Shanmugha Balan

+91 77340 18009
f20190571@pilani.bits-pilani.ac.in
sbalan7.github.io

Education

2019–2024 **M Sc Physics**, *Birla Institute of Technology and Science - Pilani*, Pilani, India

2019–2024 **B E Electrical and Electronics Engineering**, *Birla Institute of Technology and Science - Pilani*, Pilani, India

2017–2019 **Higher Secondary School**, *SBOA School and Junior College, Anna Nagar*, Chennai, India

Research Experience

Aug 22 – Present **Udaipur Solar Observatory**, *Physical Research Laboratory*, Dr Nandita Srivastava
Working on optimizing code to simulate magnetic field lines around the Sun using the Schatten Current Sheet model and the Potential Field Source Surface model.

Dec 20 – Present **Department of Physics**, *BITS Pilani*, Dr Kaushar Vaidya
Working on data about the star clusters in our galaxy from the Gaia Mission by the European Space Agency, queried through VizieR, a database maintained by the University of Strasbourg. Built a uniform data analysis pipeline in Python called StarStuff to study the structural and dynamical properties of star clusters and stellar evolution.

Jan 22 – Jul 22 **Institute for Astronomy**, *University of Hawaii*, Dr Roger CC Lin
Variable stars selected from the AAVSO database were queried in the PanSTARRS DR1 archives for their time series light curve data. A transformer-based model was trained in Python and used to reconstruct and predict light curves of variable stars given an initial light curve.

Oct 21 – Jan 22 **Space Technology Cell**, *Indian Space Research Organization*, Dr Dipti Patil
Theorized a model predictive controller model to determine a safe and optimal landing trajectory for a lunar spacecraft. Implemented a simulation of the controller in Python to select controlled descent trajectories.

Summer 2018 **Computational Systems Biology Lab**, *IIT Madras*, Dr Karthik Raman
Analyzed protein networks for the bacterium E. coli using data from the STRING database and made a network graph with NetworkX. Used the interactions to identify potential target proteins for novel drugs to act upon using graph centrality measures.

Publications

1 **Shanmugha Balan**, Khushboo K. Rao, Kaushar Vaidya, Manan Agarwal, and Souradeep Bhattacharya. Dynamical Evolution of Open Clusters using Gaia EDR3, July 2022, Poster at Gaia DR3 Symposium.

2 **Shanmugha Balan**, Khushboo K. Rao, Kaushar Vaidya, Manan Agarwal, and Souradeep Bhattacharya. Dynamical Evolution of Open Clusters using Gaia EDR3. In preparation.

3 Souradeep Bhattacharya, Khushboo K. Rao, Manan Agarwal, **Shanmugha Balan**, and Kaushar Vaidya. A *Gaia* EDR3 search for tidal tails in disintegrating open clusters. *arXiv e-prints*, page arXiv:2209.08259, September 2022. Submitted to MNRAS.

Projects

Aug 22 – Present **Denoising Astrophysical X Ray Images**, Dr Sainath Bitragunta
Using images from NASA's Chandra X Ray Observatory data archive with the CIAO tool to test the performance of different image denoising algorithms.

Dec 21 – Present **Indian Sky Watch Array Network Project**, Dr Avinash Deshpande (from Raman Research Institute), Dr Sainath Bitragunta and Dr Tapomoy Guha Sarkar, with TRAC
Visited Gauribidanur Radio Observatory to get acquainted with SWAN's instrumentation. Applied radio interferometry techniques to observe energetic radio transients in nebulae and to image them.

May 21 – July 21 **DCNs to mimic Matched Filtering for Gravitational Waves**, with TRAC
Reimplemented a deep convolutional neural network from a paper by Gabbard et al to replicate results obtained by matched filtering in the detection of gravitational wave signals. Attained comparable results with a smaller model but a slightly worse accuracy.

