Nir Emelianenko

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Education

University of Waterloo, B.Sc. of Mathematical Physics, Honours, Co-op Program — Sept 2023 – May 2028

- **Coursework:** Quantum Mechanics, Lagrangian & Hamiltonian Mechanics, Electricity & Magnetism, Abstract Linear Algebra, Multivariable Calculus, Ordinary Differential Equations (ODEs), Computational Physics.
- **Extracurricular:** Science ambassador, Physics and Math Tutor.
- **Awards:** University of Waterloo Merit Scholarship.

Skills & Qualifications

- **Programming:** Python (NI-DAQmx, NumPy, SciPy, Matplotlib, Scikit-learn), LabVIEW, LaTeX, Markdown.
- **Tools:** Mantid Workbench, MS Office Suite (Excel, PowerPoint), Git.
- **Languages:** English (Fluent), Hebrew (Fluent), Russian (Fluent Verbal, Intermediate Literacy).
- **Certifications & Safety Training:** WHMIS 2015, Cryogenic & Compressed Gas Safety, Laser Safety (Class 3B/4 Lasers), X-ray Safety, General User Access Training for Neutron Scattering.
- **Laboratory Hardware:** IR/Neutron interferometry, optical alignment, Spatial Light Modulator (SLM) operation, circuit testing, automated instrument control.

Experience

Research Assistant, Institute for Quantum Computing – Waterloo, ON — Jan 2025 – May 2026
Supervisor: Dr. D. A. Pushin

- Developed and optimized Python simulations of neutron wavefunctions (coherent and incoherent), modeling near- and far-field intensity distributions for small angle neutron scattering (SANS) experiments and neutron interferometry.
- Designed multiple perfect silicon crystal diffraction gratings for neutron wavefront shaping applications.
- Analyzed SANS data of structured neutrons, and expanded upon the existing theoretical models.
- Constructed various complex IR optical setups for physical simulations of neutron Phase-Grating Moiré Interferometers. Operated IR cameras, IR lasers, step motors and optical devices.
- Engineered and executed a neutron Phase-Grating Moiré Interferometry experiment at High Flux Isotope Reactor (HFIR) at Oak Ridge National Laboratory, leveraging the General-Purpose SANS diffractometer to conduct precision measurements of the Newtonian gravitational constant.
- Collaborated with research team members to align theory and simulations with experimental goals.

Physics & Math Tutor, Physics Tutoring Center – Waterloo, ON — Sept 2024 – May 2025

- Mentored 1st and 2nd year undergraduate students in Calculus, Linear Algebra, and Physics, translating complex mathematical concepts into accessible language.
- Developed personalized lesson plans and study strategies, supporting improved exam performance and conceptual understanding.

Volunteer Paramedic, Magen David Adom – Kfar Saba, IL — Sept 2017 – Aug 2019

- Served as an emergency first responder providing emergency pre-hospital care, including CPR, neurological assessments, and trauma management.
- Demonstrated ability to take charge in high-stress situations while coordinating with a medical team.

Projects

Near Infrared Phase Moiré Interferometer *Institute for Quantum Computing*

- Engineered a multi-stage 1550 nm optical beam path utilizing a Thorlabs S4FC1550 laser, waveplates, beam splitters, and diverging lenses to generate and analyze moiré interference patterns.
- Developed Python-based data acquisition pipelines to synchronously control Kosmos multi-axis stepper motors and extract 2D intensity data arrays from an ATTOLLO infrared camera.
- Integrated a PLUTO-2.1 Spatial Light Modulator to enable programmable phase masking and dynamic wavefront modulation within the interferometry setup.
- Simulated gravity-analogous phase shifts using the modulated NIR interferometer to quantify the spatial sensitivity limits of neutron PGMI architectures.

Monte Carlo Simulations for Structured Neutron Optical Gratings *Institute for Quantum Computing*

- Utilized Python to simulate neutron wave propagation using FFT-based Fresnel diffraction integrals, modeling complex diffraction gratings to analyze wave structuring properties.
- Implemented polychromatic beam modeling by summing intensities across weighted wavelength distributions to simulate temporal incoherence, while integrating gravitational free-fall corrections to account for dispersive cold neutron trajectories.
- Extended existing code to simulate the statistical behavior of spatially and temporally incoherent neutron beams across large, non-repeating grating structures.
- Optimized simulation runtime by parallelizing heavy diffraction calculations, enabling efficient high-resolution modeling of large-scale optical arrays.

N-body Gravity Simulation *Independent Project*

- Developed an object-oriented Python simulation for gravitational systems using a symplectic Euler integrator.
- Currently optimizing the simulation engine by implementing the Barnes-Hut algorithm, utilizing recursive quadtree spatial subdivision to reduce force calculation complexity from $O(N^2)$ to $O(N \log N)$.
- Visualized orbital trajectories and chaotic 3-body interactions using Matplotlib animations to analyze sensitivity to initial conditions.