Fazal Kareem

Graduate Student
Fundamental Physics in Radio Astronomy
Max Planck Institute for Radio Astronomy, Bonn
+49 15737372190
fazalabdulkareem12@gmail.com | Personal Website | ResearchGate| InpireHEP

Education

Indian Institute of Science Education and Research Kolkata — West Bengal, India
BS-MS Dual Degree in ***Physical Sciences*** — *Aug. 2018 – June 2023*

- Completed 10 semesters and graduated in June 2023
- **CGPA : 8.41/10.0** (absolute grading)

Sacred Heart Higher Secondary School,Thiruvambady — Kerala,India
Directorate of Higher Secondary Education,Kerala (11th & 12th) — *June. 2016 – May 2018*

- Subjects : Physics, Chemistry, Mathematics, Biology, English, Hindi

English Proficiency Tests

- **TOEFL iBT : 114/120** (Reading : 30/30 , Listening : 30/30 , Speaking : 27/30 , Writing : 27/30)

Publications

The Indian Pulsar Timing Array Data Release 2 — ArXiv|PASA
Dataset and Timing Analysis — *Accepted Feb 2025*

Using low-frequency scatter broadening measurements — ArXiv|MNRAS
for precision estimates of dispersion measures — *Sep 2023*

Low-frequency pulse-jitter measurement with the uGMRT — ArXiv|PASA
I: PSR J0437–4715 — *Apr 2024*

Comparing recent PTA results — ArXiv|ApJ
on the nanohertz stochastic gravitational wave background — *Sept 2023*

Multi-band Extension of the Wideband Timing Technique — ArXiv|MNRAS
April 2023

The second data release from the European Pulsar Timing Array — Arxiv|A&A
Customised Pulsar Noise Models for Spatially Correlated Gravitational Waves — *June 2023*

The second data release from the European Pulsar Timing Array — Arxiv|A&A
Search for gravitational wave signals — *June 2023*

The second data release from the European Pulsar Timing Array — Arxiv|A&A
Search for continuous gravitational wave signals — *June 2023*

The second data release from the European Pulsar Timing Array — Arxiv|A&A
Implications for massive black holes, dark matter, and the early Universe — *June 2023*

Relevant Research Projects

The second data release of InPTA Jan 2025

Indian Pulsar Timing Array *India*

* We are producing the latest data release of pulsar timing data from the uGMRT. This will include at least 5+ years of data with narrowband and multiband/wideband TOA and Noise analysis

Real-time digital signal processing using FPGA for the SKA-low Telescope July -Present

Raman Research Institute - DSP Lab, Bengaluru *India*

Supervisor : T. Prabu, Research Scientist E

* We are developing a real-time, analog, data reduction and processing setup for the SKA-low telescope using Field programmable gate arrays (FPGA). We are using a low-cost device (Red-pitaya) which is easily reprogrammable using Casper toolflow. This would be implemented on hundred thousand log-periodic antennas in the SKA-low telescope.

Removal of scattering noise from pulsar signals July 2023-Sept 2023

Indian Pulsar Timing Array *India*

Supervisor : Prof. Bhal Chandra Joshi, NCRA

* We developed a novel method to remove scattering noise from the incoming pulsar signals to increase the DM estimation precision of low-frequency pulsar observation using multiband data. I was the head of simulations and we produced 10 year datasets of multiple cases using PulPS package I developed.

IPTA 3P+ comparison 2023

International Pulsar Timing Array

* Our group developed a method to analyse and compare the data releases from 4 Pulsar timing arrays. We also compared different GWB models for the data releases and compared them using tensiometer package.

Multi-band extension of the Wideband Timing technique 2023

Indian Pulsar Timing Array *India*

* Development of two novel independent methods as extensions of the conventional wideband technique by incorporating simultaneous multi-band pulsar data encompassing profile evolution over a larger frequency space for DM and ToA estimation with enhanced precision.

