Abhimanyu Susobhanan

Areas of Interest

Gravitational Waves, Pulsars, Binary Systems, Astrophysical Software

Education

Aug 2015–Sep 2021 **Master of Science in Physics + Doctor of Philosophy in Astrophysics**, *Department of Astronomy & Astrophysics, Tata Institute of Fundamental Research, Mumbai, Maharashtra, India*
Thesis Title: Perspectives in nanohertz gravitational-wave astronomy
Advisor: Prof. Achamveedu Gopakumar

Aug 2008–May 2012 **Bachelor of Technology in Physical Sciences**, *Department of Earth & Space System Sciences, Indian Institute of Space Science and Technology, Thiruvananthapuram, Kerala, India*
CGPA: 8.27/10

Research & Professional Experience

Apr 2024 – *present* **Postdoctoral Fellow**, *Max Planck Institute for Gravitational Physics (Albert Einstein Institute), Hannover, Lower Saxony, Germany*

- Development of the `Vela.jl` package for Bayesian pulsar timing & noise analysis.
- Leading the development team for the `PINT` pulsar timing package.

Jun 2022 – Feb 2024 **Postdoctoral Fellow**, *Center for Gravitation Cosmology and Astrophysics, University of Wisconsin-Milwaukee, Milwaukee, Wisconsin, USA*

- Leading the development team for the `PINT` pulsar timing package. Frequentist pulsar timing noise characterization using PINT.
- Efficient methods for computing pulsar timing array signals due to supermassive eccentric binaries, implemented in the `GWecc.jl` package.
- A pilot all-sky single-pulsar Bayesian search for supermassive eccentric binaries using `GWecc.jl` in the NANOGrav 12.5-year data of PSR J1909−3744.
- Multi-messenger targeted search for a supermassive eccentric binary in the radio galaxy 3C 66B in the NANOGrav 12.5-year dataset.
- The `chimera` pipeline to reduce pulsar data obtained using the CHIME telescope, used for integrating CHIME data into NANOGrav.
- Pulsar timing array signals induced by hyperbolic encounters of supermassive black hole pairs, implemented in the `GW_hyp` package.
- Extension of the wideband timing technique to combine simultaneous multi-band observations.
- Noise characterization of the InPTA Data Release 1.
- Substitute instructor for *Survey of Astronomy*.
- Mentored three students
  - Mr Subhajit Dandapat (Doctoral student, Tata Institute of Fundamental Research)
  - Mr Aman Srivastava (Doctoral student, Indian Institute of Technology Hyderabad)
  - Mr Avinash Kumar Paladi (Master's student, Indian Institute of Space Science and Technology)

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Sep 2021 – Jan 2022 **Postdoctoral Fellow**, *National Centre for Radio Astrophysics, Tata Institute of Fundamental Research, Pune, Maharashtra, India*

- Led the InPTA Data Release 1 project during its initial stages.
- Mentored one student
  - Mr Neel Kohle (Master's student, St Xavier's College, Mumbai)

Aug 2015– Sep 2021 **Research Scholar**, *Department of Astronomy & Astrophysics, Tata Institute of Fundamental Research, Mumbai, Maharashtra, India*

- The `pinta` pipeline to reduce pulsar data obtained using the GMRT telescope.
- Modeling pulsar timing array signals induced by supermassive eccentric binaries.
- The *ELL1k* timing model for nearly circular pulsar binaries experiencing significant advance of periastron.
- A new phasing approach to modeling the optical outbursts of the blazar OJ 287 using its binary black hole central engine model, implemented in the `opha` package.
- An analytic solution to the third post-Newtonian-accurate Kepler equation.
- Characterization of the 2021 chromatic timing event in PSR J1713+0747.
- Modeling the jet position angle variations of the blazar OJ 287 using its binary central engine model.
- Mentored two students
  - Ms Nikita Agarwal (Undergraduate student, Manipal Institute of Technology)
  - Mr Akash Anumarlapudi (Undergraduate student, Indian Institute of Technology Bombay)
- Conducted training sessions on Linux, Python, pulsar data reduction, and pulsar timing at multiple workshops.
- Teaching assistant for *Astronomy & Astrophysics I*, *Astronomy & Astrophysics II*, and *Electrodynamics II*
- Public outreach activities including organizing National Science Day and and Frontiers of Science events, and lectures to school and undergraduate students.

Sep 2012– Jun 2015 **Scientist/Engineer**, *Liquid Propulsion Systems Centre, Indian Space Research Organization, Valiyamala, Thiruvananthapuram, Kerala, India*

- A searchable internal repository for quality assurance reports named PEARL-DB.
  - Managed a team of junior developers.
- An internal secure file-sharing service named BHANDAAR.
- Development and maintenance of the center website, employees' portal, and recruitment portal.

