

Utkarsh

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🏛 Indian Institute of Technology Bombay



Scholastic Achievements

- 2022 📌 Selected for MITACS Globalink Research Internship Program for the summer of 2023
- 2019 📌 Secured **All India Rank 22** in **National Entrance Screening Test** among **60,000** candidates
- 📌 Achieved **99.10** percentile in **JEE Advanced** among 2,45,000 eligible candidates
- 📌 Achieved **99.74** percentile in **JEE Main** out of 1.2 million candidates

Education

2019 – Present	📌 Indian Institute of Technology Bombay	8.35/10 GPA
	B. Tech. – M. Tech. Dual Degree Engineering Physics	
2016 – 2018	📌 GRM School, Bareilly	95%
	Higher Secondary - Central Board of Secondary Education	
2016	📌 GRM School, Bareilly	10/10 GPA
	Junior Secondary - Central Board of Secondary Education	

Research Experience

- 📌 **Plasmonic Nanoantennas for Strain Engineering of SPEs in 2D hBN** (Jul '22 - Present)
Guide: Prof. Anshuman Kumar LOQM Lab, Department of Physics, IIT Bombay
 - Performed literature review of the properties and theoretical understanding of SPEs in hBN.
 - Prepared **monolayer samples** of hBN with **tape exfoliation** and integrated them with **EBL fabricated plasmonic nanostructures** via a PDMS assisted **dry transfer method**
 - Analysed hBN samples via **Raman Spectroscopy** confirming the presence of monolayers. Analysed the **PL map** of monolayer hBN over the nanostructures and studied the surface topography with **AFM**
 - Contributed to setup **in-house PL mapping**, imaging, and $g^{(2)}$ and **lifetime measurements**
 - Performing **FDTD** simulations for plasmonic nanoantennas on Si substrate with and without hBN
- 📌 **Pulsed Echo Measurements for Quantum Spin Liquid phase in TaS_2** (May '23 - Present)
Guide: Prof. Kimberly Modic TQM, IST Austria
 - Studied the **theoretical signatures** of QSL phase relevant to Pulsed Echo measurements in TaS_2
 - Learnt **PFIB** technique deployed to structure crystals and transducers for optimal echo signal
 - Simulated and verified RF signals generated from PE measurements in **COMSOL** for a Si substrate
 - Worked towards realising **shear wave ZnO transducers** deploying **RF magnetron sputtering**
 - Deployed **polishing** and **tape-exfoliation** techniques on TaS_2 for optimal sputtered transducers
 - Designed and implemented a **rotor+resistance measurement setup** for in-situ PFIB measurements
- 📌 **Arbitrary Waveform Generation for Si-Quantum Dot based Qubit Control** (May '22 - Present)
Guide: Prof. Suddhasatta Mahapatra Q-Si Lab, Department of Physics, IIT Bombay
 - Lead a team of 3, developed **QCoDeS** drivers to control an **Arbitrary Waveform Generator**, a **Vector Signal Generator**, and associated equipment to engineer **RF pulses** for quantum control of spin qubits
 - Performed I-V measurements on **Si-MOSFET Hall probes** for quality check of dopant implantation, oxide integrity, ohmic contacts, etc. in the fabricated heterostructures
 - Studied the working of a **dry dilution refrigerator**, to be used for low-temperature experiments
 - Studied sensing and measurement techniques used for **quantum control** of quantum dots based spin qubits in silicon heterostructures

- **Simulations of Hybrid Quantum Systems**
Guide: Prof. Bhaskaran Murlidharan

(Jan '23 - Present)
CNQT, IIT Bombay

 - Studied **quantum transport** and **NEGF formalism** to simulate **topological superconductors**
 - Performing literature survey on 2D materials and corresponding devices implementing topological superconductivity

- **Entanglement Entropy in Coupled Harmonic Oscillator Systems**
Guide: Prof. Shankaranarayanan S

[Report] (Aug '21 - Apr '22)
Department of Physics, IIT Bombay

 - Studied the **zero-mode divergence** in entanglement entropy in a coupled harmonic oscillator and worked on understanding the contribution of high energy eigenstates to the divergence of entanglement entropy
 - Studied the relation between zero-mode divergence and **space-time curvature** and the **EUP**

- **Quantum Many-Body simulations with Machine Learning**
Guide: Prof. Nilmani Mathur

[Report] (May '21 - Feb '22)
Department of Theoretical Physics, TIFR

 - Conducted literature survey on the applications of **Tensor Networks** and implementation of **MPS** and **PEPS** as numerical ansatz for approximating interesting quantum many-body wave-functions
 - Implemented **importance sampling** in Monte Carlo for the **2-D Ising model** and **classical XY model** with the **Metropolis** and **Wolff cluster** algorithms and analysed the thermodynamic properties
 - Implemented a **restricted Boltzmann machine** to generate Monte Carlo samples for the 2-D Ising model
 - Learnt about the **inaccuracies in generative machine learning methods** for simulating the phase transitions of the Ising and the XY models

Projects

- **Optical Investigation of Shape and Size-controlled Silver Nanoparticles**
Guide: Prof. Mohd. Aslam

(Jan '23 - Present)
Department of Physics, IIT Bombay

 - Preparation of **Ag nanoparticles** using the **Polyol method** for better control on the particle size
 - The **surface plasmon absorption** in Ag NPs will be characterized using **UV-Vis spectroscopy**
 - Learning **PVD**, **AFM** and **SEM** for further extension of the project and characterization of the sample

- **Gamma-ray Spectroscopy | Instrumentation Subsystem | GLEE | IITBSSP**
A global mission that aims to conduct science and test technology on the surface of the moon using chipsats

