

Parth Bhargava

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EDUCATION

National University of Singapore

Bachelor of Science in Physics (Honors, Distinction)

Aug 2024 – May 2028

GPA: 4.43

COURSEWORK

Experimental Physics:

- Measured **carrier mobility** and type in semiconductors via **Hall effect**; cross-validated through **magnetoresistance analysis** ($R^2 > 0.99$); identified **intrinsic transition temperature** at 106°C ; comprehensive error propagation and uncertainty analysis
- Determined **lattice constants** via **X-ray diffraction** with sub-2% accuracy; applied **structural fingerprinting** and **Bragg's law** to identify unknown crystal phases (KBr); validated **Kramers theory** for bremsstrahlung cutoff; extracted Planck's constant from voltage measurements
- Calibrated **Helmholtz field configuration**; validated **five independent scaling laws** ($R^2 > 0.997$); quantified uncertainty in field constant to **3.3%** through cross-method comparison; corrected mathematical error in diameter dependence ($T \propto d^2$ vs $T \propto d$)
- Characterized **electron spin resonance** in paramagnetic systems; extracted **g-factors** and analyzed **hyperfine interactions**; measured resonance frequencies and determined spin parameters
- Analyzed **laser light propagation** through optical media; measured **diffraction patterns**, beam characteristics, and intensity profiles; studied interference phenomena and optical properties

Theoretical & Computational:

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

PROJECTS

Quantum Wavepacket Visualization

Jan 2025 – Mar 2025

Developed interactive visualizations of quantum phenomena in Python using numerical methods

- 3D simulation** of a quantum wavepacket traversing a potential barrier; implemented time-dependent Schrödinger equation solver with finite difference methods
- Quantum harmonic oscillator** dynamics; visualization of energy eigenstates, probability densities, and time evolution
- Interactive parameter controls for barrier height, width, and initial wavepacket momentum; publication-quality plots with proper normalization

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, and how simple rules generate complex patterns across scales; chaos theory, bifurcations, attractors
- Network Science & Information Theory:** Information flow, network structures, and connections between abstract mathematics and physical systems; graph theory, entropy, information geometry

- **Computational Modeling:** Simulation, geometric intuition, and bridging theoretical frameworks with numerical methods; fluid dynamics, pattern formation, multi-scale modeling