

# KUNAL VERMA

Hostel 5, 209, IISER Mohali, Sector 81, Punjab-140306  
+91 9354444893 ◊ ms18148@iisermohali.ac.in ◊ [kunal1729verma.github.io](https://github.com/kunal1729verma)  
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 with Prof. Vijay B. Shenoy, IISc (<i>Ongoing</i>)</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 via finite-size scaling analysis.</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>• <i>Complex Langevin</i> and the <i>Lefschetz Thimble</i> methods as primary candidates to deal with the “sign problem” in Lattice QCD, which makes application of standard Monte Carlo methods problematic.<ul style="list-style-type: none"><li>– <i>Complex Langevin</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 Thimbles</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>• 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><li>• Wrote a code for detection of peaks in a <math>\gamma</math>-ray spectrum that were generated.</li></ul>	

- 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 physically realizing it using NMR.
- Designed an algorithm for experimentally computing 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.

## 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.

## PRESENTATIONS

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1. **Path Integrals in Quantum Mechanics** ([slides](#))      seminar presentation in IDC452: Seminar Delivery (2022).
2. **Sign Problem and Lefschetz Thimbles** ([slides](#))      seminar presentation in IDC451: Seminar Delivery (2021).
3. **Lamb Shift and the origin of QED** ([slides](#))      term paper presentation for PHY306: Advanced Quantum Mechanics (2021).

## AWARDS

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

## WORKSHOPS/CONFERENCES

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<b>From Quantum Matter to Quantum Computers, 2022</b>	MPI-PKS, Dresden.
<b>Frustrated Metals and Insulators (Hybrid), 2022</b>	ICTS, Bengaluru.
<b>Shivalik HEPCATS meeting, Winter 2021</b>	IISER Mohali.
<b>REYES Summer Workshop 2020 (Online)</b>	Old Dominion University, Virginia.

Conference on QFTA 2019  
NIUS Physics 16.1 and 16.2 Camp  
National Science (Vijayoshi) Camp 2018

IISER Mohali.  
HBCSE, TIFR, Mumbai.  
IISER Bhopal.

## 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.