Sarthak Choudhary

Astroparticle Physicist

⚲ Warsaw, Poland ✉ Email in LinkedIn ⌂ Projects Ⓘ ORCiD

Personal Profile

I have a dynamic background in experimental physics. I have worked on writing a novel algorithm for analyzing X-ray spectroscopic data from Chandrayaan-1 lunar orbiter, development of multilayer mirrors for X-ray astronomy, wavelength shifters for liquid argon detectors, and a Monte Carlo Simulation code for Pulse Shape Discrimination in DEAP-3600 dark matter detector. I have hands-on experience in assembling and operating liquid argon experimental setups. I also have experience in calibrating Silicon Photomultipliers operating at cryogenic temperature.

Highlights

- Developed a Python module for monitoring and reporting PSD parameters in DEAP-3600 detector. This tool will become a part of standard software suite used by the DEAP-3600 collaboration.
- Worked-out an analytic optical raytracing model to guide and verify sophisticated full physics Monte Carlo Simulation codes for liquid argon radiation detectors: C. Türkoülu & SC, J. Phys.: Conf. Ser. 2156 012236 (2021)
- While studying optical characteristics of Silicon Photo-Multipliers, I discovered an anti-reflection coating which was not disclosed by the manufacturer. This was a key ingredient for improving our simulations: M. G. Boulay et al. Eur. Phys. J. C 81, 1099 (2021)
- Commissioned and calibrated an optical cryostat for studies of fluorescent materials: SC et al. JINST 19, C05019 (2024)
- Successfully applied to Teacher Training Call by Open Astronomy School of the International Astronomical Union. Awarded 10 amateur telescopes for conducting this event.

Education

PhD: Astroparticle physics   2021-2024

AstroCeNT, Nicolaus Copernicus Astronomical Center of Polish Academy of Sciences, Warsaw, Poland

Thesis: Detection and Characterisation of Scintillation Light and Dark Matter Sensitivity of Liquid Argon Detectors

*Defense: Tentatively in mid-April 2025

MTech: Astronomical Instrumentation   2017-2019

Indian Institute of Astrophysics, Bengaluru | University of Calcutta, Kolkata, India

BTech: Electronics, Instrumentation, and Control   2012-2016

YMCA University of Science and Technology, Faridabad, India

Summer Schools

TRIUMF Graduate Instrumentation & Detector School	**June 2024**
INFN School On Underground Physics	**June 2021**

Certifications

Machine Learning Specialization   Jan 2024

Deeplearning.Ai | Standford Online
Verify here: tinyurl.com/27zvtama

Experience

Doctoral Researcher 2021-2024

AstroCeNT, Warsaw

- **Monte Carlo Pulse Shape Discrimination (PSD) Model for Liquid Argon Dark Matter Detectors**
  Contributed to the development of physics-based Monte Carlo Pulse Shape Discrimination model for liquid argon dark matter detectors. Performed cross-checks and applied corrections to the mathematical foundation of the model. Also implemented new features for improving code diagnostics and modularity. Collaborated with experimentalists and computer scientists for efficient implementation of necessary features. I also implemented DEAP-3600 detector specific physics in this code.

- **Python module for monitoring and reporting PSD parameters in DEAP-3600 detector**
  Developed a Python based analysis module for online analysis using a data-driven Pulse Shape Discrimination model. This module will be used for generating weekly reports on detector performance for eminent scientists who oversee the operation of the DEAP-3600 detector. The module performs data processing: applies event selection cuts, fits the PSD model to data, packages the analysis products as a ROOT file, and saves plots as pdf files. This tool will be integrated into the software suite used by the DEAP-3600 collaboration.

- **Analytic Model for Estimation of Light Yield (AMELY) for liquid Argon detectors**
  Worked-out an analytic optical raytracing model to do a quick estimation of the amount of light yield. Implemented the code in form of a jupyter notebook. This tool assisted in developing GEANT4 simulations for several liquid argon experiments. It also facilitated the discovery of certain relations between detector design parameters and its sensitivity.