Selected Publications

2024 [1] **Abhimanyu Susobhanan**, "*Bayesian pulsar timing and noise analysis with Vela.jl: an overview*", The Astrophysical Journal, 980, 165, DOI: 10.3847/1538-4357/adaaec

2024 [2] **Abhimanyu Susobhanan**, David Kaplan, Anne Archibald, et al., "*PINT: Maximum-likelihood estimation of pulsar timing noise parameters*", The Astrophysical Journal, 971, 150, DOI: 10.3847/1538-4357/ad59f7

2024 [3] Subhajit Dandapat, **Abhimanyu Susobhanan**, et al., "*Efficient prescription to search for linear gravitational wave memory from hyperbolic black hole encounters and its application to the NANOGrav 12.5-year dataset*", Physical Review D, 109, 103018, DOI: 10.1103/PhysRevD.109.103018

2024 [4] Gabriella Agazie, ..., **Abhimanyu Susobhanan**, et al., "*The NANOGrav 12.5-year data set: A computationally efficient eccentric binary search pipeline and constraints on an eccentric supermassive binary candidate in 3C 66B*", The Astrophysical Journal, 963, 144, DOI: 10.3847/1538-4357/ad1f61

2023 [5] Avinash Kumar Paladi, ..., **Abhimanyu Susobhanan**, et al., "*Multi-band Extension of the Wideband Timing Technique*", Monthly Notices of the Royal Astronomical Society, 527, 213–231, DOI: 10.1093/mnras/stad3122

2023 [6] Aman Srivastava, ..., **Abhimanyu Susobhanan**, et al., "*Noise analysis in the Indian Pulsar Timing Array Data Release I*", Physical Review D, 108, 023008, DOI: 10.1103/PhysRevD.108.023008

2023 [7] **Abhimanyu Susobhanan**, "*Post-Newtonian-accurate pulsar timing array signals induced by inspiralling eccentric binaries: accuracy, computational cost, and single-pulsar search*", Classical and Quantum Gravity, 40, 155014, DOI: 10.1088/1361-6382/ace234

2023 [8] Subhajit Dandapat, Michael Ebersold, **Abhimanyu Susobhanan**, et al., "*Gravitational Waves from Black-Hole Encounters: Prospects for Ground- and Galaxy-Based Observatories*", Physical Review D, 108, 024013, DOI: 10.1103/PhysRevD.108.024013

2022 [9] Pratik Tarafdar, ..., **Abhimanyu Susobhanan**, et al., "*The Indian Pulsar Timing Array: First data release*", Publications of the Astronomical Society of Australia, 39, E053, DOI: 10.1017/pasa.2022.46

2021 [10] Jaikhomba Singha, ..., **Abhimanyu Susobhanan**, et al., "*Evidence for profile changes in PSR J1713+0747 using the uGMRT*", Monthly Notices of the Royal Astronomical Society: Letters, 507, L57–L61, DOI: 10.1093/mnrasl/slab098

2021 [11] Lankeswar Dey, ..., **Abhimanyu Susobhanan**, et al., "*Explaining temporal variations in the jet position angle of blazar OJ 287 using its binary black hole central engine model*", Monthly Notices of the Royal Astronomical Society, 503, 3, 4400–4412, DOI: 10.1093/mnras/stab730

2021 [12] **Abhimanyu Susobhanan**, Yogesh Maan, Bhal Chanda Joshi, et al., "*pinta: The uGMRT Data Processing Pipeline for the Indian Pulsar Timing Array*", Publications of the Astronomical Society of Australia, 38, E017, DOI: 10.1017/pasa.2021.12

2020 [13] **Abhimanyu Susobhanan**, Achamveedu Gopakumar, George Hobbs, and Stephen Taylor, "*Pulsar timing array signals induced by black hole binaries in relativistic eccentric orbits*", Physical Review D, 101, 043022, DOI: 10.1103/PhysRevD.101.043022

2018 [14] **Abhimanyu Susobhanan**, Achamveedu Gopakumar, Bhal Chanda Joshi, and Ranjan Kumar, "*Exploring the effect of periastron advance in small-eccentricity binary pulsars*", Monthly Notices of the Royal Astronomical Society, 480, 5260-5271, DOI: 10.1093/mnras/sty2177

2017 [15] Yannick Boetzel, **Abhimanyu Susobhanan**, Achamveedu Gopakumar, Antoine Klein, and Philippe Jetzer, "*Solving post-Newtonian accurate Kepler equation*", Physical Review D, 96, 044011, DOI: 10.1103/PhysRevD.96.044011

Skills

Programming Languages	`C++, Python, C, Julia, Java, JavaScript, PHP, Wolfram Language, LaTeX, bash`
Astrophysical software	`PINT, TEMPO2, ENTERPRISE, PSRCHIVE, DSPSR`
Telescope observations	Giant Metre-wave Radio Telescope, Parkes Radio Telescope
Data analysis	Bayesian inference, Data visualization

Languages

Malayalam (native), English, Hindi

Awards and Fellowships

2022-2024 NANOGrav NSF Physics Frontier Center Postdoctoral Fellowship

2019 **Ratanbai Jerajani Award** for the best seminar in the area of Astronomy and Astrophysics at TIFR

2019 **Sarojini Damodaran Fellowship** for international travel

2006-2012 **National Talent Search Scholarship**

References

Dr. Rutger van Haasteren
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Hannover, Lower Saxony, Germany
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Prof. David Kaplan
Center for Gravitation Cosmology and Astrophysics, University of Wisconsin-Milwaukee,
Milwaukee, Wisconsin, USA
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Prof. Achamveedu Gopakumar
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