

# CURRICULUM VITAE

## ILIA KUK



### CONTACT

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### EDUCATION

University of Arizona, Tucson, AZ  
Ph.D. Applied Mathematics, in progress, expected 05/2027  
Adviser: Prof. I. R. Gabitov • GPA 3.8

Skolkovo Institute of Science and Technology (Skoltech), Moscow, Russia  
Ph.D. student, Physics (transferred to UA) 09/2020–08/2022

Ufa State Aviation Technical University, Ufa, Russia  
Specialist (accelerated M.S. equivalent),  
Infocommunication Technologies and Special Communication Systems, 09/2015–06/2020

### RESEARCH INTERESTS

Nonlinear dynamical systems; integrable systems; inverse scattering problem; quantum-like computations; machine learning; neural operators; low-rank approximations; optical communications; high performance computing.

### TECHNICAL SKILLS

- Programming/HPC: Python, C/C++, CUDA, OpenMP, MPI, profiling/optimization, Linux, Git.
- Tools: MATLAB, Mathematica, LaTeX.
- Machine Learning experience: PyTorch, Fourier Neural Operator, CNN, GAN, NLP.

### RESEARCH EXPERIENCE

- Inverse Scattering and Optical Communications — Skoltech (2020-2022), UA (2022–Present)
  - Developed an affine-map formulation of the inverse scattering transform (IST) for NLSE; derived low-rank approximation of this map (arXiv:2507.20470).
  - Studied pulse interactions in weakly nonlinear coherent optical communications (*J. Phys.: Conf. Ser.*, 2021).
  - Developed a GPU-accelerated NLSE solver in CUDA

- (code: <https://github.com/CosmosRedshift7/NLSE-CUDA>).
  - Explored hybridization of machine learning with integrability of model equations in nonlinear fiber optical systems.
- Quantum-inspired (Topological Acoustic) Computing — UA / New Frontiers of Sound · (2024–Present)
  - Designed and experimentally validated acoustic analogs of Hadamard, CNOT, and T quantum gates on a nonlinear metastructure; developed a unified representation enabling multiple logical operations using distinct physical actions within the same platform (JASA, 2025).
  - Shor’s algorithm (in preparation): Realized the period-finding core of Shor’s algorithm on a topological acoustics platform using phase bit (phibit) logic. Manuscript in submission; invention disclosure planned.
- Biosphere 2 Climate Control via Neural Operator and Digital Twin — UA (2023–2024)
  - Performed system identification for a non-isothermal rainforest biome; built neural operator forecasting models for control.
  - Prototyped model predictive control strategies and data pipelines for the Biosphere 2 facility.
- Orbital Angular Momentum (OAM) Wireless and Radio-over-Fiber — USATU (2018–2020)
  - Ultra-wideband vortex antenna array design for high-capacity wireless links (UWB), extending OAM methods beyond RoF; explored array topology and mode purity (related works: J. Phys.: Conf. Ser., 2019; IEEE TELFOR, 2019).
  - Optics-to-THz OAM conversion: Developed the theoretical framework for difference-frequency generation transferring OAM from optical to THz bands and provided a theoretical justification for the law governing conversion of the vortex beam’s topological charge; performed numerical simulations to validate mode transfer efficiency (Computer Optics, 2019).
- Electrical Engineering and Instrumentation (Patented Devices) — USATU (2018–2019)
  - Time-pulse integrating voltage converter — co-inventor; mixed-signal voltage-to-time/pulse-rate converter using an integrator and two-threshold regenerative comparator with state-dependent polarity switching. RU 2689805 (2019).
  - “Radio-ball” liquid flow converter — co-inventor; primary flow-measurement transducer and front-end electronics. RU 2685798 (2019)
- Microscale Chiral Propulsion — Skoltech Summer School (2017)
  - Selected as a winner of the international competition in physics for students and invited to the Research workshop on theoretical physics (Skoltech, Moscow; Summer 2017), organized by Leonid Levitov (MIT) and colleagues.
  - Developed a Green’s-function approach for Stokes-flow propulsion of chiral bodies; recovered Stokes’ drag law; analyzed helical propellers; compared with nano-propeller experiments; proposed optofluidic chiral sorting (arXiv:1804.08664) — advised by Prof. Dmitri Kharzeev (Stony Brook University).

## TEACHING EXPERIENCE

- Spring 2023 — Teaching Assistant, MATH 107 Exploring and Understanding Data, University of Arizona.
- Fall 2023 — Teaching Assistant, MATH 112 College Algebra Concepts and Applications, University of Arizona.
- Fall 2023 and Spring 2024 — Recitation Coordinator (PhD course), MATH 581 Methods of Applied Mathematics, University of Arizona.

