Nimish Sharma

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About me

I am a fifth-year undergraduate student at the Department of Physical Sciences at the Indian Institute of Science Education and Research, Kolkata, with a strong passion for photonics and experimental physics. Alongside my academic pursuits, I have developed significant expertise in computational physics and am expanding my skills into combining computational simulations along with experimental work on metasurfaces. I thrive in collaborative environments and enjoy working in teams to solve complex scientific problems. Beyond academics, I am an avid football player and guitarist, always seeking a balance between analytical thinking and creative expression.

Reseach Interest

Nano-photonics

- I am interested in exploring how light interacts with different materials, especially through the fields of photonics and metasurfaces. My recent work involved analysis of the Mueller matrix of a waveguide plasmonic crystal using a dark-field polarization microscopy setup to infer spin-orbit interactions of light and its implications, such as spin-orbit-spin coupling. This gave me a solid foundation in experimental optics and polarization analysis, which I hope to build on further.
- I enjoy using optical techniques to uncover hidden material properties, and I want to bridge the gap between simulation and experiment. My goal is to use computational tools like MATLAB and Python to create models that not only explain experimental data but also help guide the experiments themselves. I believe combining simulations with hands-on lab work leads to a deeper and more accurate understanding.
- I also want to move into the field of quantum optics, where light and quantum mechanics come together. I have some experience in this area, having worked in Bio-Nap lab and learned tools like Qiskit. I'm curious about how quantum ideas like qubits can be built and controlled using light, especially with potential applications in quantum computing and information processing.
- One area that excites me a lot is the use of single-photon and multi-photon imaging techniques in biology. These methods, along with fluorescence microscopy, offer powerful ways to look inside living systems at extremely small scales. I see huge potential for applying advanced optical and quantum tools to biomedical imaging, helping us understand biological processes better and possibly improve diagnostics.
- Overall, I want to bring together computational physics, experimental optics, and quantum technologies to push the boundaries of how we study light and matter. I'm especially motivated by the real-world impact this work can have, whether it's in building better photonic devices or advancing medical imaging techniques.

Relevant Courses

- Advanced Electricity, Magnetism, and Optics
- Advanced Optics Laboratory
- Chemistry of Materials
- Quantum Information Processing
- Biophysics II
- Condensed Matter Physics
- Field Theory and Relativistic Quantum Mechanics
- Condensed Matter Laboratory
- Numerical Analysis Methods - MATLAB
- Quantum Mechanics - I, II, III
- Linear Algebra - I
- Programming and Data Structures in C
- Computational Physics
- Data Structures and Algorithms in C
- Spectrochemistry & Organic Synthesis Lab
- Nuclear Physics Lab
- Optics and Modern Physics Lab
- Electronics Lab

Education

Indian Institute of Science Education and Research Kolkata August 2021 – May 2026

- BS-MS in Physics along with a minor in Computer Science.
- **CGPA(Current) :** 8.1

Experience

Bio-NaP Lab | IISER Kolkata January 2025 - Present

- Joined Bio-NaP lab at IISER Kolkata and currently working on dark field polarization microscopy setup.
- Integrating MATLAB simulations for the far-field Mueller matrix measurements and confirming experimental results, inferring spin-orbit interaction effects.
- Involved in experimental research on light-matter interaction of various metasurfaces and analysis of spectral and momentum domain Mueller matrices for the same.
- Investigating applications of plasmonic interactions for enhanced imaging and sensing technologies.

First Principle Investigations on Heusler Alloys | IAS SRFP – SVNIT Surat May 2024 – July 2024

- Basics of Density Functional Theory and solid state physics were studied to grasp the theoretical understanding. It included reading research papers on Heusler alloys to understand their properties and structure.
- To get familiarised and gain confidence with the DFT software (QE and WIEN2k), results were replicated from a paper on Ti2VGe and the half-metallic nature was confirmed.
- Proceeding from the success, further first-principle calculations were performed for our chosen alloy. Structural optimisations, magnetic properties, elastic properties, dynamical stability and electronic properties were calculated.
- Finally, I compiled and submitted a report detailing DFT theory, software usage, and findings to the Indian Academy of Sciences.

Quantum Computing | Summer Internship – IISER Bhopal May 2023 – July 2023

- Quantum Computing basics, including introduction to quantum gates, entanglement, quantum teleportation, and algorithms.
- Building a binary classifier for the Iris dataset by developing a Quantum Deep Learning Network.
- Tested the network on IBMQManila and compared its results with various Classical Machine Learning models such as Logistic Regression, KNeighbour and Decision Tree classifier.
- Creating a presentation and writing a report to conclude the results and learnings.

