboratory, University College London** 23 Jan 2025
UCL Astrophysics seminar (invited talk)

[3] **GRANDMA collaboration (a part of LIGO/VIRGO)** 05 Dec 2024
Seminar/Telecon (invited talk)

[4] **Institute for Computational Cosmology, Durham University** 14 Jun 2024
Friday Lunchtime Astrophysics Talks (FLAT) (invited talk)

[5] **Kobe International Conference Center, Kobe Port Island** 4 Aug - 8 Aug 2023
CCP2023 - 34th IUPAP Conference on Computational Physics (contributed talk)

[6] **Faculdade de Ciências da Universidade de Lisboa** 30 May - 1 Jun 2023
CosmoVerse@Lisbon, First Annual Conference (poster)

[7] **Faculty of Physics, Odesa I.I. Mechnikov National University** 16 Aug - 20 Aug 2021
XXI Gamow International Astronomical Conference-School (contributed talk)

[8] **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)

Selected Publications

As of Jan 2025, 22 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 $>$ 270 citations and h-index of 10

according to NASA ads and > 250 citations, h-index of 10 according to Web of Science. Here are some selected publications:

[1] Fabiano F. Santos (including Oleksii Sokoliuk) et al. "Holographic boundary conformal field theory within Horndeski gravity". In: *JHEP* 12 (2025), p. 217.

[2] Oleksii Sokoliuk et al. "AdS Black Hole Thermodynamics and Microstructures from $f(Q)$ Gravitation". In: *Fortschritte der Physik* 72.1 (2024), p. 2300043.

[3] Sanjay Mandal, Oleksii Sokoliuk, et al. "H_0 tension in torsion-based modified gravity". In: *Nucl. Phys. B* 993 (2023), p. 116285.

[4] 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.

[5] 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.

[6] Fabiano F. Santos, Oleksii Sokoliuk, and Alexander Baransky. "Holographic Complexity of Braneworld in Horndeski Gravity". In: *Fortschritte der Physik* 71.2-3 (2023), p. 2200141.

[7] 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.

[8] Oleksii Sokoliuk and Alexander Baransky. "Cosmological constraints on bulk viscous $f(Q,T)$ gravity". In: *Astron. Nachr.* 343.5 (2022), e220003.

[9] 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.

[10] Oleksii Sokoliuk, Alexander Baransky, and P. K. Sahoo. "Kuchowicz gravastars in the braneworld formalism". In: *Phys. Lett. B* 829 (2022), p. 137048.

[11] 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.

[12] Oleksii Sokoliuk, Alexander Baransky, and Praduymn Kumar Sahoo. "Non-singular T-K axion stars with/without the dynamical bosonic field in the presence of negative Λ term". In: *Phys. Dark Univ.* 35 (2022), p. 100972.

[13] 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.

[14] Oleksii Sokoliuk, Sanjay Mandal, et al. "Generalised Ellis–Bronnikov wormholes in $f(R)$ gravity". In: *Eur. Phys. J. C* 82.4 (2022), p. 280.

[15] Oleksii Sokoliuk, Sneha Pradhan, et al. "Buchdahl quark stars within $f(Q)$ theory". In: *Eur. Phys. J. Plus* 137.9 (2022), p. 1077.

[16] Oleksii Sokoliuk, Subhrat Praharaj, et al. "Accretion flows around exotic tidal wormholes - I. Ray-tracing". In: *Astron. Astrophys.* 665 (2022), A139.

[17] 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.

Observations of near-earth objects and comets were published in 14 Minor Planet Electronic Circulars (MPEC 🔗) and observations of Gamma Ray Bursts in GRB Coordinates Network (GCN 🔗).

Collaborative Papers

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

[1] 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.

[2] 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.* 973.2 (2024), p. 117.

[3] 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.

[4] 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.

[5] 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.

Conference Proceedings & Other

[1] Cristina Andrade (including Oleksii Sokoliuk) et al. "GRANDMA Observations of SN 2023wrk, a Luminous Type Ia Supernova with Significant Unburned Carbon in the Outer Ejecta". In: *Research Notes of the AAS* 8.10 (Oct. 2024), p. 273.

[2] 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

[1] Kenneth M. Lanzetta (including Oleksii Sokoliuk) et al. "Direct Images of the Cosmic Web of Intergalactic and Circumgalactic Gas in the Distant Universe". In: *arXiv* (Dec. 2024).

