Swetha Arumugam

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Research Interests

Radio Astronomy, X-ray Astronomy, Pulsars, Compact Objects, Gravitational Waves, Radio Transients and Gravitational Wave Transients, Interstellar Medium, Instrumentation, High-Energy Astrophysical Phenomena.

Education

- **Indian Institute of Technology, Hyderabad** — Hyderabad, India
  Bachelors in Electrical Engineering; CGPA: 9.01/10 — *Aug 2020 - Present*

Skills

- **Statistics**: Bayesian statistics, Monte Carlo simulation, Likelihood inference, Bootstrapping, Hypothesis testing, Statistical significance evaluation, MCMC
- **Programming Languages**: C/C++, Python, SQL, MATLAB, Unix Scripting, Verilog
- **Tools/Libraries**: ds9, PostgreSQL, `emcee`, `dynesty`, `astropy`, `scipy`, `astroML`, Bash, Git/GitHub, Mathematica, Origin
- **Technical**: Data Visualization, Machine Learning, Cloud Computing, Data Structures and Algorithms, Database Management Systems

Publications/Preprints

[1] Arumugam S, Desai S. 2023 **Classification of pulsar glitch amplitudes using extreme deconvolution**. *Journal of High Energy Astrophysics* **37**, 46–50. (doi:10.1016/j.jheap.2022.12.003).

[2] Srivastava A, Desai S, Kolhe N, Surnis M, Joshi BC, Susobhanan A, Chalumeau A, Hisano S, K N, Arumugam S, *et al.* 2023 **Noise analysis of the Indian Pulsar Timing Array data release I**. *Phys. Rev. D* **108**, 023008. (doi:10.1103/PhysRevD.108.023008).

[3] Paladi AK, Dwivedi C, Rana P, K N, Susobhanan A, Joshi BC, Tarafdar P, Deb D, Arumugam S, Gopakumar A, *et al.* 2023 **Multi-band Extension of the Wideband Timing Technique**. *arXiv e-prints* arXiv:2304.13072. (doi:10.48550/arXiv.2304.13072).

[4] Antoniadis J, Arumugam P, Arumugam S, Babak S, Bagchi M, Bak Nielsen AS, Bassa CG, Bathula A, Berthereau A, Bonetti M, *et al.* 2023 **The second data release from the European Pulsar Timing Array II. Customised pulsar noise models for spatially correlated gravitational waves**. *arXiv e-prints* arXiv:2306.16225. (doi:10.48550/arXiv.2306.16225).

[5] Antoniadis J, Arumugam P, Arumugam S, Babak S, Bagchi M, Bak Nielsen AS, Bassa CG, Bathula A, Berthereau A, Bonetti M, *et al.* 2023 **The second data release from the European Pulsar Timing Array III. Search for gravitational wave signals**. *arXiv e-prints* arXiv:2306.16214. (doi:10.48550/arXiv.2306.16214).

[6] Antoniadis J, Arumugam P, Arumugam S, Babak S, Bagchi M, Bak Nielsen AS, Bassa CG, Bathula A, Berthereau A, Bonetti M, *et al.* 2023 **The second data release from the European Pulsar Timing Array IV. Search for continuous gravitational wave signals**. *arXiv e-prints* arXiv:2306.16226. (doi:10.48550/arXiv.2306.16226).

[7] Antoniadis J, Arumugam P, Arumugam S, Auclair P, Babak S, Bagchi M, Bak Nielsen AS, Barausse E, Bassa CG, Bathula A, *et al.* 2023 **The second data release from the European Pulsar Timing Array: V. Implications for massive black holes, dark matter and the early Universe**. *arXiv e-prints* arXiv:2306.16227. (doi:10.48550/arXiv.2306.16227).

