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 density** and **mobility** in n-type and p-type germanium via **Hall effect**; determined n-type: $n = 6.25 \times 10^{20}$ m^{-3}, $\mu = 0.363$ $m^2/(V \cdot s)$; p-type: $n = 8.60 \times 10^{20}$ m^{-3}, $\mu = 0.287$ $m^2/(V \cdot s)$; cross-validated mobility through **magnetoresistance** ($R^2 > 0.99$); observed **extrinsic→intrinsic transition** at 106°C via sign reversal
- Determined **LiF lattice constant** via **X-ray diffraction**: $d = 2.047 \pm 0.017$ Å (1.93% deviation); identified unknown crystal as **KBr** through structural fingerprinting: $d = 3.282 \pm 0.006$ Å (0.24% deviation); extracted **Planck's constant** from bremsstrahlung cutoff: $h = 8.7 \times 10^{-34}$ J · s (31% deviation, limited by S/N)
- Calibrated **Helmholtz field constant** through five independent experiments: $c = 6.81 \times 10^{-4}$ $T \cdot A^{-1}$ (3.3% uncertainty); validated all **scaling laws** ($R^2 > 0.997$); determined unknown loop area: 110 ± 4 cm^2; corrected diameter analysis using **quadratic fitting** ($T \propto d^2$)
- Characterized **electron spin resonance** in DPPH; extracted **g-factor**: $g = 1.905 \pm 0.025$ (4.9% deviation from free electron); validated frequency-field linearity ($R^2 = 0.9995$)
- Measured **Gaussian beam propagation** of He-Ne laser; determined **beam waist**: $W_0 = 0.394 \pm 0.008$ mm; **Rayleigh range**: $Z_R = 770 \pm 15$ mm (0.1% agreement with theory); beam quality: $M^2 = 1.08 \pm 0.05$; all intensity profiles fit Gaussian ($R^2 > 0.998$)

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