Mahadevan Subramanian

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Education

- **Indian Institute of Technology, Bombay** — **CGPA: 9.58/10**
  Second year undergraduate, Engineering Physics — *Jul 2019 – Present*
- **HSC** — **89.7%**
  Intermediate/+2 — *Jul 2017 – Mar 2019*
- **ICSE** — **95.67%**
  Matriculation — *Mar 2017*

Pursuing **Honors** in **Physics** and a **Minor** in **Computer Science and Engineering**

Scholastic Achievements

- Secured **Department Rank 4** (of 51 students) after first year of B.Tech (Department of Physics) *Jun 2020*
- **Joint Entrance Exam**
  - Achieved **99.58 percentile** in **JEE Advanced** among **200,000 participants** for entrance to IITs. *May 2019*
  - Among **top 0.09** percentile in **JEE Main Paper 1** amongst **1.5 million students** across India. *Apr 2019*
- **SAT Scores**
  - SAT I: Scored 800/800 in Mathematics section, and a total score of 1460/1600. *May 2018*
  - SAT Subject Test: Scored 800/800 in Mathematics II and Physics tests. *Oct 2018*
- Recipient of the esteemed **Kishore Vaigyanik Protsahan Yojana (KVPY) Fellowship** from IISc *May 2018*

Key Projects

Reading Project on Quantum Simulations [report]
Guide: Professor Alok Shukla, IIT Bombay — *Oct 2020 – Present*

- Studied the problem of quantum simulation and examples of implementations of **analog and digital quantum simulation**.
- Studied **Hartree-Fock theory** along with its canonical transformations with an implementation using **Given's rotations**.
- Explored physical implementations of **Bose Hubbard** hamiltonian using atoms and ions to observe phase transitions and **NMR** spectroscopy for ground state energy calculation of the hydrogen molecule.

Measurement Theory in Quantum Mechanics [report]
Guide: Professor Amber Jain, IIT Bombay — *Apr 2020 – Aug 2020*

- Reviewed the different interpretations of quantum mechanics including **Bohmian Mechanics**, **Many Worlds Interpretation** and the **Ghirardi–Rimini–Weber** theory in order to appreciate their different approaches to measurement.
- Inspected the possible breaking points for each of these theories and also understanding their respective advantages.
- Investigated papers on experimental methods aimed at bringing out the differences between these multiple interpretations.
- Examined certain experiments which aimed to find the quantum to classical transition point according to the **Ghirardi–Rimini–Weber** and **Continuous Spontaneous Localization** models.

Resynchronization of circadian oscillators, east-west asymmetry of jet-lag [report, code]
Prof: Amithabha Nandi, Course Project, Non-linear Dynamics — *Sep 2020 – Nov 2020*

- Modelling **suprachiasmatic nucleus** cells which are responsible for circadian rhythms to understand the process of jet-lag.
- Making use of the **Forced Kuramoto model** and studying the east-west asymmetry of jet-lag by simulating this model.
- Extended the model to account for continous travel instead of instantaneous and observed slightly varying dynamics.

Higher moments of average of transverse momentum of p-p collisions [report, code]
Prof: Sadhana Dash, Course Project, Data Analysis and Interpretation — *Oct 2020 – Nov 2020*

- Analysed data of transverse momentum of proton-proton collisions at 13 TeV obtained using Pythia Generator 8.
- Calculated higher moments of the average transverse momentum for different multiplicity classes using **ROOT** macros.
- Observed the variation of values of standardized variance, intensive and standardized skewness for different multiplicities.

Quantum Information and Computing [report]
Reading Project, Summer of Science, Maths and Physics Club, IIT Bombay — *Apr 2020 - Jun 2020*

- Studied and compiled a comprehensive report on the fundamentals of quantum computing including **reversible computation**, **quantum measurement** and **quantum circuits** of various algorithms.
- Explored **quantum protocols** such as teleportation, superdense coding and the BB84 protocol.
- Analysed **quantum algorithms** including Grover's search algorithm and quantum fourier transform along with its application for solving the **hidden subgroup problem** more efficiently.
- Implemented unitary decompositions, phase estimation, discrete logarithms and the BB84 protocol using **Qiskit** and **Q#**.

