

# KUNAL VERMA

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Interested in theoretical and computational condensed matter physics.

## EDUCATION

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<b>Indian Institute of Science Education and Research, Mohali</b> BS-MS Dual Degree, Physics Major Cumulative GPA: 9.52/10.0 (till Semester 8).	<i>August 2018 - Present</i>
<b>Apeejay School, Sheikh Sarai, New Delhi</b> All India Senior Secondary School Examination Percentage - 95.4% (CBSE)	April 2017 - March 2018
<b>Apeejay School, Sheikh Sarai, New Delhi</b> All India Secondary School Examination CGPA - 10.0 (CBSE)	April 2015 - March 2016

## RESEARCH EXPERIENCE

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<b>Masters thesis project with Prof. Vijay B. Shenoy, IISc</b> <i>Project Assistant</i>	January 2022 - Present <i>IISc, Bengaluru</i>
<ul style="list-style-type: none"><li>• Currently working on studies to explore the phases of <math>\mathbb{Z}_2</math> lattice gauge theory using quantum Monte Carlo methods.</li><li>• Preliminary work involved studying the classical Ising model in 2D and extracting critical exponents to get acquainted with numerical methods.</li><li>• Working with <i>C++</i>, <i>Python</i>.</li></ul>	
<b>Research internship with Dr. Anosh Joseph, IISER Mohali</b> <i>Research Intern</i>	April 2021 - Sept 2021 <i>Remotely</i>
<ul style="list-style-type: none"><li>• 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<ul style="list-style-type: none"><li>– <i>Complex Langevin method</i>: 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.</li><li>– <i>Lefschetz Thimble method</i>: 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.</li></ul></li><li>• Since both methods rely on complexifying the fields, we also investigated the similarities and differences between the two.</li><li>• Worked with <i>Python</i>, <i>Mathematica</i>.</li></ul>	
<b>Winter Project (NIUS 16.2) with Dr. Rudrajyoti Palit, TIFR Mumbai</b> <i>Research Intern</i>	December 2019 <i>TIFR, Mumbai</i>
<ul style="list-style-type: none"><li>• 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.</li></ul>	

- Wrote a code for detection of peaks in a  $\gamma$ -ray spectrum that were generated.
- Discontinued due to COVID-19 pandemic.

### Research internship with Dr. Kavita Dorai, IISER Mohali

Research Intern

May 2019 - July 2019

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

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**PHY101-Mechanics**

Help Session Tutor, Spring Semester 2022 - IISER Mohali.

## AWARDS

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**INSPIRE Scholar 2018-2023**

**Certificate for Academic Excellence**

**S.W.A.N Imaging Challenge 2019**

SHE (Scholarship for Higher Education).

for a 10.0 SPI in Semester 4, 6 and 7.

Winner (Team), organized by RRI Bangalore.

## TECHNICAL SKILLS

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### 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

$\text{\LaTeX}$ , gnuplot, Git, GitHub.

## RELEVANT COURSEWORK

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- **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*).

## WORKSHOPS/CONFERENCES

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**Frustrated Metals and Insulators (Hybrid), 2022**

**Shivalik HEPCATS meeting, Winter 2021**

**REYES Summer Workshop 2020 (Online)**

**Conference on QFTA 2019**

**NIUS Physics 16.1 and 16.2 Camp**

**National Science (Vijyoshi) Camp 2018**

ICTS, Bengaluru

IISER Mohali

Old Dominion University, Virginia

IISER Mohali

HBCSE, TIFR, Mumbai

IISER Bhopal