[2] Oleksii Sokoliuk. "Probing Physics beyond ΛCDM 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

- ➤ European Physical Journal C (2022)
- ➤ New Astronomy (2022)
- ➤ Foundations of Physics (2022, 2024)
- ➤ Scientific Reports (2023)
- ➤ Annalen der Physik (2023)
- ➤ Indian Journal of Physics (2023)

- ➤ Physics of the Dark Universe (2023 (2))
- ➤ Pramana (2024)
- ➤ Annals of Physics (2024 (3))
- ➤ Physics Letters B (2024)
- ➤ Int. J. Mod. Phys. A (2024)

Memberships

- 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

Monetary awards - 8400$ total:

- ♦ CA21136 ITC Conference Grant for CCP2023 - 2200$
- ♦ CA21136 STSM Grant - 2200$
- ♦ CA21136 Conference Grant for CosmoVerse@Lisbon - 1000$
- ♦ CA21136 Conference Grant for CosmoVerse@Krakow - 1000$ (declined due to personal reasons)
- ♦ Scholarship of the President of Ukraine - 1000$
- ♦ MAO NAS travel grant - $2 \times 500$$

Computing time allocations - 0.85M CPUh total:

- ♦ Co-PI: 300k CPUh on IUCAA Pegasus, with Prof. Jiajun Zhang as Co-PI and Prof. P. K. Sahoo as PI
- ♦ Co-PI: ∼200k CPUh on Australian NCI Gadi with Subhrat Praharaj as PI
- ♦ Co-PI: ∼300k CPUh on IUCAA Pegasus with Prof. P. K. Sahoo as PI
- ♦ Co-PI: ∼50k CPUh on OzSTAR with Prof. John Webb as PI

Observational proposals - 21ks total:

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

Public Outreach

- ❑ 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
- ❑ Keynote speaker for $\sim$ 250 people of general public at the event *"Stargazing in the Botanic Gardens"*

Skills

Languages	Ukrainian (native tongue), Russian (native tongue), English ($\sim$ C2, very fluent)
Programming Languages	Python (advanced), LaTeX(advanced), Mathematica (advanced), Matlab (intermediate), Haskell (intermediate), Futhark/ML (beginner), C/C++ (beginner)
Software	**N-body/SPH/Lattice simulations:** Gadget-2/4, ME/MP/MG/Axion-Gadget, SWIFT, zwindstroom, NGenIC, 2LPTic, monofonIC, MUSIC, $\mathcal{C}$osmo$\mathcal{L}$attice **Approximate simulations, emulators:** COLA, MG-PICOLA, LPICOLA, forge. **Post-processing:** eht-imaging, UFalcon, DeepSphere, GLAMER, eMaNu, swiftsimio, VELOCIRaptor/ROCKSTAR, SAGE/RSAGE/cifog, L-Galaxies. **GRMHD, ray-tracing:** iharmd3D, athena++, BHAC, RAPTOR, gyoto. **Cosmology, MCMC:** CAMB/MGCAMB, CLASS/MG-CLASS I/II, reps, pymc3, emcee, Cobaya/MGCobaya. **Parallel Computing:** MPI, OpenMP, Slurm, worked with Cray/ARM

Projects

CA21106 - COSMIC WISPers in the Dark Universe Oct 2022 - Oct 2026
– Working Group 2: WISPs Dark Matter and Cosmology

CA21136 - CosmoVerse Oct 2022 - Oct 2026
– Working Group 3: Fundamental Physics

Mathematical Modeling in Interdisciplinary Research of Processes and Systems Based on Intelligent Supercomputer, Grid and Cloud Technologies Jan 2021 - Jan 2025
– Grant for the Lab of LSS, MAO NAS of Ukraine

Developed Software & Simulations

`RAMA`	Code can be used with `reps` output to find z, l at which N-body simulation coincide with the desired cosmology in the presence of massive neutrinos. Available at RAMA.
`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 MG-SWIFT.
`zwindstroom`	With the help of Willem Elbers, modified initial conditions generator monofonIC to include massive neutrinos and non-standard cosmologies simultaneously. Available at MG-monofonic.
`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 ASPIC.

References

Name	**Dr. P. K. Sahoo**	Name	**Dr. Irina Vavilova**
Position	Professor	Position	Professor
Employer	Department of Mathematics BITS Pilani	Employer	Lab for Large Scale Structure MAO NASU
e-mail	`pksahoo` `@hyderabad.bits-pilani.ac.in`	e-mail	`irivav` `@mao.kiev.ua`
Website	www.bits-pilani.ac.in	Website	www.mao.kiev.ua

Name	**Dr. Charles Wang**	Name	**Dr. Alexander Baransky**
Position	Professor	Position	Senior Scholar
Employer	Department of Physics University of Aberdeen	Employer	Lisnyky Observational Station Kyiv Astronomical Observatory
e-mail	`c.wang` `@abdn.ac.uk`	e-mail	`abaransky` `@ukr.net`
Website	www.abdn.ac.uk	Website	www.orcid.org