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Devashish Shah

Third Year Undergraduate at IIT Bombay

GitHub
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Research Interests

My interests are primarily centered around Quantum Computing and Cosmology, although I love exploring various areas of Physics, Mathematics, and Electronics.
I find the experimental side of Quantum Computing, especially **Quantum Control and Measurement**, extremely intriguing, and I wish to explore this and related fields further. So far, my experience in the field of Quantum Computing has been inclined towards instrumentation involved in measurement and data acquisition.
I am also interested in General Relativity and Cosmology, particularly **Inflationary Cosmology**, and how Quantum Effects during Inflation, the period of exponential expansion led to the universe we see today.

Education

- Indian Institute of Technology, Bombay *(Nov'20-Present)*
  - Major: Bachelor of Technology in Engineering Physics with Honors **GPA: 9.42/10**

Key Projects and Research

RF Pulse Engineering [Report] *(May'22-Present)*

Guide: Prof. Suddhasatta Mahapatra, Department of Physics, IIT Bombay

QCoDeS is an open source Python-based data acquisition framework developed by the **Copenhagen/ Delft/ Sydney/ Microsoft quantum computing** consortium, made to facilitate measurements in nanoelectronics.

- Developing drivers using QCoDeS to control an Arbitrary Waveform Generator, a Vector Signal Generator, and associated equipment to engineer **Radio Frequency pulses** for **quantum control** of **spin qubits**.
- Studied sensing and measurement techniques used for quantum control of spin qubits in **Quantum-Dots** fabricated in Silicon hetero-structures at the Silicon Quantum Computing (QSi) lab at IIT Bombay.
- Built an Analog circuit using Op-Amps that mimics the current $\{I_{SD}(V_{G1}, V_{G2})\}$ map through a **Single Electron Transistor** capacitively coupled to two plunger gates on a larger voltage scale.

Models of Inflation | Research Project *(Nov'21-Present)*

Guide: Prof. Vikram Rentala, Department of Physics, IIT Bombay

- Research project studying the different **Models of Inflation** which explain how **quantum fluctuations** in the very early, near homogeneous universe grew to form the large scale structure we see today.
- Current focus of the project is on studying Cosmological Inflation and re-deriving results from the **T.A.S.I.** (Theoretical Advanced Study Institute) **lectures on Cosmology** by Daniel Baumann *(Jul 2009)* linked here.
- Read up on all relevant topics in **General Relativity** and **Physical Cosmology** with *Spacetime and Geometry* (by Sean Carroll) and *Modern Cosmology* (by Scott Dodelson) as the primary reference books.

Other Projects

Data Analysis of High Energy p-p Collisions | Course Project *(Sep'21-Nov'21)*

Prof. Sadhana Dash, IIT Bombay | PH219: Data Analysis and Interpretation

- Analyzed and interpreted data consisting of 4 million observations of high energy (Center of Mass Energy $\sim 13\,Tev$) proton-proton collisions generated using **PYTHIA 8 Monte Carlo** event generator.
- Studied the relationship between net-charge fluctuation and multiplicity by analyzing and plotting statistical parameters (like mean, std. deviation, etc) related to net-charge fluctuations using **ROOT - Cern** data analysis software. The project report and codes can be found here.

Nonlinear Dynamics in Biological Co-evolution | **Course Project** *(Sep'21-Nov'21)*

Prof. Amitabha Nandi, IIT Bombay | PH567: Nonlinear Dynamics

- Analyzed, interpreted, and recreated results of a paper on the application of the **Replicator Equations** in studying nonlinear behaviour and **Bifurcation Theory** for biological co-evolution of three species.
- Simulated the nonlinear **Phase Space** behaviour of the three co-evolving species populations using numerical methods to solve the replicator equations (differential equations) and plotted it using **Python**.
- The project report and presentation summarizing the analysis and conclusions can be found here.

Huffman Coding | **Course Project** *(Feb'22-Apr'22)*

Prof. Maniraj Mahalingam, IIT Bombay | EE224: Digital Systems

Huffman coding is a **lossless data compression** algorithm that assigns variable length codes to different characters based on the frequency of occurrence as compared to constant length of conventional ASCII.

- Designed an easily extensible **digital circuit** using a collection of both **sequential and combinations** logic elements that can perform compression using Huffman coding for a message consisting of 3 letters.
- Used components like **logic-gates**, **flip-flops**, registers, counters, and memory elements working in sync with a system clock summarizing the final circuit design in the report linked here.

