

Arush Gupta | CV

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Project reports, presentations, and talk summaries are available at the hyperlinks enclosed in [.]

Research Interests/Problems that caught my eye

Safety of Automated Vehicles, Deep Learning for System Health Monitoring and Failure Prediction

Education

Indian Institute of Technology (IIT) Bombay, Mumbai, India

5-year Interdisciplinary Dual Degree Programme, *Graduated*: August 2021

[Master of Technology](#), Microelectronics, Electrical Engineering

↔ Thesis title - "Conductance Signatures of Majorana Zero Modes in Kitaev Chain"

[Bachelor of Technology](#), Mechanical Engineering

• **Cumulative Performance Index (CPI)**: 8.81/10

Publications

- A. P. Roy, N. Bajaj, **A. Gupta**, V. Sathe, S. K. Mishra, R. Mittal, M. D. Le, and D. Bansal, 2021, "Strong trilinear coupling of phonon instabilities drives the avalanche-like hybrid improper ferroelectric transition in $\text{SrBi}_2\text{Nb}_2\text{O}_9$ ", *Physical Review B*, Vol. 103, Iss. 13, doi: 10.1103/PhysRevB.103.134111

Research Experience

- **Using NLP to Extract Information from Research Papers** Scheduled for May - Sept 2022
[Research Internship](#) | Supervisor - *Prof. Stefano Sanvito*, Trinity College, Dublin
- **Conductance Signatures of Majorana Zero Modes in Kitaev Chain** Aug 2020 - Jun 2021
[\[Master's thesis \(Link\)\]](#) | Supervisor - *Prof. Bhaskaran Muralidharan*, EE, IIT Bombay
Analyzed variations of conductance signatures of Majorana Zero Modes with the tuning parameters of a model p-wave superconductor using the Non-Equilibrium Green's Function formalism.
 - Modelled the Kitaev chain as a channel connected to normal leads in the wide-band limit.
 - Used Local Density of States calculations to show that a pair of Majorana edge modes appear at the ends of the Kitaev chain at zero-energy which remained intact within the topological regime.
 - Used linear and non-linear transport conductance calculations to show that Majorana Zero Modes exhibit characteristic high-conductance signatures that matched with analytical energy spectrum calculations of the Kitaev chain. Further, analysed effect of dephasing interactions on the topologically protected states in the Kitaev chain.
 - Platform used: Python
- **Topological Quantum Computation Using Majorana Fermions** Jan - Apr 2020
[\[Research Exposition \(Link\)\]](#) | Supervisor - *Prof. Bhaskaran Muralidharan*, EE, IIT Bombay
 - Exposition on the braiding properties of non-Abelian anyons, aspects of the emergence of Majorana Fermions, and physical set-ups to realise Majorana Fermions in condensed matter systems.
- **Coulomb Blockade Effect in a Single Spin-Degenerate Channel** Aug - Oct 2019
[Research Intern](#) | Guide - *Prof. Bhaskaran Muralidharan*, EE, IIT Bombay
 - Used the Lindblad Master equation to model current through a single spin-degenerate channel.
 - A double-sigmoidal curve was obtained for the current through the channel vs the voltage across the channel, showcasing single-electron charging energy, i.e, the Coulomb blockade effect.
 - Platform used: MATLAB

- **Nanoscale Phonon Transport Using Monte Carlo Simulations** May - Jul 2019
Research Intern | Guide - Prof. Dipanshu Bansal, ME, IIT Bombay
 - Fourier's law of heat conduction breaks down at the nanoscale, as phonon transport is not diffusive in nature. The motivation and aim was to model heat transfer at the nanoscale.
 - Studied a one-dimensional heat transfer solver, which employs the Boltzmann Transport Equation (BTE) to simulate phonon transport at the nanoscale and uses Monte Carlo methods to simulate phonon creation and annihilation events required for BTE.
 - Using a geometric formulation for linear propagation of phonons, extended the solver to solve for two-dimensions and for various boundary conditions at the system wall.
 - Platform used: MATLAB

Talks

- **Introduction to Quantum Computing** | [[Poster \(Link\)](#)], [[Summary \(Link\)](#)] 08 May 2020
Quarantalks by Maths and Physics club, IIT Bombay
 - Delivered a talk to introduce the paradigm of quantum computing using a toy problem of the Deutsch-Jozsa algorithm.
- **Let's Go Quantum: Applications of Quantum Physics** | [[Poster \(Link\)](#)] 20 Oct 2019
IIT Bombay R&D expo 2019
 - Delivered a talk to illustrate applications of quantum physics.

