Curriculum Vitae/Resume

Arghya Ranjan Das
Graduate Student | Purdue University
Department of Physics and Astronomy

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Education

Aug 2023-present — **Purdue University**
- Ph.D in Physics; *CGPA* : **3.98** out of 4.0
- Advisor : Miaoyuan Liu

Aug 2022-July 2023 — **Indian Institute of Science (IISc)**
- Master of Science, Major in Physics; *CGPA* in Physics : **9.5** out of 10
- Overall *CGPA* : 9 out of 10

Aug 2018 - July 2022 — **Indian Institute of Science (IISc)**
- Bachelor of Science (Research), Major in Physics; *CGPA* in Physics : **9.4** out of 10
- Overall *CGPA* : 8.9 out of 10

2014 - 2018 — **School : B. D. M. International**
- Higher Secondary Examination (XII Standard); Obtained **94.8%** cumulatively, with a **100%** in Mathematics
- Secondary Examination (X Standard); *CGPA* : **10** out of 10

Achievements

2025 **Awarded by LPC Guests and Visitors (G&V) Program**, funded by the U.S. CMS Operations program
2024 **Awarded Dr. Rolf Scharenberg Summer Graduate Fellowship**, funded by Wendell and Nancy Lutz
2018-23 **Awarded KVPY Fellowship**, the highest undergraduate level fellowship given by Government of India
2018 **Qualified in JEE Mains and JEE Advance** : All India Engineering Entrance Examination (AIEEE)

Publications

Feb 2025 — **Performance measurements of the electromagnetic calorimeter and readout electronics system for the DarkQuest experiment**
Report number : FERMILAB-PUB-24-0967-CSAID-PPD
Nucl. Instrum. Meth. A, Vol. 1080 (2025) 170792 | arXiv:2502.20590 [physics.ins-det]

Sept 2023 — **QPOs in compact sources as a non-linear hydrodynamical resonance : Determining spin of compact objects**
Arghya Ranjan Das, Banibrata Mukhopadhyay
Astrophys.J. 955 (2023) 2, 86 | arXiv:2308.09759 [astro-ph.HE]

Oct 2022 — **Asymptotically flat vacuum solution for a rotating black hole in a modified gravity theory**
Arghya Ranjan Das, Banibrata Mukhopadhyay
Eur. Phys. J. C 82, 939 (2022) | arXiv:2203.07690 [gr-qc]

Research Experience

Jan 2025 - Present

Analysis for Di-Higgs search in $bb\tau\tau$ final states Github
Mentor : Miaoyuan Liu
Purdue University, Indiana, USA
CMS collaboration

- Currently working on the $HH \rightarrow bb\tau\tau$ final state, focusing on the boosted and semi-resolved topology in **Run 3** data. The analysis utilizes nominal and scouting triggers, leveraging upon dedicated taggers—such as the Scouting GloParT developed by our group—for enhanced event reconstruction in the scouting data stream. We are developing an optimized selection strategy, with the goal of enabling future sensitivity to the Higgs self-coupling (κ_λ).

June 2025 - Present

Hardware-Aware Pruning for Real-Time Detector Readout Github
Mentor : Miaoyuan Liu
CERN, Geneva, Switzerland
CMS collaboration

- Developing structured pruning techniques for FPGA/ASIC deployment, focusing on maximizing resource efficiency by targeting DSP and BRAM utilization constraints and PACA (Pattern-Aware Channel-wise Approximation) pruning algorithm, which selects a minimal set of kernel patterns to reduce logic and memory footprint without accuracy loss. These methods are being integrated into the `PQuant` repository and are fully compatible with `hls4ml` for seamless HLS.

June 2024 - Present

Training-Time Sparsity Enforcement with Modified Differential Multiplier Method (MDMM) Github
Mentor : Miaoyuan Liu
Purdue University, Indiana, USA
Fermilab, Illinois, USA
SmartPixels Collaboration

- Developed a novel training-time pruning framework using the Modified Differential Multiplier Method (`MDMM`) in `Keras`, enabling precise control of sparsity as a differentiable hyperparameter (Lagrange multiplier) integrated into the optimization process. This approach enforces target sparsity levels in neural networks within a single training pass, maintaining very high accuracy while significantly reducing computational overhead. This makes it particularly effective for real-time detector applications. Now also integrated in the `PQuant`, compatible with `hls4ml`.

Nov 2023 - Present

MaPSA Testing and Outer Tracker Contributions
Mentor : Miaoyuan Liu
Purdue University, Indiana, USA
Fermilab, Illinois, USA

- Actively involved in MaPSA testings at Purdue and Fermilab testing facilities, performing detailed characterization including leakage current measurements, pixel and mask integrity tests, bad bump inspections, etc. Future plans include continued contributions to Outer Tracker testing at Fermilab.

Aug 2023 - Present

Smartpixels : On-Pixel Featurization for Single-Layer Silicon Tracking using Machine Learning Github
Mentor : Miaoyuan Liu
Purdue University, Indiana, USA
Fermilab, Illinois, USA
SmartPixels collaboration

- Implement AI in the detector readout electronics for fast data reduction. Using a traditional technique would be very slow and computationally expensive, making the fast readout ineffective. By applying Machine Learning algorithms, we can swiftly predict the parameters of the hit and its uncertainty for subsequent layers. This approach enables the selective tracking of pertinent data while disregarding irrelevant information, ensuring a rapid and computationally efficient process.

