Department of Physical Sciences
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Shivam Kumar

EDUCATION

Indian Institute of Science Education and Research, Mohali, Punjab, India
BS-MS - Physics Majors with Data Science Minor, final year (10th Semester)
Integrated Master's Course *Aug '20 - May '25*

Anugraha Narayana Singh College Barh, Patna, Bihar, India *2019*
Bihar School Examination Board - Percent
Score in Physics, Chemistry, and Mathematics: 94 Percent

AGV High School Barh, Patna, Bihar, India *2017*
All India Secondary School Examination
Cumulative Grade Point Average(CGPA): 9.8
Central Board of Secondary Education, Delhi

RESEARCH
INTERESTS

- Experimental Quantum Optics
- Atomic, Molecular and Optical Physics
- Condensed Matter Physics

RESEARCH
PROJECTS AND
LAB SKILLS

Master's Thesis
Development of a Compact Laser System quantum technological experiments(Zerovak)
Supervisor: **Prof. Dr. Patrick Windpassinger** *May '24 - Dec '24*

- Contributing to project Zerovak, a collaboration between UHH Hamburg and JGU Mainz, and funded by German Aerospace Center (DLR).
- Developed a laser system from scratch, working independently on this project. Worked with FPGA devices and advanced electronics, characterized its functioning, and designed optical architecture and optical circuit.
- Built an experimental setup with the optical circuit to measure the beat note for characterizing the modulation index. Simulated the sidebands for the modulated light in python to obtain the modulation index.
- Performed measurements on frequency stability of the laser. Measured PSD of the error signal for locked laser to obtain the various noise contributions. Designed electronics to reduce the electrical noise.
- Worked with Rubidium 85 and 87. Performed frequency modulation spectroscopy to lock the frequency of the laser.
- Designed the optical imaging system for performing fluorescence imaging. Calculated the number of atoms and the size of the atom cloud in the MOT chamber.
- Calculated the background pressure due to Rubidium (released by ion pump) and other gases present in the vacuum cell using the loading curve and lifetime of the atom cloud to estimate the pressure quality of the vacuum cell.
- To remove an extra laser for repump, I used an EOM instead, which creates sidebands exactly at repump frequency (6.8 GHz away from the cooling/cyclic transition frequency of Rubidium 87).

BECCAL Project
Supervisor: **Prof. Dr. Patrick Windpassinger**   *May '23 - July '23*

- Contributed to the BECCAL (Bose-Einstein Condensate Cold Atom Laboratory) project, a joint space mission between NASA and the German Aerospace Center (DLR) aimed at conducting cold and ultracold atom experiments aboard the International Space Station (ISS).
- Developed and implemented a thermal control system to maintain precise temperature conditions in the vapor cells.
- Automated data acquisition and control processes using National Instruments devices such as PXI-6284, PXIe-6738, PXIe-8861, and PXIe-1088. Designed a graphical user interface to streamline data acquisition and control measurements, improving efficiency and reliability, using Python
- Created Python-based programs to automate control of equipment from Rigol Technologies and Rohde & Schwarz, enhancing the precision and repeatability of experimental procedures.

Monte Carlo Methods for an Ising Model Of A Ferromagnet
Supervisor : **Prof. Sanjeev Kumar**   *July '22 - Sept'22*

- Familiarized myself with Ising Model and its applications.
- Simulated the 2D Ising Model for ferromagnet and antiferromagnets in Python using Monte Carlo methods.
- Used Metropolis Algorithm in calculating various observables with the help of Python programming Language.
- Developed code for different types of Hamiltonians and interactions among spins and its consequences on the value of observables.

Ultra-Low Temperature Physics Lab
Supervisor : **Dr. Anant Venkatesan**   *May '22 - July '22*

- Worked in Python to operate on Liquid Instrument devices.
- Studied about quartz crystal, how its frequency changes when it is subjected to different conditions, and using this property in calculation of very small masses with certain accuracy.

LABORATORY
SKILLS

Condensed Matter Physics Lab:
- Measurements on various materials using standard equipment
    - Hall effect to study carriers in semi-conductors.
    - Four-probe method for resistance measurement.
    - Magnetic hysteresis loop on various magnetic materials.

Advanced Optics and Spectroscopic lab:
- Advanced optics experiments involving study of coherence on Michelson interferometer, Fabry-Perot atelon, Ultrasonic diffraction,microwave diffraction, etc.

Advanced Electronics and Instrumentation Lab:
- Micro-controller: Architecture and design. Executing electronic circuits using the micro-controller. Logic Gates, Flip Flops, Registers, and Counters. Basic digital I/O. Digital-to-Analog and Analog-to-Digital conversion.

Nuclear Physics Lab:
- Geiger-Muller (GM) Counter-based experiments: To determine the best operating voltage and the resolving time, and the dead time of the GM counter. To investigate the Binomial, Poisson and Gaussian probability distributions by counting radiation events with a GM counter and study the statistical fluctuations.
- Scintillation counter based experiments: To study the scattering of high-energy photons by electrons. Detection of scattered photons in a scintillation counter. Measuring energies of scattered photons and recoil electrons as function of scattering angle.

INDEPENDENT READINGS AND ONLINE COURSES

Machine Learning courses on Coursera : Certificate
- Supervised Learning (Regression and classification)
- Unsupervised Learning
- Advanced Learning Algorithms

Concepts in Magnetism and Superconductivity: NPTEL
- Certificate

Introduction to Laser: NPTEL
- Certificate

AWARDS & ACHIEVEMENTS

- Awarded Merit-Cum means fellowship for the 7th consecutive semester. *Aug '24*
- Recipient of Shraman Foundation Scholarship. *Jan' 2023-present*
- Elected as the member of Student Representative Committee of IISER Mohali. *Sep' 2022-Aug' 2023*
- Qualified Joint Entrance Examination (JEE) Advanced 2020. *September 2020*
- Got 2nd place in the Intermediate (12th) examination from BSEB board in the Patna district, Bihar. *April 2019*

EXTRA CURRICULAR ACTIVITIES

- Love playing chess, badminton, cricket and listening to classical Indian music, especially Sitar.
- Volunteered in TREX Startup Conclave: Startup Summit, 2022.
- Demonstrated Physics experiments to school students on Foundation Day at IISER Mohali, 2022.
- Volunteered in Insomnia 2022, college fest of IISER Mohali, handled the funding management for the fest.