Integration of Payment Portal | Summer Project – IISER Kolkata May 2023 – July 2023

- Built an Integration for a Payment Gateway into the existing mess website for my Institute.
- Used Django framework and SQLite. Learned front-end webpage designing using CSS and Javascript.
- Finally, I wrote a report concluding the work and things learned during the project.

Workshops

Nonlinear Fiber Optics | IKAA July 2025 - present

- The course lays a solid foundation on the theory and simulations of how light behaves inside optical fibers, starting right from Maxwell's equations.
- I learned about various nonlinear effects like self-phase modulation and four-wave mixing, and how they influence pulse propagation in fibers.
- We used tools like MATLAB and MEEP to simulate light behaviour in fibers, which helped connect theory with hands-on application.
- Overall, the course built a solid foundation in nonlinear fiber optics, with interesting real-world applications like communication systems and radar signal distribution.

Physics through Computational Thinking | NPTEL – IISER Bhopal Feb 2023 - April 2023

- Wolfram Alpha and Fortran programming language.
- Introduction to Monte-Carlo Simulations and simulating statistical models.
- Application of Numerical Methods (Euler, Runge Kutta(2,4), etc.)

From Atoms to Materials: Predictive Theory and Simulations | edX – Purdue University December 2023

- Relating the application of Classical Mechanics, Quantum Mechanics and Statistical Mechanics to the Real World.

- Online DFT and running MD simulations(on NanoHub) on basic molecules and predicting their thermal and electronic properties.

Lunar Exploration through Artificial Intelligence | Spartificial May 2022 - June 2022

- Introduction to various Unsupervised Machine Learning Algorithms.
- It also familiarised me with techniques like classification, clustering, and different state-of-the-art machine learning models like ResNet.
- The platform used was Kaggle.

Winter School for Quantum Computing | IISER Kolkata December 2022

- Introduction to basic quantum gates and quantum algorithms. Discussion of the issue of decoherence of quantum particles.
- Vast applications in the fields of medicine, finance, material sciences, etc.

Projects

Term Paper - Metasurfaces & Flat Optics Oct 2024 - Dec 2024

- Discussed the effect of the Optical Spin Hall effect and spin-orbit interaction in the domain of metasurfaces.
- Mathematically derived the effects of the gradient of refractive indices in an anisotropic medium, which leads to the fabrication of metasurfaces.
- Finally, I wrote and presented a term paper on the field review of metasurfaces and flat optics.

Term Paper - Casimir Effect January 2024 - May 2024

- We studied how quantum forces (Casimir forces) arise between two finite potential barriers in a 1D system using massless Dirac fermions.
- I used the Hellmann-Feynman theorem and matrix methods to calculate the force without running into the usual mathematical divergences.
- I showed how the force can switch from attractive to repulsive depending on the spin orientation of the barriers, which could be useful in nano-device design.

Library Management System January 2024

- Developed a Library Management system with a user and an admin login in C.
- Incorporated various features for the book records, such as searching, issuing, deleting, etc.
- Received an outstanding group assignment mention for the project.

LiFi 2020

- Built a working prototype for transmitting audio data through the light spectrum.
- Won various awards for it at the school level.

Bus Booking Portal using Python and MySQL Github

- Developed a bus booking portal using Python and MySQL as the DBMS.

Extra-Curricular

Summer Volunteer | Ek Pehal foundation June 2023

- Volunteered to teach underprivileged middle and high school kids as part of the Ek Pehal Foundation.
- Taught English, Maths and Physics for 6 hours per week

Menstrual Hygiene Drive | FARZ foundation November 2022

- Facilitated logistics and organised a menstrual hygiene campaign for schools in rural areas.
- Educated and lectured middle school students about the importance of menstrual hygiene in the modern day.
- Successfully helped organise the sanitary pad distribution drive for rural school students.

Additional Experience And Awards

- **Summer Fellow:** Completed a Summer Research Fellowship Program 2024 offered by the Indian Academy of Sciences at SVNIT Surat.
- Part of the OPTICA community as a member of SPIE student chapter of IISER Kolkata.
- Represented my Institute as a part of the Football Team at Parakram - ISM Dhanbad.
- Participated and won 1st place in the Interbatch Football Tournament 2025.
- Participated and won the Spring Pong - annual Table Tennis auction tournament
- Won gold medal in the International English Olympiad.
- Participated as a guitarist in RAMPAGE - the annual inter-college Band tournament.
- Won gold medal in annual inter-college Futsal tournament.

Technological Skills

Coding: C, Python, MATLAB, Qiskit, MySQL, Latex.

Softwares: Quantum ESPRESSO, Origin, GNU-Plot, NanoHub(MD software), WIEN2k, Wolfram Mathematica.

Others: Unsupervised Machine Learning, Fundamentals of DFT and MD.