Swetha Arumugam

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Research Interests

Gravitational Waves, Pulsars, Compact Objects, Time-Domain Astronomy, Transients, Radio Astronomy, Multi-wavelength Astronomy, High-energy Astronomy, Gamma-ray Bursts, Instrumentation, Instrumentation, Galaxies, Interstellar Medium.

Education

Indian Institute of Technology, Hyderabad — Hyderabad, India
Bachelors in Electrical Engineering; CGPA: 9.04/10 — *Aug 2020 - June 2024*

Research Experience

Mitacs Research Intern — University of Alberta, Canada
under Prof. Gregory Sivakoff — *May 2023 - Aug 2023*

- Cross-matched VLASS and Gaia sub-sub-giants (SSGs) to study them in Radio spectrum.
- Developed and implemented cutting-edge analytical pipelines to process and analyze VLASS fits files to classify SSGs as variable and transient events, contributing further to the study of Globular Clusters.
- Performed analysis and developed pipeline in Python using various modules like `astropy`, `photutils`, etc.

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 and reduced its raw data using `Pinta` pipeline.

Publications/Preprints

Contributed Authorship

1. Arumugam, S. & Desai, S. **Classification of pulsar glitch amplitudes using extreme deconvolution**. *Journal of High Energy Astrophysics* **37,** 46–50. doi:10.1016/j.jheap.2022.12.003 (Mar. 2023).
2. Srivastava, A. *et al.* **Noise analysis of the Indian Pulsar Timing Array data release I**. *Phys. Rev. D* **108,** 023008. doi:10.1103/PhysRevD.108.023008 (2 July 2023).
3. Paladi, A. K. *et al.* **Multiband extension of the wideband timing technique**. *Monthly Notices of the Royal Astronomical Society* **527,** 213–231. ISSN: 0035-8711. doi:10.1093/mnras/stad3122 (Oct. 2023).
4. EPTA Collaboration, InPTA Collaboration, *et al.* **The second data release from the European Pulsar Timing Array. II. Customised pulsar noise models for spatially correlated gravitational waves**. **678,** A49. doi:10.1051/0004-6361/202346842 (Oct. 2023).
5. EPTA Collaboration, InPTA Collaboration, *et al.* **The second data release from the European Pulsar Timing Array. III. Search for gravitational wave signals**. **678,** A50. doi:10.1051/0004-6361/202346844 (Oct. 2023).

Other Publications

6. Kikunaga, T. *et al.* **Low-frequency pulse-jitter measurement with the uGMRT I : PSR J0437−4715**. *arXiv e-prints,* arXiv:2312.01875. doi:10.48550/arXiv.2312.01875 (Dec. 2023).
7. The International Pulsar Timing Array Collaboration, *et al.* **Comparing recent PTA results on the nanohertz stochastic gravitational wave background**. *arXiv e-prints,* arXiv:2309.00693. doi:10.48550/arXiv.2309.00693 (Sept. 2023).
8. Singha, J., *et al.* **Using low-frequency scatter-broadening measurements for precision estimates of dispersion measures**. *arXiv e-prints,* arXiv:2309.16765. doi:10.48550/arXiv.2309.16765 (Sept. 2023).
9. EPTA Collaboration, InPTA Collaboration, *et al.* **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 (June 2023).
10. EPTA Collaboration, InPTA Collaboration, *et al.* **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 (June 2023).

Projects

Superresolution and Satellite Track Removal in Astronomical Images IIT Hyderabad, India
under Prof. Sumohana Channappayya *Jan - May 2023*

- Implemented various methods for generating high-resolution astronomical images from low-resolution, blurred observations, such as **wavelet**-based and **CNN**.
- Addressed the issue of satellite track pollution in ground-based and low-orbit space telescope images, particularly relevant in the era of Starlink satellite constellations, 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.

Correlation Coefficients IIT Hyderabad, India
under Prof. Shantanu Desai *Jan - May 2022*

- 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 Crandall, S., Houston, S., & Ratra, B. (2014).
- Assessed the statistical significance of non-Gaussian error distribution in $^{7}_{3}$Li abundance measurements from Spite et al, concluding that it does not offer a comprehensive solution to the Lithium Problem.

Electrical Projects:

- Formulated practical solutions to optimize wireless network performance, specifically tackling issues of self-interference and transmit power consumption within the realm of Full-Duplex Communication.
- Showcased proficiency in signal processing by innovatively designing and implementing solutions to real-world electrical engineering challenges.

Posters and Presentation

InPTA efforts for nHz Gravitational Waves hunt - Japan Week IIT Hyderabad, India
Poster Presentation

Dynamic Radio Universe University of Alberta, Canada
3-Minute Thesis

Classification of Pulsar Glitch Amplitudes using Extreme Deconvolution IIT Kharagpur, India
Poster Presentation

Achievements

- 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.
- 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* in the Department of Physics.

Teaching Assistant

Data Science Analysis IIT Hyderabad
Prof. Shantanu Desai *Jan 2023 - May 2023*

- Assisted professor in the management and coordination of the course, fostering an environment conducive to learning and active student engagement..
- Contributed to grading and assessment, and providing constructive feedback to aid over 100 students in their understanding and improvement.

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`, Git/GitHub

Technical: Data Visualization, Machine Learning, Cloud Computing, Data Structures and Algorithms, Database Management Systems

Relevant Courses

Physics: Modern Physics, Astronomy and Astrophysics, Nuclear Physics, Optics and Photonics

Data Science and ML: Bayesian Data Science, 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, Electromagnetic Wave Propagation, Physics of Electrical Engineering Materials

University Volunteering

Cepheid Core Member IIT Hyderabad, India
Astronomy and Astrophysics club *July 2021 - April 2022*

- Organized and facilitated outreach events, informative sessions, and stargazing events as part of the club.
- Demonstrated leadership in engaging with students and enthusiasts, fostering a passion for astronomy and hands-on learning.

Electronika Senior Core Member IIT Hyderabad, India
Electronics club *July 2021 - May 2023*

- Mentored junior members in a Smart Helmet project, showcasing leadership and technical guidance.
- Designed and implemented a Health Monitoring System, demonstrating creativity and practical electronics skills.

Epoch member IIT Hyderabad, India
Machine Learning and Data Science Club *July 2021 - April 2022*

- Contributed to knowledge-sharing sessions and collaborative data analysis projects in the club.
- Engaged in interdisciplinary conversations, exploring the intersection of machine learning with other scientific disciplines.

Extracurricular Activities

- Member of **Gravitational Radiation and Science with Pulsars** (GRASP), where interesting pulsar projects and papers are discussed.
- Digital Arts Volunteer for National Service Scheme (NSS) India.
- Served as a Core Member of IITH's Art Club (Gesture).
- Actively contributed to the Campus Mental Health Community through Sunshine program.