Research Experience

- **Research Intern - MITACS GRI** — University of Alberta, Canada
  under Prof. Gregory Sivakoff — *May 2023 - Aug 2023*
  - Cross-Matched VLASS catalog with Gaia sub-sub-giants (**SSGs**) catalog to identify **transient** and variable events, to help further in the study of **Globular Clusters**.
  - Performed analysis of VLASS FITS files in **Python** and **ds9**.
  - Developed computational pipeline for advanced data analysis and handling of large datasets of VLASS in Python.
  - Contributed to refining transient identification and classification using the VLASS data.
- **Indian Pulsar Timing Array Consortium (InPTA)** — Pune, India
  Associate Member — *June 2022 - Present*
  - **Data Base Management**: Currently working with the National Center for Radio Astrophysics (NCRA) to develop and manage upgraded Giant Metrewave Radio Telescope (uGMRT) legacy database using **PostgreSQL**.
  - **Observational Radio Astronomy**: Active observer for InPTA, conducting 50+ hours of observations using uGMRT.
  - **Raw Data Reduction**: Reducing raw data obtained from observations using `Pinta` pipeline.
- Member of **Gravitational Radiation and Science with Pulsars** (GRASP), where interesting pulsar projects and papers are discussed.

Projects

- **Superresolution and Satellite Track Removal in Astronomical Images**
  under Prof. Sumohanna Channappayya *Jan-May'23*
  - Developed a novel method for generating high-resolution astronomical images from low-resolution, blurred observations while effectively eliminating satellite trails using **Hough Transform** technique.
  - Conducted a comparative analysis between deep learning-based super-resolution reconstruction techniques, specifically the **CNN** process, and advanced **wavelet**-based methods.
  - Evaluated the performance of our approach using metrics such as PSNR, MSE, and SSIM, and provided a benchmark for future research in this field.
- **Residual Self-Interference Cancellation and Optimal Control with RIS for Full-Duplex Communication**
  under Prof. Zafar Ali Khan *Jan-May'23*
  - Implemented and analyzed Full-Duplex Communication Systems using Python to improve its reliability.
  - Conducted simulations to evaluate the effectiveness of the traditional method, **superimposed** method, and 'self-proposed' method, demonstrating their potential to improve the performance of full-duplex communication systems.
  - Proposed practical solutions for enhancing wireless network performance, focusing on capacity and reliability improvements, addressing challenges such as self-interference and transmit power consumption.
- **Correlation Coefficients**
  under Prof. Shantanu Desai *Jan-May'22*
  - Conducted a statistical analysis of correlation coefficients, including Pearson's sample correlation coefficient, Spearman rank correlation coefficient, and Kendall Tau.
  - Analyzed the characteristics of each coefficient and their applications in exploratory data analysis, structural modeling, and data engineering.
  - Demonstrated proficiency in data analysis and **statistical modelin**g techniques, including **hypothesis testing** and **regression analysis**.
- **Cosmic Lithium Problem**: **Non-Gaussian Error Distribution of $^{7}_{3}$Li Abundance Measurements**
  - Undertook an independent study to enhance personal understanding of the Cosmic Lithium Problem, drawing inspiration from the research findings of Crandall, S., Houston, S., & Ratra, B. (2014).
  - Conducted an analysis of the error distribution in $^{7}_{3}$Li abundance measurements sourced from the research conducted by Spite et al, with the aim of assessing its statistical significance.
  - Employed various probability distribution functions to characterize the error distribution, contributing to a deeper comprehension of its statistical properties.
  - Concluded that, while the non-Gaussian nature of the data was of interest, it did not offer a comprehensive solution to the Lithium Problem.
- **Electrical Projects**:
  - Spearheaded a project focused on **Digital Signal Processing**, encompassing the design and implementation of innovative solutions to real-world electrical engineering challenges.
  - Demonstrated adeptness in signal conditioning techniques by conceiving and designing a Schmitt trigger circuit, leveraging Arduino and KiCAD. Employed LtSpice simulations to verify the effectiveness of the signal conditioning in eliminating noise from digital circuit signals, ultimately enhancing signal quality and reliability.

