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Devashish Shah

Third Year Undergraduate at IIT Bombay

GitHub
My Website

Research Interests

To a large extent, my interests revolve around two broad fields; Quantum Computing and Cosmology.
I find the experimental side of Quantum Computing, especially **Quantum Control and Measurement**, extremely intriguing. 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, especially the study **Inflationary Cosmology** and how Quantum Effects during this 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**
- People's Education Society Jr. College *(May'18-Jun'20)*
  - **XII** Grade [Physics, Chemistry, Mathematics & Computer Science] **95.23%**
- D.A.V. Public School *(Apr'18)*
  - **X** Grade **97.6%**

Key Projects

RF Pulse Engineering *(Jun'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.
- Please find the reports summarizing the QCoDeS related work done during the summers (Jun'22 to Jul'22) here.

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.

Teaching Experience

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

Physics Department, IIT Bombay

Fulfilled the duty of **tutoring, solving doubts and grading quizzes** for freshmen year courses. Conducted weekly tutorials to discuss problem sets and provided general course-work related guidance.

- Tutored a batch of 45 students for the 1^{st} year course PH-108, **Basics of Electricity and Magnetism**.
- Tutored a batch of 45 students for the 1^{st} year course PH-107, **Quantum Physics and Applications**.

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.
- Reviewed the final reports and video explanation about the project submitted by the students.

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.

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.

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.

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.

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: Basics of Electricity & Magnetism; Classical Mechanics; Quantum Mechanics - I, II*, III*; Waves, Oscillations and Optics; Non-linear Dynamics; General Relativity; Photonics*; Group Theory*

Data Analysis: Data Analysis and Interpretation

Electronics: Introduction to Electronics; Analog Circuits Lab; Digital Systems; Digit Electronics Lab; Microprocessors Lab*

Mathematics: Calculus, Linear Algebra, Differential Equations, Complex Analysis, Numerical Analysis

Programming: Computer Programming and Utilization

(*) Courses to be completed by Nov'22

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

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.