The Gaia Theory | **Course Project** *(Aug'21-Sep'21)*

Prof. Kiran Kondabagil, IIT Bombay | BB647: Introduction to Evolutionary Biology

- Studied the modern version of the **Gaia Theory** and topics from **System Sciences** which are crucial to understand a planet's atmospheric and surface phenomenon, especially those affecting Earth ecosystems.
- Reviewed scientific papers on theories suggesting possible bottlenecks faced for evolution of life on a planet, focusing on the novel **Gaia Bottleneck Hypothesis**, seeking the answer to Fermi's Paradox.

Electronics Projects | **Lab Courses** *(May'21-Present)*

Physics Department, IIT Bombay

- Designed, Simulated and Physically implemented several circuits including Op-Amp based filters, Oscillators, PID Controllers, Amplifiers and Finite State Machine Implementations.

General Theory of Relativity | **Reading Project** *(May'21-July'21)*

Maths and Physics club, IIT Bombay | Summer of Science

- Completed a reading project (and report) on Einstein's **General Theory of Relativity** studying the fundamentals of Riemannian Geometry, Tensor Algebra, Gravitation and exploring Inflationary Cosmology.

Teaching Experience

Teaching Assistant | **PH-108** | **PH107** *(Mar'21-Jul'22)* | *(Nov'21-Mar'22)*

Physics Department, IIT Bombay

Conducted weekly tutorials to discuss problem sets, solved doubts and provided general course-work related guidance.Tutored a batch of 45 students for freshmen year courses:

- PH-108, **Basics of Electricity and Magnetism**.
- PH-107, **Quantum Physics and Applications**.

Notes I made for the tutorial sessions are linked here.

Summer of Science Mentor *(May'22-Jul'22)*
Maths and Physics Club, IIT Bombay

- Guided students for the research based reading project on the topics of **Cosmology and Dark Matter**.
- Provided resources for learning basics of Cosmology and helped with topic related doubts whenever required and reviewed the final reports and video explanation about the project submitted by the students.

Technical Skills

Programming: C, C++, Python (incl. packages like scipy, einsteinpy, etc.), HTML, QCoDeS

Technical Software: MATLAB, Mathematica, ROOT-Cern, LaTeX, Autocad, SolidWorks, Photoshop

Spoken Languages: English, Hindi, Gujarati, Marathi

Scholastic Achievements

- Currently **Department rank 6** out of 66 students in Engineering Physics batch of 2024. *(Jul'22)*
- Secured **All India Rank 612** out of 250,000 candidates in **JEE-Advanced 2020**. *(Oct'20)*
- Secured **99.87 Percentile** out of 0.87 million candidates in **JEE-Main 2020**. *(Sep'20)*
- Selected for Kishore Vaigyanik Protsahan Yojana (**KVPY**) fellowship in SX catagory, provided by IISc, ranking in the **Top 1.36%** out of 0.97 million candidates. *(Apr'20)*

Key Courses Undertaken

- **Physics:** Group Theory*; Photonics*; Quantum Mechanics II*,III*; General Theory of Relativity; Waves, Oscillations and Optics; Quantum Mechanics I, Data Analysis and Interpretation; Special Relativity; Thermal Physics; Classical Mechanics; Physics Lab; Quantum Physics and Applications; Basics of Electricity and Magnetism.
- **Mathematics:** Introduction to Numerical Analysis; Differential Equations I, II; Complex Analysis; Calculus; Linear Algebra.
- **Electronics:** Digital Systems; Microprocessors Lab*; Electronics Lab (Analog and Digital).
- **Miscellaneous:** Philosophy*; Engineering Graphics & Drawing; Chemistry; Biology; Chemistry Lab; Gender in the Workplace; Computer Programming and Utilisation.

(*) Courses to be completed by Nov'22

Extracurricular Activities

- Regularly play **Squash** and participated in NSO sports in my freshman year.
- Secured **2nd** position among multiple participating schools from all over Thane, in Inter School Quiz Competition conducted by **Rotary Club** of Thane Lake City (2017-18).
- Taekwondo **Poom Black Belt** certificate received from the **World Taekwondo federation**.
  - Participated in several Tournaments winning a Silver in state level S.F.A (2016), Bronze in the 4th Invitational Kudo Championship (2012) among others.
- Secured **A grade** in both the Elementary and Intermediate Examinations conducted by the Art Directorate of the Government of Maharashtra.