KUNAL VERMA

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Interested in theoretical and computational condensed matter physics.

EDUCATION

Indian Institute of Science Education and Research, Mohali *August 2018 - Present*
BS-MS Dual Degree, Physics Major
Cumulative GPA: 9.52/10.0 (till Semester 8).

Apeejay School, Sheikh Sarai, New Delhi April 2017 - March 2018
All India Senior Secondary School Examination
Percentage - 95.4% (CBSE)

Apeejay School, Sheikh Sarai, New Delhi April 2015 - March 2016
All India Secondary School Examination
CGPA - 10.0 (CBSE)

RESEARCH EXPERIENCE

Masters thesis project with Prof. Vijay B. Shenoy, IISc January 2022 - Present
Project Assistant *IISc, Bengaluru*

- Currently working on studies to explore the phases of $\mathbb{Z}_2$ lattice gauge theory using quantum Monte Carlo methods.

- Preliminary work involved studying the classical Ising model in 2D and extracting critical exponents to get acquainted with numerical methods.

- Working with *C++, Python*.

Research internship with Dr. Anosh Joseph, IISER Mohali April 2021 - Sept 2021
Research Intern *Remotely*

- The research project involved the study of numerical methods to get around the "sign problem" plaguing Lattice QCD and condensed matter systems. The project involved attacking the sign problem via the following methods

  - *Complex Lagevin method*: Based on stochastic quantization of the fields. The field configuration is evolved according to a SDE and its equilibrium configuration is chosen as the sampling configuration.

  - *Lefschetz Thimble method*: new manifolds, equivalent to the original domain of integration, are found in the complexified space, along which the imaginary part of the action is constant and, therefore, the integral is (mostly) real.

- Since both methods rely on complexifying the fields, we also investigated the similarities and differences between the two.

- Worked with *Python, Mathematica*.

Winter Project (NIUS 16.2) with Dr. Rudrajyoti Palit, TIFR Mumbai December 2019
Research Intern *TIFR, Mumbai*

- Introduction to methods of radiation emission and detection, interaction of radiation with matter and detector working principles. Detection of gamma rays using scintillation detectors and photomultiplier tubes.

- Wrote a code for detection of peaks in a γ-ray spectrum that were generated.

- Discontinued due to COVID-19 pandemic.

Research internship with Dr. Kavita Dorai, IISER Mohali May 2019 - July 2019
Research Intern *IISER Mohali, Punjab*

- Introduction to basics of Quantum Computing and ways of physically realizing quantum computers.

- Designed algorithms for experimentally evaluating expectation values of operators.

- Performed Quantum State Tomography of mixed states to extract the approximate density matrix using IBM-Q Experience.

TEACHING EXPERIENCE

PHY101-Mechanics Help Session Tutor, Spring Semester 2022 - IISER Mohali.

AWARDS

INSPIRE Scholar 2018-2023 SHE (Scholarship for Higher Education).
Certificate for Academic Excellence for a 10.0 SPI in Semester 4,6 and 7.
S.W.A.N Imaging Challenge 2019 Winner (Team), organized by RRI Bangalore.

TECHNICAL SKILLS

Computational Methods

Monte Carlo simulations, Path Integral (quantum) Monte Carlo , Molecular Dynamics simulations, Runge Kutta methods, numerical integration techniques.

Scientific Programming languages

Fluent in Python (scipy, numpy, matplotlib), *Intermediate* knowledge of C++, *Basic* knowledge of Fortran90, Mathematica.

General computing tools

LaTeX, gnuplot, Git, GitHub.

RELEVANT COURSEWORK

- **Mandatory Theory courses** - Classical Mechanics, Quantum Mechanics, Electromagnetism, Mathematical Methods for Physics-I, Statistical Mechanics, Advanced Quantum Mechanics, Nuclear and Particle Physics, Solid State Physics, Atomic and Molecular Physics.

- **Mandatory Lab courses** - Advanced optics and spectroscopy lab, Advanced Electronics lab, Nuclear Physics lab, Condensed Matter Physics lab.

- **Elective courses** - Modelling Complex Systems, Relativistic Quantum Mechanics and Quantum Field Theory (QFT-I), Gravitation and Cosmology, Non-linear Dynamics and Chaos, Machine Learning, Biostatistics.

- **Online NPTEL courses** - Computational Physics with Fortran (*Ongoing*), Introduction to Quantum Computing: Quantum Algorithms and Qiskit (*Ongoing*).

HOPS/CONFERENCES

Frustrated Metals and Insulators (Hybrid), 2022	ICTS, Bengaluru
Shivalik HEPCATS meeting, Winter 2021	IISER Mohali
REYES Summer Workshop 2020 (Online)	Old Dominion University, Virginia
Conference on QFTA 2019	IISER Mohali
NIUS Physics 16.1 and 16.2 Camp	HBCSE, TIFR, Mumbai
National Science (Vijyoshi) Camp 2018	IISER Bhopal