

Sarthak Choudhary

Astroparticle Physicist

📍 Warsaw, Poland



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LinkedIn



Projects



ORCID



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Personal Profile

I am an experimental physicist with a dynamic scientific background. I have worked on developing an algorithm for analysing X-ray spectroscopic data from Chandrayaan-1 lunar orbiter, development of multilayer mirror telescopes for X-ray astronomy, characterisation of wavelength shifters for liquid argon detectors, and validation of a Monte Carlo Simulation code for Pulse Shape Discrimination in DEAP-3600 dark matter detector.

Highlights

- Developed a Python module for monitoring and reporting PSD parameters in DEAP-3600 detector.
- Worked-out an analytic optical raytracing model to guide and verify sophisticated full physics Monte Carlo Simulation codes for liquid argon radiation detectors: [C. Türkoğlu & 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 wavelength shifting 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: Optimization of light collection in liquid argon detectors And Modelling pulse shape discrimination for dark matter searches

*Defence: Tentatively in June 2025

Coursework: Introduction to Machine Learning, Statistics under AI, Intelligent Information Systems, Experimental Search for Dark Matter

MTech: Astronomical Instrumentation

2017-2019

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

Coursework: Photon-Detection Techniques in X-ray and γ -ray astronomy, Digital Image Processing

BTech: Electronics, Instrumentation, and Control

2012-2016

YMCA University of Science and Technology, Faridabad, India

Coursework: Analogue Integrated Circuits, Analogue and Digital Electronics, Digital Signal Processing

Certifications

Machine Learning Specialization

Jan 2024

Deeplearning.AI | Stanford Online

Verify here: tinyurl.com/27zvtama

Experience

Doctoral Researcher

2021-2025

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 PSD 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. This tool was adapted from an existing ROOT/C++ code. 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. If this exercise were performed using Monte Carlo simulations, it would have been relatively more compute-intensive.

- **Characterising the fluorescence properties of polyethylene naphthalate (PEN) as a wavelength shifter for VUV photons**

Collaborated on multiple experiments for characterising PEN under argon scintillation light (in vacuum ultraviolet regime) 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. Coordinated meeting between pan Europe teams for conducting a measurement at CERN. This experimental work was crucial for proving the usefulness of PEN as a scalable wavelength shifter.

- **Quality Assessment of PEN wavelength shifters for DarkSide-20k veto**

I commissioned a custom gas argon experimental setup for characterisation of PEN with argon scintillation light. However, the recorded events were noisier than anticipated. To address this, I developed an algorithm leveraging tools from the DarkSide-20k collaboration. The algorithm employs matched filtering to reject events that do not resemble genuine Silicon Photomultiplier (SiPM) signals, significantly improving the signal-to-noise ratio.

Outreach Coordinator

2022-2024

DEAP-3600 collaboration, Canada

- Managed the public [website](#) and [twitter](#) account of DEAP-3600 collaboration.
- Organized an online MasterClass on direct dark matter detection which was attended by about 75 undergrad students.

Junior Research Fellow

2019-2020

Indian Institute of Astrophysics, Bengaluru

- Analysed solar flare X-ray spectra from the Chandrayaan-1 lunar mission using [an algorithm](#) developed as part of my master's thesis.
- Contributed to the research & development of multilayer mirror for X-ray telescopes with magnetron sputtering deposition.

Coursework Projects

- **Machine Learning based particle classifier**

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

- **Sentiment analysis using machine learning**

Employed a machine learning approach for classifying negative movie reviews. I used NLTK's Naive Bayes classifier and trained the model on an IMDb movie review data set.

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 characterisation 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. Türkoğlu & 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](#)

- Master's thesis. Choudhary, S. Study and design of a soft X-ray imager and spectrometer for observation of non-flaring Sun. <http://dx.doi.org/10.13140/RG.2.2.26734.01607> (2019)

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 & Characterisation 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 2021, Valencia, Spain.
- Presented a poster on study of elemental abundances in flaring solar corona using soft X-ray spectra in IRIS-10 (2019) meeting held in Bengaluru, India.

Grant Applications

- Preludium Grant application to National Science Center, Poland for project titled Wavelength shifter characterisation with Argon Gas scintillation light at cryogenic temperature. *Outcome*: not accepted, though the proposal and the research methodology were considered well written
- Grant application for conducting a teacher training workshop by Open Astronomy School of the International Astronomical Union. *Outcome*: accepted, awarded 10 hobby telescopes

Workshops

- Julia programming workshop organized by the Geoplanet Doctoral School in spring 2024
- Workshop on Communication of research results to general public held in March 2023
- PASIFIC Open Science Workshop held in November 2022
- Attended ROOT workshop-2022

Computing Skills

- **Scientific Computing**: data analysis, mathematical modelling, Monte Carlo simulations
- **Programming Language**: Python (NumPy, SciPy, pandas, scikit-learn, PyTorch, PyROOT), Markdown
- **Software Tools**: Visual Studio Code, JupyterLab, Slurm workload manager, Latex, Bash
- **Version Control**: Git

Hardware R&D Skills

- Cleanroom operation
- Operating Vacuum pumps
- Liquefaction of gaseous argon
- Operating high voltage PMTs