Muhammad Bilal Azam

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Google Scholar: https://scholar.google.com/citations?user=WfHM6RIAAAAJ&hl=en&oi=ao
GitHub: https://github.com/teckyonAI

Education

- **Illinois Institute of Technology** — Chicago, United States
  Doctor of Philosophy in Physics — *August 2021 – Present*
  Thesis Supervisor: Prof. Dr. Zelimir Djurcic
- **Lahore University of Management Sciences** — Lahore, Pakistan
  Master of Science in Physics — *August 2017 – June 2019*
  Thesis Title: Dark Energy in Causal Set Theory
  Thesis Supervisor: Prof. Dr. Maqbool Ahmed
- **Bahauddin Zakariya University** — Multan, Pakistan
  Masters of Science in Physics — *October 2013 – May 2015*
- **Bahauddin Zakariya University** — Multan, Pakistan
  Bachelors of Science in Mathematics and Physics — *November 2011 – May 2013*

Research Experience

- **Graduate Research Assistant** — Jun. 2022 – Present
  Argonne National Laboratory — *Lemont, United States*
  - **Photon Detection Calibration System**: Working on design, simulation, and testing photon detection calibration systems for the Deep Underground Neutrino Experiment (DUNE) detector prototypes.
  - **Neutrino Event Generator and Multiplicity Studies**: Conducting charged-current multiplicity studies to compare measured data with simulations from neutrino generators, aiming to select the optimal generator for future DUNE analyses.
  - **Event Selection Optimization and AI/ML Reconstruction**: Tuning simulated events, optimizing neutrino event selection, and enhancing AI/ML-based particle reconstruction using HPC workflows and hyperparameter optimization, including systematic uncertainty studies.
- **Research Assistant for Course Translation** — Oct. 2020 – Jan. 2021
  Lahore University of Management Sciences — *Lahore, Pakistan*
  - **Learning How to Learn (Adaptation Project)**: Adapted and translated course assessments from English to Urdu for the Coursera course by Barbara Oakley and Dr. Terrence Sejnowski.
- **Research Assistant** — Jun. 2019 – Jul. 2020
  Lahore University of Management Sciences — *Lahore, Pakistan*
  - **Everpresent Lambda in the Closed Universe**: Studied the effects of strong and weak curvature on dark energy behavior, developed a formalism for fluctuating Λ including metric functional derivatives, and worked on incorporating CMB anisotropies into the model.
- **Master's Thesis** — Aug. 2018 – May 2019
  Lahore University of Management Sciences — *Lahore, Pakistan*
  - **Dark Energy in Causal Set Theory**: Addressed the fine-tuning and naturalness problems of dark energy in a spherical topology universe using unimodular gravity and causal set theory, based on the fluctuating cosmological constant model of Ahmed et al. (2004), under the supervision of Dr. Maqbool Ahmed.

Research Publications

- Abud, A. A., Abi, B., Acciarri, R., Acero, M. A., Adames, M. R., Adamov, G., **Azam, M. B.**, ... & DUNE Collaboration. (2025). DUNE Software and Computing Research and Development. *arXiv preprint*, arXiv:2503.23743
- Abud, A. A., Abi, B., Acciarri, R., Acero, M. A., Adames, M. R., Adamov, G., **Azam, M. B.**, ... & DUNE Collaboration. (2025). The DUNE Science Program. *arXiv preprint*, arXiv:2503.23291
- Abud, A. A., Abi, B., Acciarri, R., Acero, M. A., Adames, M. R., Adamov, G., **Azam, M. B.**, ... & DUNE Collaboration. (2025). The DUNE Phase II Detectors. *arXiv preprint*, arXiv:2503.23293
- Abud, A. A., Abi, B., Acciarri, R., Acero, M. A., Adames, M. R., Adamov, G., **Azam, M. B.**, ... & DUNE Collaboration. (2025). Neutrino Interaction Vertex Reconstruction in DUNE with Pandora Deep Learning. *arXiv preprint*, arXiv:2502.06637
- Abud, A. A., Abi, B., Acciarri, R., Acero, M. A., Adames, M. R., Adamov, G., **Azam, M. B.**, ... & DUNE Collaboration. (2024). The track-length extension fitting algorithm for energy measurement of interacting particles in liquid argon TPCs and its performance with ProtoDUNE-SP data. *arXiv preprint*, arXiv:2409.18288
- Abud, A. A., Abi, B., Acciarri, R., Acero, M. A., Adames, M. R., Adamov, G., **Azam, M. B.**, ... & DUNE Collaboration. (2024). DUNE Phase II: Scientific opportunities, detector concepts, technological solutions. *Journal of Instrumentation, 19(12)*, P12005. DOI: 10.1088/1748-0221/19/12/P12005
- Abud, A. A., Abi, B., Acciarri, R., Acero, M. A., Adames, M. R., Adamov, G., **Azam, M. B.**, ... & DUNE Collaboration. (2024). First measurement of the total inelastic cross section of positively charged kaons on argon at energies between 5.0 and 7.5 GeV. *Physical Review D, 110(9)*, 092011. DOI: 10.1103/PhysRevD.110.092011
- **Azam, M. B.**. (2024). First Physics Studies with DUNE Near Detector Prototype (2×2). Bulletin of the American Physical Society.