Deep Learning for Leaf Disease Detection [website, code]
Institute Technical Summer Project, Institute Technical Council *Apr 2020 - Jun 2020*

- Developed a **DenseNet** model in **TensorFlow** which diagnoses diseases in apple leaves with over **95%** accuracy.
- Analysed Heatmaps and Intermediate Layer Activations to further improve the model performance on unseen data.
- The aforementioned model could classify any given image of apple leaf as healthy or having rust or scab disease or both.
- Built and deployed a **website** where one can upload images of apple leaves and obtain the results predicted by the model. The backend of the website was developed on Django, and HTML, CSS and JS were used for the frontend.

Positions of Responsibility

Convener, Maths and Physics Club, IIT Bombay
Institute Technical Council, IIT Bombay *May 2020 – Present*

- Working in a team of eight students to foster enthusiasm in Physics and Mathematics, tending to a community of over **1,000 students** on campus and **10,000 enthusiasts** online.
- Adapted the structure and events of the club to an **online format** in order to engage enthusiasts during the COVID-19 pandemic by organizing online talks by students and professors all over the world, conducting online quizzes and contributed to writing blog posts on various scientists and scientific concepts.
- Hosted and prepared questions for an online quizzing event titled "Trivia Time" for quizzing on Math and Physics trivia.

Moderator, Quantum Computing Workshop [workshop material]
Maths and Physics Club, IIT Bombay *Jul 2020 – Aug 2020*

- Developed course-content to moderate an 8-day **Quantum Computing Workshop** for introducing **Qiskit** and basic concepts of Quantum Computing which attracted **500+** students from multiple universities across India.
- Designed questions involving coding to supplement theoretical understanding of topics such as **BB84 protocol**, **Grover's algorithm** and **Quantum Fourier transform** and their applications such as period finding and finding discrete logarithms.
- Conducted live hands-on-sessions and created presentations for guiding the participants to understand the underlying concepts and clearing doubts and moderated a forum with 200+ active participants for clearing doubts.

Teaching Assistant, PH 107 (Quantum Physics and Application)
Instructor: Prof. CV Tomy, Department of Physics, IIT Bombay *Dec 2020 – Present*

- Responsible for conducting tutorials for a class of 40 students, guiding and mentoring them with their coursework.
- Conducted and evaluated quizzes for the course and held doubt sessions when necessary.

Technical Skills

- **Languages:** C++, Python
- **Packages & Softwares:** NumPy, SciPy, Matplotlib, Pandas, TensorFlow, Qiskit, ROOT
- **Others:** HTML, CSS, AutoCAD, Solidworks, Arduino IDE, Q#

Relevant Courses

- **Physics :** Classical Mechanics, Introduction to Special Theory of Relativity, Non-linear Dynamics, Thermal Physics, Basics of Electricity and Magnetism, Quantum Physics and Application
- **Math :** Complex Analysis, Differential Equations II, Linear Algebra, Calculus
- **Computer Science :** Logic for Computer Science, Computer Programming and Utilization
- **MOOCs :** Completed Deep Learning Specialization offered by **deeplearing.ai** (Coursera)
- **Other :** Data Analysis and Interpretation, Digital Systems, Introduction to Electronics, Economics, Biology, Physical Chemistry, Organic and Inorganic Chemistry

Extracurricular Activities

Core and Technical

- Completed the **IBM Quantum Challenge**, a quantum programming challenge based on **Qiskit**. *May 2020*
- Secured **1st** place in the **Observation Planning GC** (inter-hostel astronomy competition). *Oct 2019*

Culturals

- **Institute Cultural Summer Project** *Aug 2020*
  - Composed two original songs using a digital audio workstation which have been released on various streaming platforms under **Symphony**, music club of IIT Bombay.
- **Goonj GC, Music Arcade GC** (inter-hostel music competitions) *Feb, Mar 2020*
  - Performed keyboard in **Goonj GC** and arranged an original piece that was performed by our band.
  - Secured **2nd** position in **Music Arcade GC** and was awarded best keyboardist.
- Performed keyboard in **Surbahaar**, an annual musical event in IIT Bombay with an audience of 2,000 people