Parth Bhargava

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EDUCATION

National University of Singapore *Aug 2024 – May 2028*

Bachelor of Science in Physics (Honors, Distinction) **GPA: 4.43**

COURSEWORK

Labwork:

- Measured **carrier type**, **density**, and **mobility** in n-type and p-type germanium via **Hall effect**; cross-validated mobility through independent **magnetoresistance analysis** ($R^2 > 0.99$); characterized **temperature-dependent transition** from extrinsic to intrinsic conduction at 106°C
- Determined **lattice constants** via **X-ray diffraction** using **Bragg's law**; achieved **sub-2% accuracy** for LiF and **0.24% deviation** for KBr identification through structural fingerprinting; extracted **Planck's constant** from bremsstrahlung cutoff analysis
- Calibrated **Helmholtz field constant** through five independent experimental methods with **3.3% uncertainty**; validated all **electromagnetic torque scaling laws** ($R^2 > 0.997$); determined unknown loop geometries via **magnetic moment measurements**; corrected mathematical model using **quadratic fitting** ($T \propto d^2$ vs linear)
- Characterized **electron spin resonance** in paramagnetic systems; extracted **g-factors** from frequency-field relationships with excellent linearity ($R^2 = 0.9995$); analyzed **Zeeman splitting** and resonance conditions
- Measured **Gaussian beam propagation** and **spatial intensity profiles**; determined **beam waist** and **Rayleigh range** with **sub-1% agreement** to theoretical predictions; characterized **beam quality factor**; validated **Gaussian beam optics** model ($R^2 > 0.998$)

Theory & Computation:

- **Mechanics:** Lagrangian and Hamiltonian formulations, coupled ODEs, variational principles, phase space dynamics
- **Electromagnetism:** Maxwell's equations, boundary-value problems, vector calculus, gauge theory
- **Quantum Mechanics:** Schrödinger equation, operator methods, eigenvalue problems, perturbation theory
- **Mathematical Methods:** Linear algebra, ODEs/PDEs, Fourier analysis, complex analysis, special functions
- **Computation:** Python, Julia, C++; numerical methods (finite differences, Runge-Kutta), data analysis, visualization
- **Experimental Methods:** Statistical analysis, uncertainty propagation, calibration, regression, error budgets

PROJECTS

Quantum Wavepacket Visualization *Jan 2025 – Mar 2025*

Developed interactive visualizations of quantum phenomena in Python

- **3D simulation** of quantum wavepacket traversing potential barrier using finite difference methods
- **Quantum harmonic oscillator** dynamics; visualization of energy eigenstates and time evolution

ACHIEVEMENTS

- **BITSAT: 321/390**, strong proficiency in Physics, Chemistry, and Mathematics
- **JEE Mains: 99.14 percentile** (Top 1% of 2 million candidates)
- **JEE Advanced Rank: 9112**, exceptional problem-solving abilities
- Awarded **Silver Medal** in International Aerospace Olympiad 2024
- **IISER Aptitude Test Rank: 357**

INTERESTS

- **Complex Systems & Nonlinear Dynamics:** Emergence, collective behavior, chaos theory, and how simple rules generate complex patterns across scales
- **Network Science & Information Theory:** Information flow, network structures, graph theory, and connections between abstract mathematics and physical systems
- **Computational Modeling:** Simulation, geometric intuition, and bridging theoretical frameworks with numerical methods