May 2022 - May 2023

Modeling Quasi periodic Oscillation (QPO) due to resonance of perturbed fluid in accretion disk GITHUB

Mentor : BANIBRATA MUKHOPADHYAY

Indian Institute of Science, Bangalore, India

- **Master's Thesis**
- Modified epicyclic frequencies by considering motion of fluid instead of test particle in the accretion disk. Modelled QPO frequecies with this modified epicyclic frequencies considering non-linear resonance. Using this model we showed a great fitting with observational data and thereafter determining the mass and spin of NS and BH for various sources.

Aug 2022 - March 2023

Low energy dark matter detection in XENON collaboration with S2 only analysis

Mentor : RAFAEL LANG

Purdue University, Indiana, USA

- The XENON collaboration's dark matter detectors utilize liquid xenon to detect particle interactions through two light flashes, S1 and S2. These signals help estimate the event's depth. Although in low-energy interactions, only the S2 signal appears. The S2-only technique allows sensitivity to 2-3 times lower energies than usual. The current focus is on using Machine Learning to determine the event's depth from the S2 waveform.

July 2022 - Feb 2023

Classification and unsupervised clustering of recent Gaia XP spectra GITHUB

Mentor : ASHISH MAHABAL

California Institute of Technology, California, USA

- Having photometric data from about 200M sources, it is a massive archive of data. Our work mainly focuses on determining how many classes these spectra can be categorized into using unsupervised machine learning. We make a similar transformation of dm−dt technique. This was further mapped non-linearly to a latent space using an Autoencoder neural network and applying Gaussian Mixture Model (GMM) to cluster the sources based on this latent space.

May 2021 - May 2022

Modified $f(R)$ gravity and rotating solution GITHUB

Mentor : BANIBRATA MUKHOPADHYAY

Indian Institute of Science, Bangalore, India

- **Bachelor's thesis**
- Explored various models of $f(R)$ gravity and thoroughly studied a models of asymptotically flat $f(R)$ gravity. Studied Newman Janis Algorithm and applied it to get the rotating solution of a black in the modified $f(R)$ gravity. Numerically found that various parameters of the black hole like r_{ISCO},r_{MB}, horizon radius, etc., changes. Ans also gave an analytical approximation for small B (modification parameter), and we reproduced the results of theories with dimensional branes, suggesting that higher dimensional branes results are a special scenario of the present model. The modified solution allows the spin parameter to be greater than unity, supporting the *cosmic censorship hypothesis*.

Aug 2021 - Dec 2021

Variational Quantum Linear Solver for complex valued equations

Mentor : SUDHIR VEMPATI

Indian Institute of Science, Bangalore India

- Analytically determining the best Hamiltonian to understand the best algorithm to determine solution of complex valued equations. Also, a best possible 2-design ansatz to effectively studying the possibility of solutions. Next, implementing these Hamiltonian and ansatz in an arbitrary number of spin-qubit systems to optimize the code in both spatial and temporal order and at the same time to achieve accurate results for *complex valued* equations.

April 2020 - July 2020

Accretion disks around compact objects

Mentor : BANIBRATA MUKHOPADHYAY

Indian Institute of Science, Bangalore India

- Studied gas and plasma dynamics in astrophysical context. Studied accretion is very simple cases like binary accretion following with studying of different type of accretion disks based on Shakura-Sunyaev model. Touched upon the General relativistic theories with Bondi accretion and Novikov-Thorne model.

Feb 2020 - July 2020 | **Studying Inflation and Non-Minimally coupled ultra-light axions as cold dark matter**
Mentor : Shiv K. Sethi
Raman Research Institute, Bangalore India
› Studying inflationary model of expanding universe. Studying the non-minimally coupled ultra-light axion as scalar fields as Cold Dark Matter (CDM) candidate and studying the perturbation model of multi-component fluid for Cosmic Microwave Background (CMB) anisotropies.

May 2019 - July 2019 | **Theory of special and general relativity**
Mentor : Abhijit Bhattacharyya
University of Calcutta, Kolkata, India
› Thoroughly studied the theory of special relativity and derived the theory from scratch with hints from Einstein's original paper. Learnt Tensor analysis, non-Euclidean geometry and General relativity. Later got introduced to Cosmology and studied expanding universe using FRW metric.

Workshops

2024 **Fast Machine Learning for Science**
Purdue University, Oct 15–18, 2024
2022 **Physics at early Universe**
Indian Centre for Theoretical Sciences
2019 **Undergraduate Research Showcase**
Indian Institute of Science
2017,2018 **Vijyoshi National Science Camp**
KVPY in collaboration with INSPIRE
2016 **Jagadish Bose National Science Talent Prog.**

Volunteering

2024 **Machine Learning Hackathon Challenge**
NSF HDR ML Challenge
Poster here
2022 **Radio Astronomy Workshop**
Pravega 2022, Indian Institute of Science
Hands on workshop hosted by Naxxatra
2019 **Square Kilometre Array (SKA) Vigyan Samagam**
Department of Atomic Energy, Department of Science and Technology, National Council of Science Museum, India

Skills

Advanced Physics Courses	Particle Physics II, General Relativity, Fundamentals of Astrophysics, Quantum Field Theory I, Electromagnetic Theory, Quantum Mechanics I and II, Statistical Mechanics, Nuclear and Particle Physics, Mathematical Methods of Physics, Classical Mechanics.
Advanced Math Skills	Differential/Integral Calculus, Linear Algebra, Tensor Algebra, Statistics
Programming Skills	C/C++, Python, Mathematica, MATLAB
Technical Skills	Tensorflow, Keras, PyTorch, numpy, Pandas, JAX, ROOT
Human Languages	Fluent in English, Bengali (Mother Tongue), Hindi
Extracurriculars	Advanced self-defence, Life savings in water-bodies

Referees.

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