(Feb '21 - Nov '21)

 - Conducted extensive literature survey on the **Lunar radiation environment** and related missions
 - Analysed possibilities for onboard detection of **alpha particles**, **neutrons** and **X/ γ -rays** using **PIN diodes**, **SDDs**, **SiPMs**, **CMOS** and **CCD** detectors given the stringent power and space requirements of LunaSats
 - Designed a **small, low-powered gamma-ray spectroscopy system** for the $5 \times 5 \text{ cm}^2$ chip with PIN diodes and devised the testing, simulation, and calibration plan, incorporating the various possible effects of radiation on the circuit and **guided two students** in the design and simulation phase

- **Lens Module | Instrumentation Subsystem | STADS | IITBSSP**
A CubeSat-compatible Star Tracker-based Attitude Determination System to be tested onboard the PS4-OP

(Feb '20 - July '20)

 - Devised **requirements** for compatible lens systems based on **bench-marked performance criteria**
 - Designed, simulated and analysed various **multiple and single-lens systems** in **Zemax OpticStudio**

- **Piano Man : Portable Piano on a Glove**
Guide: Prof. Varun Bhalerao

[Presentation] (Sep '21 - Oct '21)
Department of Physics, IIT Bombay

 - Implemented a **position based note selection algorithm** on an **Arduino Uno** using an **U/S sensor**
 - Integrated an **LCD** display, along with an **ROM** to **read-write** the sequence of notes being played

- **Higher moments of transverse momentum in p-p collisions**
Guide: Prof. Sadhana Dash

[Report] (Oct '20 - Dec '20)
Department of Physics, IIT Bombay

 - Applied the data analysis framework **ROOT** developed by **CERN** to analyse over **two million events** generated using **PYTHIA 8** for p-p collisions at 13 TeV center of mass energy
 - Confirmed **positive skewness** for various multiplicities by calculating higher moments of transverse momentum

■ Transverse Spinning of Unpolarised Light

Guide: Prof. Anshuman Kumar

[Report] (Jan '21 - Apr '21)

Department of Physics, IIT Bombay

- Studied the formulation of **evanescent waves** and **Gaussian beams** generated by unpolarised sources
- Confirmed the existence of the transverse spin angular momentum from respective **coherency matrices**
- Reproduced the **spin angular momentum density plots** for a Gaussian beam

■ Coherent State Representation of Photons

Guide: Prof. Urjit Yajnik

[Report] (May '22)

Department of Physics, IIT Bombay

- Derived the coherent states for a harmonic oscillator and the **vacuum distribution** for a scalar field with the corresponding creation and annihilation operators
- Related the **plane-wave photon state** with the coherent state representation of the corresponding quantum field

Positions of Responsibility

Nov '20 - Mar '21

■ Teaching Assistant | Quantum Physics and Applications

- Managed a batch of **37 UG students** and conducted weekly tutorial sessions and quizzes
- Personally clarified doubts of academically weaker students to motivate them and boost their performance

May '21 - Nov '21

■ Subsystem Head | Instrumentation Subsystem

- Guided a **14-member inter-system team** towards best instrument integration practices
- Executed **three-step recruitment process** to short-list and mentor **8 students** for the subsystem from **50+ applicants** by evaluating their technical ability, practical approach and teamwork

Skills

Programming	C++, Python - (PILPython, QCoDeS, NumPy, Matplotlib, pandas, TensorFlow), VHDL, Arduino IDE
Software	Mathematica, Ansys- Lumerical FDTD, ROOT, Qiskit, LTSpice, OriginLab, Quartus
Experimental	Photoluminescence spectroscopy, Photon Correlation Study, Laser alignment, Raman Spectroscopy, Atomic Force Microscopy, Scanning Electron Microscopy, Physical Vapor Deposition, UV-Vis Spectroscopy

Courses

Physics	Quantum Transport, Semiconductor Physics, Advanced Laboratory Techniques in Nanoscience, Quantum Information and Computing, Quantum Optics, Methods in Material Characterisation, Nanoscience: Introduction to Fabrication, Atomic and Molecular Physics, Statistical Physics, Electromagnetic Theory, Introduction to Condensed Matter Physics
Mathematics	Calculus, Linear Algebra, Real Analysis, Introduction to Numerical Analysis, Complex Analysis, Differential Equations
Labs	Solid State and Nuclear Physics Lab, Optics and Spectroscopy Lab, Op-Amp and Digital Electronics lab, Microprocessors lab
Miscellaneous	Neural Networks and Deep Learning, Improving Deep Neural Networks, Structuring Machine Learning Projects - all by Deeplearning.ai

Extracurricular

Social service

- Received a **special mention** for exemplary volunteering work under the department of **Sustainable Social Development, NSS, IIT Bombay** completing **80+** hours of social work

	<ul style="list-style-type: none"> Visited SNJB College, Nashik representing Department of Sustainable Social Development, NSS and interacted with the students and professors and demonstrated experiments to school students
Workshops	<ul style="list-style-type: none"> Completed Quantum Computing Workshop organised by MnP Club IIT Bombay Completed Astrophysics Workshop organised by Krittika: The Astronomy Club and Tech-fest Completed Learner's Space's Scientific Computation and Mathematical Modelling boot-camp organised by Maths and Physics club IIT Bombay as a part of the Technical Summer School
Miscellaneous	<ul style="list-style-type: none"> Submitted a conference proceeding in the International Conference on Advanced Learning Technologies presenting a game-based approach to address difficulty in sentence construction for DHH students