Aswin Suresh

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Education

Indian Institute of Technology Bombay **2020 – Present**
Bachelor of Technology in Engineering Physics *GPA: 8.43/10*
Minor in Data Science and Artificial Intelligence with GPA 10.0/10

Research Experience

Real-Bogus Astrophysical Event Classification for GROWTH India Telescope **August '22 – Present**
Guide: Prof. Varun Bhalerao, Dept. of Physics, IIT Bombay

- Reviewed literature on various **deep learning models** and data augmentation methods used by transient observatories such as Zwicky Transient Facility (**ZTF**), **MeerLICHT** and **GOTO** for detection of transients in image subtraction residuals
- Implemented a pipeline to robustly remove **bogus transients** by characteristics in positive and negative image subtraction residuals and working on improving the image subtraction and **candidate vetting** pipelines for the GROWTH India Telescope

Automation and Updates of CZTI Interface for Fast Transients **November '21 – August '22**
Guide: Prof. Varun Bhalerao, Dept. of Physics, IIT Bombay

- Developed a pipeline to **inject artificial Gamma Ray Burts** in raw event data from the Cadmium Zinc Telluride Imager (CZTI) aboard AstroSat, to quantify the efficiency of CZTI data processing pipelines using T90 and SNR calculations
- **Automated untriggered searches** for GRBs in CZTI data with functionalities to process bulk data as well as day-to-day data inflow using CZTI Interface for Fast Transients - an automated pipeline to identify bursts from lightcurves and time-energy plots
- Created a 40-second **animation** of **spatial distribution of Gamma Ray Bursts** detected by AstroSat CZTI to commemorate its detection of 500 GRBs, highlighted extensively by press and media agencies across India as well as internationally
- Carried out triggered and untriggered searches for GRBs with **ten** Gamma-ray Coordinates Network Notices published in 2022

Automated Identification of Solar Flares **March '22 – Present**
Indian Space Research Organization (ISRO)

- Developed *SuryaDrishti*, a standalone web-based application using Python and Angular to **identify and categorise** X-ray bursts from **Solar X-ray Monitor** aboard Chandrayaan-2 based on peak energy flux, with functionalities to aid flare analysis
- As part of a team of 6, led the implementation **statistical algorithms** to identify solar flares from raw data and used an Elementary Flare Profile **(EFP)** fit to extract properties of scientific interest such as Temperature and Emission Measure
- Implemented curve fitting of a modified exponential gaussian and compared its performance against EFP fit using multiple metrics

Workshops

ZTF Summer School | *Zwicky Transient Facility* **Summer '22**

- Implemented **statistical and deep learning methods** to perform tasks such as classification of supernovae spectra, fast-transient identification and **real-bogus classification** of transients in ZTF data as well as filter out **noise artifacts** from ZTF alert stream
- Performed neutrino follow-up of localisation from **IceCube** observatory and analysed **3D localisation** data and **HEALpix** maps from LIGO and performed **galaxy cross-match** to find galaxies that have 90% volume probability for **GW170817**
- Learnt techniques in **Bayesian Statistics** and worked with the nuclear physics and multi-messenger astrophysics pipeline to generate lightcurve models for **kilonovae** and **GRB afterglows** and create injected **electromagnetic and GW signals**

Course Projects

Estimating Parameters of Binary Black Hole Mergers **October '22 – November '22**
Course Project | Guide: Prof. Archana Pai, Dept. of Physics, IIT Bombay

- Performed parameter estimation using the **bayesian inference** library **Bilby** to obtain chirp mass, distance, inclination, geocent time and phase of an injected non-spinning binary black hole signal from **three detector strain** data by carefully choosing priors
- Studied **noise characteristics** of LIGO detectors and calculated the auto-spectral density and **whitened strain** using **GWpy**, which was used to estimate the chirp mass of the system using the frequency evolution from **Q-transform** of whitened data

Photometry and Supernovae: A Case Study **July '21 – November '21**
Krittika Summer Projects, IIT Bombay

- Implemented a python pipeline to perform aperture and point spread function **photometry** and obtain the lightcurve of supernova **SN2018hna**, using optical data from **GROWTH India Telescope** to understand its astrophysical properties
- Performed **image reduction** and photometry using Astropy and Aperture Photometry Tool (**APT**) and attempted curve-fitting the lightcurve using the Python library **SNCosmo** to obtain an estimate of the **red-shift** of the supernova

Chaos Computing **October '22 – November '22**
Course Project | Prof. Amitabha Nandi, Dept. of Physics, IIT Bombay

- Simulated *chaogates* - a **dynamical computing device** that can morph into different digital logic gates depending on a non-linear function - using the **logistic map and tent map** independently on Python, Arduino and a CMOS simulation with NgSPICE
- Calculated the Lyapunov exponents, created orbit diagrams and bifurcation maps for the CMOS simulation at various bias voltages