Jan 21 – April 21 **Properties of Open Star Clusters using Gaia Data**, Dr Kaushar Vaidya
Used Gaia DR2 based cluster membership information to extract dynamical and structural properties of star clusters with a binary track. Additionally, examined the morphology of the clusters to search for tidal tails in them.

Teaching Experience

Fall 2022 **Teaching Assistant**, *Computational Physics*, under Dr Navin Singh
Prepared notes and assignment questions on root finding, numerical integration and differential equation solvers. Will eventually add notes on Monte Carlo methods and molecular dynamics and demonstrate simulations in class. Assisting students in implementing algorithms and conducting doubt clearance sessions.

Spring 2022 **Teaching Assistant**, *Nonlinear Dynamics and Chaos*, under Dr Tapomoy Guha Sarkar
Prepared notes on dynamical systems, limit cycles, Hamiltonian mechanics and chaotic maps. Assisted in the conduction of evaluatives for the course and by clearing doubts of students. Demonstrated simulations on chaotic maps.

Skills

Proficient

Languages Python, C, C++, MATLAB

Libraries Numpy, Scipy, Astropy, Matplotlib, Scikit-Learn, PyTorch, TensorFlow, OpenCV

Familiar

Languages Julia, HTML, CSS

Technologies PFSSPY, CIAO, LaTeX, Bash Scripting, Git, Windows, Ubuntu

Languages Spoken

Proficient English, Tamil, Hindi

Familiar French, Spanish

Conferences and Workshops

July 22 Gaia Symposium: DR3 and Beyond, Indian Institute of Astrophysics, Bangalore

March 22 Astronomical Society of India, 40th Meeting, Indian Institute of Technology, Roorkee

March 22 HPC Workshop on Radio Astronomy Data Analysis in the SKA era, ASI

Relevant Coursework

Birla Institute of Technology and Science, Pilani, India

Physics	Classical Mechanics; Electromagnetic Theory I and II; Optics; Quantum Mechanics I and II; Statistical Mechanics; Computational Physics; Theory of Relativity; Atomic and Molecular Physics; Nuclear and Particle Physics; Introduction to Astronomy and Astrophyics*; General Theory of Relativity and Cosmology^{+}
Electrical Engineering	Digital Design; Signals and Systems; Communication Systems*; Digital Signal Processing*; Digital Image Processing*
Mathematics	Mathematics I (Multivariable Calculus); Mathematics II (Linear Algebra and Complex Analysis); Probability and Statistics; Mathematics III (Differential Equations); Optimization*

* - Currently taking the course; $^{+}$ - Auditing the course

MOOCs from Coursera

Deep Learning Specialization; Tensorflow in Practice Specialization; Applied Data Science Specialization; Introduction to Programming in MATLAB; Introduction to Bioinformatics

Audited Online Courses

CNNs for Visual Recognition (Stanford Online); NLP with Deep Learning (Stanford Online); Deep Reinforcement Learning (UC Berkeley); Essential Radio Astronomy (NRAO); Data Driven Astronomy (University of Sydney)

Activities and Hobbies

Jan 21 – Present **The Radio Astronomy Club**, *Coordinator*

Also was the Chief Editor of the blog. Managed the SWAN and LIGO Data Analysis projects. Involved in recruiting, outreach, and training of new recruits to the club.

Oct 19 – Apr 22 **Physics Association**, *Chief Editor/Events Coordinator*

Created and edited articles for the blog; was formerly the events coordinator and helped conduct events during APOGEE, the technical fest of BITS Pilani.

Oct 19 – Apr 22 **Microsoft Learn Student Ambassadors**, *Team Lead*

Conducted and managed all the events conducted by the club including technical games during APOGEE, workshops and merchandise sales.

Jan 20 – Jun 21 **FreeLunch Magazine**, *Senior Editor*

Authored and edited over 15 articles for the blog on a variety of topics on science and technology ranging from computer graphics to machine learning, hacking to algorithms and science.

Other Current Hobbies

Skywatching, Quizzing, Chess, Football