These talks were designed to introduce first and second year undergrads to concepts in the field without much emphasis on complex mathematical concepts so as to better facilitate learning.

Teaching Experience

- **Department of Electrical Engineering, IIT Bombay**
 Served as teaching assistant for the following courses:
 - EE724: Nanoelectronics ([Excellence award for teaching assistantship](#)) Spring 2020-21
 - EE101: Introduction to Electrical and Electronics Circuits Autumn 2020-21
- **English Language Improvement Training Programme, IIT Bombay** May 2018 - Mar 2020
 A student initiative under Student Mentorship Programme, IIT Bombay to help students bridge the gaps in their academic and social lives which may have arisen due to low proficiency in the language.
 - Served as a tutor conducting weekly classes and group activities for students to work on their English language speaking skills.
 - Worked to implement a dynamic and activity-centric curriculum.

Research/Exploratory trips

- **Rutherford Appleton Laboratory, Harwell, Oxfordshire, U.K.** 02 - 10 Dec 2019
Guide - Prof. Dipanshu Bansal, ME, IIT Bombay
 - Learnt how to use the test automation library 'Genie' for Python to automate inelastic neutron-scattering (INS) measurements at the MARI time-of-flight chopper spectrometer. [[Publication link](#)]*Visit sponsored by the Department of Science and Technology, Government of India*
- **Atomic Physics and Quantum Optics Lab, IISER Pune, India** 02 Nov 2019
IITB Maths and Physics Club field trip to Indian Institute of Science Education and Research Pune
 - Attended a lecture by Prof. Umakant D Rapol on the basics of optical quantum computing.
- **Raja Raman Centre for Advanced Technology, Indore, India** 26 - 30 Aug 2019
Guide - Prof. Dipanshu Bansal, ME, IIT Bombay
 - Learnt the working principles of various Spectroscopy techniques.*Visit sponsored by the Department of Mechanical Engineering, IIT Bombay*

Academic Projects

- **Band Structure Calculations for Graphene Nanoribbon** | Course project Autumn 2020-21
Course: *Physics of Nanoscale Devices II* - Prof. Ashwin Tulapurkar
 - Aim of the project was to understand the ease with which the tight-binding model can be used to render band structure calculations for complex periodic structures like Graphene nanoribbons
 - Modelled the Hamiltonian for the nanoribbon and subsequently coded a calculation for its eigenvalues to get the bandstructure.
- **Neutron Diffraction and X-ray Photospectroscopy** | Term Paper Autumn 2019-20
Course: *Lattice Dynamics and Thermal Energy Transport* - Prof. Dipanshu Bansal
 - Learnt and documented the fundamentals of aforementioned spectroscopy techniques, including mechanism of probe beam generation, beam routing optics, mounting procedure for samples, mechanism of signal detection, and post-processing of data.
- **Relating Thermodynamics to Information Theory** | Term Paper Autumn 2018-19
Course: *Thermal and Statistical Physics* - Prof. K. G. Suresh
 - Learnt and documented the basics of information theory and how it might connect to thermodynamics by noting the similarities in the expressions for mutual information and free energy for a given system.
- **Automatic Flame Regulator** | Course Project Spring 2017-18
Course: *Mechanical Measurements* - Prof. Amit Agrawal
 - Proposed a novel measurement set-up that uses machine learning to train a control algorithm intended to regulate fuel consumption rate whilst making tea in order to save heating energy.
 - Selected amongst the top 9 proposals in a class of 90 to be presented to the class.
- **Laser Printer Disassembly** | Course Project Autumn 2017-18
Course: *Engineering Metallurgy* - Prof. Parag Bhargava
 - Disassembled a printer in a team of 15, and exhibited the materials used in the printer.