Posters and Presentation

- **Transient Identification using VLASS data to understand Globular Clusters** University of Alberta, Canada
  3-Minute Thesis
  - Delivered a concise and engaging 3-minute thesis presentation highlighting my transformative internship experience at the University of Alberta under the guidance of Prof. Gregory Sivakoff.
- **Classification of Pulsar Glitch Amplitudes using Extreme Deconvolution** IIT Kharagpur, India
  Poster Presentation
  - Presented my research paper titled *Classification of Pulsar Glitch Amplitudes using Extreme Devolution* at the prestigious Inter-IIT tournament, showcasing my expertise in astrophysical data analysis.

Teaching Assistant

- **Data Science Analysis** IIT Hyderabad
  Prof. Shantanu Desai *Jan 2023 - May 2023*
  - Assisted professor in classroom management and maintaining accurate records.
  - Contributed to grading and assessment and offering constructive feedback to over 100 students.

Relevant Courses

- **Physics:** Modern Physics, Astronomy and Astrophysics, Nuclear Physics
- **Data Science and ML:** Data Science Analysis, Matrix Theory, Introduction to AI and ML, DBMS I, Calculus I & II, Vector Calculus, Differential Equations, Complex Variables
- **Certified Courses - Coursera:** Machine Learning, Data-Driven Astronomy, The Evolving Universe, Understanding Einstein: The Special Theory of Relativity, Understanding Modern Physics I: Relativity and Cosmology, Astro 101: Black Holes, Exploring Quantum Physics
- **Signal Processing:** Signals and Systems, Digital Signal Processing, Communication Systems, Wireless Communication, Image and Video Processing, Information Theory, Topics in Data Storage and Communication
- **Electrical Core Fundamentals:** Control Systems, Engineering Electromagnetics, Physics of Electrical Engineering Materials, Circuit and Network analysis, Semiconductor Device Fundamentals, Introduction to VLSI Design, Power Electronics
- **Analog and Digital Electronics:** Digital Systems, Analog Electronics, Analog Lab, Analog Circuits

Achievements

- Selected as a **MITACS - Globalink Research Intern** at the University of Alberta, Canada (12-weeks fully funded, during May-July 2023), on the project *The Dynamic Radio Universe*.
- Received IIT-Hyderabad's **Saroj Sharma Memorial Award** for Research Excellence for female UG students.
- Recipient of IIT-Hyderabad's **Merit Cum Means Scholarship** for three years.
- Secured **99.98 percentile** and **All India Rank of 5883** in **JEE Mains 2020** (out of 1.17 million candidates) and an **All India Rank of 9252** in JEE Advanced 2020, the common entrance exam for admission into the IITs.

Positions of Responsibility

- **Electronika Senior Core Member**
  Electronics club of IITH *Aug 2020 - May 2023*
  - Mentored junior members in a club project focused on the Smart Helmet. Additionally, designed and constructed a Health Monitoring Clock as part of my club contributions.
- **Cepheid Core Member**
  Astronomy and Astrophysics club of IITH *July 2021 - April 2022*
  - Organized outreach events, informative sessions, and captivating stargazing events that connected students and enthusiasts with the wonders of the cosmos. Collaborated effectively with the Electronics Club to facilitate access to a telescope, enabling students to witness and learn about celestial phenomena firsthand.
- **Epoch member**
  Machine Learning and Data Science Club of IITH *July 2021 - April 2022*
  - Active member of the Machine Learning and Data Science Club, participating in knowledge-sharing sessions, collaborative data analysis projects, and discussions on emerging trends in AI and data analytics.

Extracurricular Activities

- Digital Arts Volunteer for National Service Scheme (NSS) India.
- Served as a Core Member of IITH's Art Club (Gesture) and actively contributed to the Campus Mental Health Community.