Arnav Raj Metrani

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Education

Indian Institute of Science Education and Research, Mohali — Mohali, India
Integrated MSc. in Physics — *Jan 2022 —*

Projects

Studying Negative Group Velocity in a Cold Atom Ensemble — June 2025 —
Dr. Mathilde Hugbart- Rb1 team, Cold Atoms group at Institut de Physique de Nice (INPHYNI) — *Nice, France*

- Assisted in the analysis and physical demonstration of negative group velocity in a Rubidium-85 cold atom setup.
  - Performed literature review of results obtained in different mediums and conditions.
  - Programming work included modelling the pulse reshaping after distortion by the atomic cloud, and determining the ideal experimental parameters for the setup.
  - Theoretical work included deriving expressions for group velocity and refractive index with respect to setup parameters.
  - Implemented a saturation absorption spectroscopy setup (as training)
  - Characterized optical components (AOM and EOM) to determine the best approach for generating optical pulses in the setup.

Physical Implementations of Quantum Key Distribution Protocols — May 2024 — July 2024
Professor Varun Raghunathan- Indian Institute of Science, Bangalore — *Bangalore, India*

- Assisted in the analysis and physical implementation of the T-12 protocol and the MDI-QKD protocol.
  - Theoretical aspects included analysis of BB-84, T-12,MDI-QKD protocols, SKR and QBER analysis, analysis of physical components used, characterization of beamsplitter operations, and characterization of single photon and coherent pulses.
  - Programming work included streamlining the instruments' calibration processes, SKR and QBER analysis for T-12 protocol, and analysis of MDI-QKD scenarios.
  - Practical work included running the setup (for T-12 protocol and MDI-QKD protocol) for calibration purposes and for obtaining real-time experimental data.
- Project report and code

Introduction to Quantum Algorithms and Quantum Error Correction — May 2023 — July 2023
Professor Kuntal Roy- Indian Institute of Science Education and Research, Bhopal — *Online*

- Studied foundational aspects of Quantum Computing, various Quantum Algorithms, Quantum Error Correction Algorithms, and applications of Quantum Fourier Transform incl. QFT addition.
- Wrote and executed quantum circuits on IBM-Q's public quantum computers (written on Qiskit).
- Project report and code

Introduction to Special Relativity and Analysis — June 2023 — August 2023
Professor Jasjeet Singh Bagla- Indian Institute of Science Education and Research, Mohali — *Mohali, India*

- Project comprised of studying Lorentz transforms, Minkowski geometry analysis, paradoxes, four-vector formulation, analysis of accelerating frames including Rindler frames, electrodynamic effects and optical effects.

Course work

- **Physics Coursework:** Introduction to Mechanics, Introduction to Electromagnetism, Waves and Optics, Thermodynamics, Quantum Mechanics, Electrodynamics, Classical Mechanics, Differential Equations, Advanced QM, Statistical Mechanics, Foundational QM, Solid State, Nuclear Physics, Atomic and Molecular Physics, QCQI, Nonlinear Optics, General Relativity, Physics of Fluids, Introduction to Quantum Optics
- **Math Coursework:** Introduction to Group Theory, Real Analysis in One variable, Introduction to Differential Geometry, Introduction to Differential Equations, Probability Theory, Theory of Computation, Linear Algebra and Group Theory
- **Lab Coursework:** PHY312- Logic gates, flip flops, registers and counters, clock circuits, and programming with Arduino

Other activities

Blog on STEM Oct 2022 —

- Written 10 articles on various STEM topics (Site link).

Co-convener of IISER Mohali's Physics Club Oct 2022 — Oct 2023

- Demonstrations in IISER-M Foundation Day 2023, physics club organiser in 2024 edition.
- Workshops on Special Relativity, QCQI, CV and Email writing, and PhD applications.
- 10 talks incl. a panel on Summer Internships.
- Hosted Grand Canonical Ensemble in 2023. (The Physics Club's annual week.)

Talks and Presentations Sep 2023 —

- (Extended) Introduction to Quantum Algorithms
- Quantum Bayes' rule affirming consistency in measurement inferences in quantum mechanics
- Quantum circuits cannot control unknown operations
- Quantum Cryptography
- Self-Focusing in Nonlinear Media

Skills

- **Programming Languages**: Python, Java, Mathematica, LabVIEW
- **Electronics**: Operating devices: Waveform generators, oscilloscopes, RedPitaya (Arduino analogue), laser diode system, beam profiling software, power meter software
- **Experimental techniques**: Optical alignment, beam coupling, using optical components (polarization analyser, AOM, EOM)