Posterior comparison of Noise Models using EPTA and EPTA+InPTA data 2023

Indian Pulsar Timing Array, European Pulsar Timing Array

* The application of the tension metric evaluation for the noise posteriors on the EPTA dataset and the combined EPTA and InPTA datasets

Pulsar Profile Simulator Dec 2022 Onward

Indian Pulsar Timing Array *India*

Position: Project lead

* Developing a program to simulate PSRFITS files with DM variation, scatter broadening, jitter, and other ISM effects for a given pulsar for testing different DM determination schemes
* Developed software with a Python wrapper for an underlying C code that uses TEMPO2 for phase and period of pulsar signals

Thesis Project: Probing the presence of an SMBHB in a Blazar July 2022 Onward

Tata Institute of Fundamental Research, Mumbai *Maharashtra, India*

Supervisor : Prof.Achamveedu Gopakumar *Report*

* Blazar PKS 2031-021
* By incorporating the effects of orbital eccentricity and the general relativistic periastron advance in the post-Newtonian approximation to General Relativity

The science of low-frequency GW searches July 2022 - Dec 2022

Indian Institute of Science Education and Research, Kolkata *West Bengal, India*

Supervisor : Prof.Rajesh Kumble Nayak *Report*

* Using spacecraft doppler tracking
* Study about the future aspect of SDT in future outer solar system planets missions to Uranus and Neptune

Gravitational Wave Analysis June - August 2021

Indian Institute of Technology, Madras *Tamilnadu, India*

Supervisor : Prof.Chandra Kant Mishra *Report*

* Learned the basic tools and techniques of gravitational wave analysis
* Studied general theory of relativity and formation, evolution and detection of gravitational waves.
* Analytical and computational analysis techniques
* Hands-on project using PyCBC, Lalsuit, Python, Mathematica for GW analysis

Gravitational Waves in General Relativity Semester 8

Indian Institute of Science Education and Research, Kolkata *West Bengal, India*

Supervisor : Prof.Rajesh Kumble Nayak *Report*

* Proper derivation of gravitational waves from the General Theory of Relativity

Covid Data Analysis June – September 2021

Indian Institute of Science Education and Research, Kolkata *West Bengal, India*

Supervisor : Prof.Dibyendu Nandi

* Monitored the covid situation in India through open-source resources and data analysis.
* Used epidemiological models to predict the evolution of covid in India, most of which agreed with the real-life evolution.
* Website under the banner of CESSI to provide day-to-day update of our models to the general public.

Workshops Attended

IPTA Student Week and Science Meeting July 2023

International Pulsar Timing Array *India*

InPTA Student Week August 2022

Indian Pulsar Timing Array *India*

* Online coding tutorial for pulsar timing
* Hands-on workshop with raw data from upgraded Giant Metrewave Radio Telescope (uGMRT)
* **Special uGMRT observation session**

GW Open Data Workshop May 23 - May 25 2022

Gravitational Wave Open Science Center(GWOSC)

* Online coding tutorial and data challenge

* Hands-on experience with LIGO-VIRGO GW data analysis pipelines

School on Black Holes and Gravitational Waves Jan 17 - Jan 22 2022
Centre for Strings, Gravitation, and Cosmology, IIT, Madras *Tamilnadu, India*

* Basics of Gravitational waves and Black hole physics
* Hands on tutorial sessions for each lecture

Technical Skills

Scripting Languages: Python(Numpy, Scipy, Pandas, Tempo2, Libstempo, Bilby, Emcee, PTMCMC, Matplotlib, PyCBC, Lalsuit, gwosc, gwpy), C, Matlab, Mathematica, GnuPlot, HTML, CSS
Markup Languages: LaTeX,Word
Spoken Languages:English, Hindi , Malayalam
Other Skills: Photoshop, Illustrator, Premier Pro, After Effects, Final Cut Pro, Canva, Figma, Logic Pro

Relevant Courses

* Introduction to General Relativity
* Python for data analysis
* Computational Physics
* Special Theory of Relativity
* Mathematical methods of physics
* Intermediate Electricity and Magnetism
* Data Structure and Cpp
* Basic Statistical Mechanics
* Intro to Astrophysics

Awards and Achievements

* Co-Chairperson of IGrav Communications Working Group
* Member of IPTA EPO Work Group, IPTA GW Work Group, IPTA Data Acquisition WG, IPTA Data Combination WG
* Participant of Decoherance (Astrophysics contest) by IISc, Bengaluru, January 2019, where we designed experiments within a day to study a given natural phenomenon. I was selected after all India screening