## PUBLICATIONS (SELECTED)

1. Kuk, I., Djordjevic, I. B., Gabitov, I. R., Runge, K., Ige, A. S., & Deymier, P. A. (2025). Quantum logic gate analogies in nonlinear acoustics. *The Journal of the Acoustical Society of America*, 157(6), 4437-4448.
2. Kuk, I., & Gabitov, I. R. (2025). Inverse scattering transform via affine map: applications to high-speed nonlinear optical communications. *arXiv preprint arXiv:2507.20470*.
3. Kuk, I.A., Gibney D., Lopukhova E.A., & Gabitov, I.R. (2022). Hybridization of machine learning and integrability of model equations in nonlinear fiber optical systems. LBC 22.34 K57, 47, (in Russian).
4. Gibney, J., Kuk, I. A., & Gabitov, I. R. (2021, April). Pulse interactions in weakly nonlinear coherent optical communication links. In *Journal of Physics: Conference Series* (Vol. 1890, No. 1, p. 012006). IOP Publishing.
5. Gabitov, I., Gibney, D., & Kuk, I. (2021). Optical communication under overlapping of dispersion broaden pulses and intrachannel four-wave interaction. In *x international conference on photonics and information optics* (pp. 22-24), (in Russian, <https://www.elibrary.ru/item.asp?id=46597559>).
6. Kuk, I.A., Gibney, D. & Gabitov, I.R. (2020). The Mamyshev effect in optical fiber lines. In *fundamental problems of optics-2020* (pp. 196-198), (in Russian, <https://www.elibrary.ru/item.asp?id=44350798>).
7. Meshkov, I. K., Gizatulin, A. R., Grakhova, E. P., Ishmiyarov, A. A., Kuk, I. A., Sultanov, A. K., ... & Vinogradova, I. L. (2020, May). Development of an experimental stand for the prototype of the radio-over-fiber telecommunication system with generation OAM signals generation in the W-band. In *Optical Technologies for Telecommunications 2019* (Vol. 11516, pp. 504-513). SPIE.
8. Bagmanov, V. Kh., Sultanov, A. Kh, Gizatulin, A. R., Meshkov, I. K., Kuk, I. A., Grakhova, E. P., Abdrakhmanova G. I. & Vinogradova, I. L. (2019). "Optics-to-THz-conversion of vortex beams using nonlinear difference frequency generation." *Computer Optics*, 43(6), 983-991.
9. Grakhova, E. P., Meshkov, I. K., Abdrakhmanova, G. I., Bagmanov, V. K., Vinogradova, I. L., Gizatulin, A. R., ... & Sultanov, A. K. (2019). "An approach for generating and detecting the signals with the given orbital angular momentum for wireless communication systems." In *Journal of Physics: Conference Series* (Vol. 1368, No. 4, p. 042038). IOP Publishing.
10. Aif, S., Kuk, I. A., & Kharzeev, D. E. (2018). "Chiral propulsion by electromagnetic fields." *arXiv preprint arXiv:1804.08664*.

## PATENTS

1. Kuk I.A. & Safinov Sh.S. (2019). "Time-pulse universal integrating voltage converter." (patent for the invention). Patent of the Russian Federation No. 2689805. - 2018128886/08; declared 08/06/2018; published May 29, 2019, Bulletin No. 16
2. Safinov Sh.S., Kuk I.A., Umetbaev F.S. & Bikbulatov T.R. (2019). "Radio-ball primary liquid flow converter." (patent for invention). Patent of the Russian Federation No. 2685798. - 2018119616/05; declared 05/28/2018; published April 23, 2019, Bulletin No. 12

## AWARDS AND HONORS (SELECTED)

- Presidential Scholarship of the Russian Federation — National merit scholarship in priority STEM fields, 2019–2020.
- “I Am a Professional” (Ya–Professional) National Student Olympiad, Russia:
  - Winner, Radio Engineering, 2019–2020
  - Prizewinner, Radio Engineering, 2018–2019
  - Prizewinner, Physics, 2018–2019

- Open International Internet Olympiad (Physics, Engineering and Technology profile) — 3rd degree diploma for winning the final round, Yoshkar-Ola, Russia, 2018.
- International Student Olympiad in Theoretical and General Electrical Engineering (Dolivo-Dobrovolsky) — 3rd place, Ivanovo, Russia, 2017.
- Letter of appreciation for high results in the Olympiad “Master’s degree at MIPT: Online Stage,” MIPT, Moscow, Russia, 2017.

#### **TRAINING, SCHOOLS AND WORKSHOPS (SELECTED)**

- Winter School: Software and Radio Engineering, Ural Federal University, Sochi, Russia, 2019.
- School-Conference: Nonlinear Processes in Condensed Matter, BashSU, Ufa, Russia, 2019.
- Skoltech Summer School (Theoretical Physics), Moscow, Russia, 2017.