- **Characterising the fluorescence properties of polyethylene naphthalate (PEN) as a wavelength shifter**
  Collaborated on multiple experiments for characterising PEN under argon scintillation light (128 nm) at cryogenic temperature. Contributed to the project by operating the cryogenic experiments with onsite teams, and performing data analysis. I had also assisted Monte Carlo simulations for these experiments with the AMELY approach. Performed spectrophotometric study of Silicon Photomultipliers to support simulations. Coordinated meeting between pan Europe teams for conducting a measurement at CERN. This experimental work was crucial for proving usefulness of PEN as a scalable wavelength shifter.

- **Quality Assessment of PEN wavelength shifters for DarkSide-20k veto detectors**
  I commissioned a custom gas argon experimental setup for characterization of PEN with argon scintillation light. The SiPM employed for recording fluorescence flashes turned out to be noisier than expected. I had to come up with an algorithmic way of rejecting noisy events to improve signal to noise ratio. I wrote code for automating this process.

Outreach Coordinator 2022-2024

DEAP-3600 collaboration, Canada

- Managed the public website and twitter account of DEAP-3600 collaboration.
- Co-organized an online MasterClass on direct dark matter detection which was attended by about 75 undergrad students.
- Contributed to a YouTube video on direct dark matter search released by DEAP-3600 collaboration on occasion of dark matter day.

Junior Research Fellow 2019-2020

Indian Institute of Astrophysics, Bengaluru

- Developed a novel algorithm for analysis of solar flare data recorded by first Indian lunar mission, Chandrayaan-1.
- Contributed to the research & development of multilayer mirror for X-ray telescopes.

Coursework Projects

- **Sentiment analysis using machine learning**
  Employed a machine learning approach for classifying negative movie reviews. I used NLTK's Naive Bayes classifier to train on IMDb movie review data set.

- **Machine Learning based particle classifier**
  Used a Machine Learning algorithm Random Forest for binary classification of particles either as "Pions" or "not-Pions".

Participation in projects

- Polish National Science Center OPUS 24: PhD student
- European Commission Horizon 2020 Twinning "DarkWave", consortium with Italy, France and Germany: team member
- Foundation for Polish Science International Research Agenda Programme AstroCeNT: PhD student

Publications

- Cryogenic setup for the characterization of wavelength-shifting materials for noble element radiation detectors. SC et al. JINST 19, C05019 (2024)
- SiPM cross-talk in liquid argon detectors. M.G. Boulay et al. Front. Phys., Sec. High-Energy and Astroparticle Physics, Volume 11 (2023)
- The optical simulation model of the DarkSide-20k Veto detector. C. Türkoülu & SC, J. Phys.: Conf. Ser. 2156 012236 (2021)
- Direct comparison of PEN and TPB wavelength shifters in a liquid argon detector. M. G. Boulay et al. Eur. Phys. J. C 81, 1099 (2021)
- Demonstration of the light collection stability of a PEN-based wavelength shifting reflector in a tonne scale liquid argon detector arXiv:2411.17934

Conference Contributions

- Presentation titled Quality Control of PEN wavelength shifters for DarkSide-20k veto in LIDINE-2024 conference held in São Paulo, Brazil.
- Co-authored poster titled Development & Characterization of a PEN-based Wavelength Shifting Reflector at LIDINE-2023 held in Madrid, Spain.
- Presentation on Monte Carlo Pulse Shape Discrimination model at DEAP-3600 collaboration meeting held in Sudbury, Canada.
- Presentation titled Direct Dark Matter Search in Liquid Argon Detectors at Conference of Doctoral Students of Polish Academy of Sciences held in Krakow, Poland.
- Presentation on Monte Carlo Pulse Shape Discrimination model and fitter for liquid Argon dark matter detectors at LIDINE-2022 conference held in Warsaw, Poland.
- Co-authored a poster titled The optical simulation model of the DarkSide-20k Veto detector at TAUP 202, Valencia, Spain.

Skills

- **Scientific Computing**: Data analysis, mathematical modelling, Monte Carlo simulations, statistical methods
- **Programming Language**: Python (NumPy, SciPy, pandas, scikit-learn, PyTorch, PyROOT)
- **Tools**: VS Code, JupyterLab, Slurm workload manager, Latex, Bash
- **Version Control**: Git