Ksenija Kovalenka

PhD Candidate | Quantum Computing & Topological Phases
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EDUCATION

PhD in Computational Solid-State Physics *September 2023 – present*
University of Manchester / National Graphene Institute / NOWNANO CDT Program

- **Research focus:** *Disorder-Driven Topological Insulator Phases in Two-Dimensional Materials.*
- **Supervisors:** Dr Mohammad Saeed Bahramy, Dr Alessandro Principi.

Master of Physics, University of Manchester *September 2019 – June 2023*
First Class Degree with Honours, grade average: 80%

- **Thesis:** *Modelling Quantum Lattices Using Deep Learning and Quantum Computing Methods.*
- **Key Modules:** Quantum Computing (80%), Quantum Field Theory (86%), Object Oriented Programming in C++ (94%), Computational Physics (93%).

RESEARCH EXPERIENCE

PhD Research, University of Manchester, UK *September 2023 – present*
Disorder-Driven Topological Insulator Phases in Two-Dimensional Materials

Project Highlights:

- Studied topology in bilayer and trilayer graphene, applying insights into symmetry and band structure to better understand their unique *topological states* and electronic behaviour.
- Conducted an extensive study on the topological Anderson insulator phase within the Haldane model, focusing on *disorder-induced transitions* between trivial and topological insulator phases.
- Gained experience in density functional theory (DFT) calculations using *VASP* and *WIEN2k*.
- Utilized *high-performance computing* (HPC) clusters for scalable simulations, enabling precise characterization of the disordered Haldane model's phases.

- **Programming & Tools**: Fortran77/90 (ARPACK diagonalization routines), Python (multifractal analysis, eigenstate characterization).

Master's Research, University of Manchester, UK *September 2023 – present*
Modelling Quantum Lattices Using a Combination of Deep Learning and Quantum Computing Methods

Project Highlights:

- Modelled topological orders in *many-body electronic systems*.
- Advanced methodologies in *quantum lattice simulations*, focusing on robust topology detection through automated deep learning models.
- Constructed *hybrid neural network* architectures in *PyTorch* with quantum circuit components from *Pennylane* for classification tasks and tested on IBM's *Qiskit* frameworks.

- **Programming & Tools**: Fortran90 (LAPACK diagonalisation), PyTorch, Pennylane, Qiskit (classical-quantum neural network implementation and testing).

Summer Research Internship, University of Manchester, UK *July 2022 – August 2022*
Quantum Mechanics and Machine Learning

- Designed a neural network for handwritten digit recognition with a 99% accuracy rate, incorporating a quantum layer for comparison with classical models in Python.

Summer Research Internship
Centre for Physical Sciences and Technology, Lithuania *July 2021 – September 2021*

- **Project Highlights:** Variational Quantum Eigensolver (*VQE*) for molecular ground states, *Hartree-Fock* approximation, quantum eigensolver simulations in *Qiskit*.

RELEVANT PROGRAMMING PROJECTS

- Scalable diagonalisation routine for custom large matrices. (*Fortan77/90, ARPACK*)
- Minimum band gap interpolation of two adiabatically connected phases of electronic system. *(Fortran90)*
- Hybrid neural network architecture for classification of the quantum phases of the solid-state system. *(Python, PyTorch, Pennylane, Qiskit)*
- Quantum Circuit Simulator. (*C++)*
- Monte Carlo techniques for modelling penetration of neutrons through shielding. (*Python)*

For more detailed project descriptions and visuals please visit https://ksenijakovalenka.github.io.

Awards
- Top 5 teams for StudentHack hackathon's main challenge, issued by UniCS Manchester. *April 2024*
- NTEC undergraduate poster competition prize. *November 2022*
- Runner-up presentation prize at the undergraduate research conference. *September 2022*
- Summer internship funded by "*Learning through Research*" programme. *July 2022*
- Best student award issued by the John Leggott College (Sixth form). *June 2019*

TECHNICAL SKILLS

Programming: Python (Jupyter Notebooks, PyTorch, Qiskit, PennyLane, Manim), Fortran (BLAS, LAPACK, ARPACK for large-scale simulations), C++ (object-oriented programming)

High Performance Computing: Familiar with MPI, Unix CLI, and GitHub version control.

Experimental Techniques: AFM, Raman spectroscopy, glovebox and cleanroom procedures.

Languages: Fluent in English, Russian and Lithuanian.

TEACHING AND ADMINISTRATIVE EXPERIENCE

Graduate Teaching Assistant, University of Manchester, UK *September 2024 - present*
- Led example sessions for 20+ students covering Quantum Mechanics, Electrodynamics, and Mathematics.

Outreach Presenter, Manchester Science and Industry Museum *February 2024, October 2024*
- Delivered public demonstrations on graphene research, engaging diverse audiences with hands-on activities.

Physics and Maths Tutor, MyTutor and Private Practice *December 2019 - present*
- Completed 300+ lessons, praised for clarity and fostering strong foundational understanding.

PASS Leader, University of Manchester, UK *December 2019 - present*
- Facilitated learning of a group of 10 first year students.

OTHER INTERESTS

- Physics Society art competition winner. Painting is displayed in the Schuster building, Department of Physics and Astronomy, Manchester.
- Schools and Universities Polo Association (SUPA) national competition participant (multiple placements in 2022-2023).
- Active Manchester University Hiking Society member. Longest hike: 7 days, ~140 km, Lithuania.
- Bouldering and rope climbing amateur.