Modelling Active Three-Body System with Arduino **September '22 – November '22**

Course Project | Prof. Pradeep Sarin, Dept. of Physics, IIT Bombay

- Solved differential equations describing a system of three **interacting active particles** in a noisy environment using Arduino Uno
- Interfaced the position and velocity output from Arduino serial monitor to MS-Excel to plot the motion of the particles in real time

Cryptocurrency Price Prediction **October '21 – November '21**

Course Project | Guide: Prof. Amit Sethi, Dept. of Electrical Engineering, IIT Bombay

- Performed exploratory data analysis of financial data on bitcoin, ethereum and litecoin, including a detailed **technical analysis** using **candlestick plots**, bollinger bands, moving averages, On-Balance Volume and **Relative Strength Index**
- Implemented deep learning models such as **Gated Recurrent Units** and **Long-Short Term Memory** using TensorFlow and Keras API to predict the price of cryptocurrency such as bitcoin and litecoin with an R^2 **metric score greater than 0.9**

Multiplicity Fluctuations in p-p Collisions **October '21 – November '21**

Course Project | Guide: Prof. Sadhana Dash, Dept. of Physics, IIT Bombay

- Performed data analysis on over **two million events** generated using PYTHIA 8 for **proton-proton collisions** at 13 TeV
- Plotted particle **multiplicity histograms**, mean, standard deviation and scaled variance of multiplicity distributions for different multiplicity classes for accepted and rejected particles, using ROOT

Awards and Scholastic Achievements

- Awarded a **Gold Medal** in **Inter-IIT Tech Meet 9.0** in the astronomy problem statement, with a final score of 209/250 - **30% higher than other teams** - based on code performance and live working demo *(2022)*
- Awarded a **Change of Branch** to Engineering Physics among **8 out of 1200+** students based on excellent grades *(2021)*
- Secured **99.62** percentile in Joint Entrance Examination **(JEE) Mains** among 0.92 million candidates *(2020)*
- Secured **96.5** percentile in Joint Entrance Examination **(JEE) Advanced** among 0.16 million candidates *(2020)*
- **3-time winner** of national level science olympiad Sastra Pratibha; invited to research institutions of DRDO, ISRO, CSIR, ICT and BrahMos with an opportunity to meet former president **Dr. APJ Abdul Kalam** *(2013 - 2016)*

Positions of Responsibility

Team Lead | Team ANYmation, IIT Bombay **June '22 – Present**

An all-student team of 15 developing physically accurate, astronomy animations through procedural techniques

- Created the first edition of outreach and presentation renders and animation for the proposed high energy transient mission **Daksha** , complete with aesthetic composition and lighting, presented at various national and international scientific conferences
- Working towards developing interactive simulations using **UNITY** aimed towards education and outreach
- **Mentoring** a group of 10 students, in procedural astrophysics animations using **Blender** and Python as part of Krittika Summer Projects 2022 by the astronomy club of IIT Bombay

Volunteer | Krittika **June '21 – August '22**

The Astronomy Club of IIT Bombay

- Created **python problem statements** and solutions for multiple events and projects including Krittika Summer Projects 2021 and 2022 and helped in organising a **lecture series** delivered by science communicators and professors of astronomy
- Assisted in astronomy outreach efforts of the club by designing social media posts highlighting interesting astronomical phenomena and conducting **stargazing sessions** using Newtonian and Equatorial telescopes, covering Deep Sky Objects (**DSOs**) and planets
- Helped organize the Krittika Summer Projects 2022, an 8-week long program aimed at **exposing students to astronomical research** and received 100+ applications along with international participation for the first time
- Organised a **high level discussion** on X-ray astronomy and unique properties of the X-ray binary **MAXI J1535-571**

Courses Undertaken

Physics:	Gravitational Wave Physics and Astronomy, Quantum Mechanics I and II, Non-Linear Dynamics, Photonics, Waves and Optics, General Relativity, Classical Mechanics, Special Theory of Relativity, Thermal Physics, Electricity and Magnetism
Mathematics:	Numerical Analysis, Linear Algebra, Differential Equations I and II, Complex Analysis, Differential Equations II, Calculus
Data Science:	Image Processing, Computer Programming and Utilization, Programming for Data Science, Data Analysis and Interpretation, Data Structures and Algorithms

Technical Skills

Languages:	Python, C/C++, SQL, ROOT
Libraries:	Astropy, NumPy, Matplotlib, SciPy, Pandas, GWpy, PyCBC, Seaborn, Tensorflow, Keras, OpenCV, SymPy, Blender Python