Extra Curricular Activities

* Developed and manages the official websites of InPTA, CESSI Covid-Dashboard, IGrav.
* Founding member of IKQRAAR-the IISER Kolkata Queer Resolution And Allies of the Rainbow
* Founding member of Gluon: The Physics Journal Club, IISER Kolkata. We have been organizing monthly faculty and research scholar talks on various fields of Science
* Launched a YouTube channel (<science.sort>) to communicate scientific topics and ideas in vernacular language(Malayalam). We produce semi-technical data-driven science videos to educate and harness interest in the general public.
* Organised East India's biggest science fest - Inquivesta, IISER Kolkata
* Athlete- Football, Kho-Kho(State level), Basketball, handball, volleyball , Athletics

References

* **Prof. Achamveedu Gopakumar** (MS Thesis Supervisor)
  Professor
  Department of Astronomy and Astrophysics
  Tata Institute of Fundamental Research, Mumbai
  gopu@tifr.res.in

* **Prof. Rajesh Kumble Nayak** (MS Thesis Coordinator)
  Professor
  Center of Excellence in Space Sciences
  Department of Physical Sciences
  Indian Institute of Science Education and Research, Kolkata
  rajesh@iiserkol.ac.in

* **Dr. Prabu Thiagaraj** (Head of DSP lab)
  Research Scientist E
  Electronics Engineering Group
  Raman Research Institute
  prabu@rri.res.in

* **Prof. Dibyendu Nandi** (Head of lab (CESSI))
  Professor
  Center of Excellence in Space Sciences
  Department of Physical Sciences
  Indian Institute of Science Education and Research, Kolkata
  dnandi@iiserkol.ac.in

Publications

Using low-frequency scatter broadening measurements ArXiv|MNRAS
for precision estimates of dispersion measures *Sep 2023*

I developed a Pulsar Profile Simulator (PulPS) to simulate ISM scattered pulsar observations and also contributed to the development of the DMscat software to remove scattering from the profiles. I was also involved in writing the manuscript and data processing.

Comparing recent PTA results ArXiv|ApJ
on the nanohertz stochastic gravitational wave background *Sept 2023*

I was involved extensively in the noise and GWB model comparison of all PTAs presented in this paper. I contributed to section 5 of the paper heavily, and the results of our work are presented in Table 1, and we generated Figure 1b, and Figure 2.

Multi-band Extension of the Wideband Timing Technique ArXiv|MNRAS
April 2023

I was involved in the development of two new techniques that leverage multiband data for the wideband timing technique. Specifically, my responsibility was to conduct a comparison between these two techniques and other existing methods for 2 out of the 15 pulsars. The results of this comparison were included in the evaluation of the paper.

The second data release from the European Pulsar Timing Array Arxiv|A&A
Customised Pulsar Noise Models for Spatially Correlated Gravitational Waves *June 2023*

I assisted in developing and troubleshooting the code for utilizing the tensiometer package to perform tension metric analysis on noise parameter chains. Specifically, I conducted a comparison between the SPNA and SPNTA chains for 7 out of the 25 pulsars from the EPTA dataset. Additionally, I conducted a comparison between the EPTA dataset and the EPTA+InPTA dataset for 2 out of the 10 pulsars.

The second data release from the European Pulsar Timing Array Arxiv|A&A
Search for gravitational wave signals *June 2023*

I made significant contributions to the code implementation that utilized the tensiometer package for conducting tension metric analysis on various algorithms and models. The results obtained from this analysis were documented in Table 2 of the paper.

The second data release from the European Pulsar Timing Array Arxiv|A&A
Search for continuous gravitational wave signals *June 2023*

I contributed to the observation (60+ hours) and data reduction (100+ hours) of the InPTA data set which is employed while assembling the DR2full+ and DR2new+ data sets.

The second data release from the European Pulsar Timing Array Arxiv|A&A
Implications for massive black holes, dark matter and the early Universe *June 2023*

I contributed to the observation (60+ hours) and data reduction (100+ hours) of the InPTA data set which is employed while assembling the DR2full+ and DR2new+ data sets.