Coursework

- **Mechanical:** Microprocessors and Automatic Controls*, Kinematics and Dynamics of Machines*, Mechanical Measurements*, Operations Research and Industrial Engineering, Advanced Thermodynamics, Materials modelling using atomistic first-principles calculations, Lattice Dynamics and Thermal Energy Transport, Optical Methods in Mechanical Engineering, Heat Transfer
- **Electrical:** Topological Electronics, Physics of nanoscale devices II, Solid state devices, VLSI Technology, Introduction to Electrical and Electronics Circuits
- **Physics:** Quantum Information and Computing, Introduction to Condensed Matter Physics, Quantum Mechanics I, Statistical Physics, Thermal and Statistical Physics, Basics of Electricity and Magnetism
- **Miscellaneous:** Linear Algebra, Differential Equations, Sociology, Economics, Calculus, Data Analysis and Interpretation, Computer Programming and Utilization, Engineering Metallurgy
- **Coursera courses:** Deep Learning Specialization (Set of 5 courses, Ongoing)
*Have done both theory and lab courses with the same name

Lab internships

- **Lab Assistant | Internal Combustion Engines Lab** May - Jun 2018
Guide - Prof. Arindrajit Chowdhury, ME, IIT Bombay
 - Part of a team responsible for performing static fire tests for a liquid rocket engine in order to collect fuel-specific load cell measurements of thrust-vs-fuel rate.

- **Lab Intern | Micro Aerial Vehicles Lab**

May - Jun 2017

Guide - *Prof. Hemendra Arya, AE, IIT Bombay*

- Scripted and ran codes on a dynamometer for acquisition of thrust-vs-voltage data for different combinations of propellers and brushless motors. (Auxilliary work - patched up a LiDAR Lite sensor to an Arduino; patch was further used for a project to map 2D environments).

Technical Skills

- **Programming Languages:** Python (NumPy, Matplotlib, SciPy), MATLAB, C++, \LaTeX
- **Hardware and Software Skills:** Embedded C, Arduino IDE, SolidWorks, AutoCAD

Extra-Curricular Activities

- **Condensed Matter Reading Group:** Ideated and initiated students' online special interest groups in collaboration with EnPoWeR, IIT Bombay. Hosted the special interest group on condensed matter physics (2020).
- **Mentor for Summer Reading:** Mentored batches of 4 students during the summers of 2019 and 2020 to cover grounding concepts in quantum computing (2019) and quantum physics (2020).
- **Content Creator, Maths and Physics Club:** Prepared a summary of key concepts involved in introductory condensed matter physics (2019).
- **Organized a lecture to promote a culture of R and D** titled "Discovering the Charm in Engineering" by Prof. Parag Bhargava (Dept. Of Materials Science, IIT Bombay) (2018).
- **Online Physics Brawl:** In teams of 3, participated in Online Physics Brawl, an international physics competition by the students of Mathematics and Physics at Charles University in Prague (2016 and 2017).
- **RC Plane:** In a team of 3, designed and built a remote controlled airplane using coroplast sheets as control surfaces and mounted servos on the wings and the tail to actuate the ailerons and the elevators of the plane (2016).
- **National Service Scheme (NSS) IIT Bombay:** Volunteered for the year 2016-17.

Academic Achievements

- Awarded excellence in **Teaching Assistantship** for the course **Nanoelectronics** of the Department of Electrical Engineering (2021).
- Granted a **conversion** to the Interdisciplinary Dual Degree Programme in the Dept. of Electrical Engineering based on exceptional technical involvement and academic performance (2019).
- Awarded recognition for exemplary contributions to the English Learning Program as **Teaching Assistant** under the Student Mentor Program of IIT Bombay (2019).
- Granted a **change of branch** from the Dept. of Aerospace Engineering to the Dept. of Mechanical Engineering based on exceptional academic performance at the end of first year (2017).
- Secured **All India Rank 923** and **3001** in **Joint Entrance Examination (Advanced) 2016** and **Joint Entrance Examination (Mains) 2016** respectively among 1.4 million candidates.

Test Scores

- **GRE General - 324/340, 4.0/6** Taken on 12th Oct 2021
Verbal Reasoning - 158, Quantitative Reasoning - 166, Analytical Writing - 4.0
- **TOEFL - 115/120** Taken on 13th Oct 2021
Reading - 29, Listening - 30, Speaking - 28, Writing - 28

References

- **Prof. Bhaskaran Muralidharan** bm@ee.iitb.ac.in
Department of Electrical Engineering, IIT Bombay, India
- **Prof. K. G. Suresh** suresh@phy.iitb.ac.in
Department of Engineering Physics, IIT Bombay, India
- **Prof. Parag Bhargava** pbhargava@iitb.ac.in
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