Projects

- **Exotic Matter and Search for Magnetic Monopoles (MoEDAL at CERN)** August 2018
  - Discussed exotic matter and its role in explaining non-baryonic physics beyond the Standard Model, with a focus on magnetic monopoles via Dirac and 't Hooft treatments and their experimental search at CERN through the MoEDAL experiment.
- **What is the meaning of "same" and "different" in context of measurements?** Summer 2018
  - Designed and conducted an experiment using conical pendulums to study the agreement between theoretical predictions and experimental results.
- **Solar Neutrino Problem** *Spring 2018*
  - Studied the solar neutrino problem and its theoretical and experimental resolution, with detailed discussions on neutrino flavor mixing via the PMNS matrix and two-neutrino mixing approximations used in oscillation data analysis.
- **Majorana Fermions and Topological Superconductors** *Spring 2018*
  - Studied topological superconductors and their connection to Majorana fermions, including a comparison with Dirac fermions and a pedagogical review of topological superconductivity. Detailed the Bogoliubov–de Gennes (BdG) Hamiltonian via mean-field theory, with emphasis on the spinless one-dimensional p-wave topological superconductor case.
- **Study of Optical Properties of Isotropic Materials by Reflection SE** *Fall 2017*
  - Studied isotropic thin films by obtaining ellipsometric parameters Ψ and Δ using J.A. Woollam's Alpha-SE Ellipsometer, extracted n, k, and d, and verified the complex reflection coefficient ρ using MATLAB. Also cross-validated the refractive index of glass thin films via Alpha-SE Ellipsometry and Michelson Interferometry.

Oral Talks

- Charged-Track Multiplicity Analysis (Link) *May 2025*
  DUNE Collaboration Meeting - FermiLab, Chicago, USA
- Advances in Physics Studies and Reconstruction with the DUNE Near Detector Prototype (Link) *Mar. 2025*
  Joint March & April Meeting, Global Physics Summit, Anaheim, USA
- Multiplicity-related studies with data-MC comparison (Link) *Sep. 2024*
  DUNE Collaboration Meeting - Santa Fe, New Mexico, USA
- First Physics Studies with DUNE Near Detector Prototype (2×2 Demonstrator) (Link) *Jul. 2024*
  New Perspectives, Fermi National Accelerator Laboratory
- First Physics Studies with DUNE Near Detector Prototype (2×2) (Link) *Apr. 2024*
  Bulletin of the American Physical Society, Sacramento, USA
- First Physics Studies with DUNE ND Prototype (Link) *Dec. 2023*
  Young Scientist Symposium Series (YSSS), Argonne National Laboratory, USA
- Track Multiplicity Analysis Update (Link) *Oct. 2023*
  2×2 First Analysis Meeting (DUNE), Fermi National Accelerator Laboratory, USA
- Physics Studies with DUNE Near Detector Prototype LArTPC (aka ProtoDUNE-ND) *Sep. 2023*
  Argonne High Energy Physics Division Seminar, Argonne National Laboratory, USA
- Everpresent Λ. III. In the Closed Universe *Oct. 2020*
  (Online) Workshop on Quantum spacetime and the Renormalization Group
  CP3-Origins, University of Southern Denmark, Odense, Denmark
- Fluctuating Cosmological Term in the Closed Universe *Feb. 2020*
  2020 Research Symposium, University of Sahiwal, Sahiwal
- Everpresent Λ in the Closed Universe *Jan. 2020*
  Poster Presentation Session of SBASSE Graduate Students with the School's Advisory Board
  DOI: 10.13140/*RG*.2.2.30779.36641
- Dark Energy in Causal Set Theory *Jan. 2019*
  1^{st} PU International Conference on Gravitation and Cosmology, Punjab University, Lahore
- Exotic Matter and Search for Magnetic Monopoles (MoEDAL Experiment at CERN) *Aug. 2018*
  7^{th} School on LHC Physics, National Centre for Physics, Islamabad
- Study of Optical Properties of Isotropic Materials by Reflection SE *Dec. 2017*
  Department of Physics, Lahore University of Management Sciences, Lahore
- Laser Systems and their Practical Applications *Mar. 2017*
  Department of Physics, Govt. Postgraduate College, Sahiwal

Conference Papers

- Evolution of Scientific Culture in Punjab
  (Critical Analysis of Interaction between Western and Native Science) *Feb. 2020*
  3^{rd} International Punjabi Conference, Lahore College for Women University, Lahore, Pakistan

Certifications

- AI for Science on Supercomputers: Advanced (Badge) *Apr. 2024*
  AI-driven Science on Supercomputers Student Training Program
  Argonne National Laboratory, USA

Research Awards

- *Selected* for Department of Energy grant for Graduate Research *Sep. 2023 – May 2025*
  Title: Participation in Intensity Frontier Neutrino Physics
  Location: Illinois Institute of Technology, Chicago, IL, United States
- *Selected* for Department of Energy-Istituto Nazionale di Fisica Nucleare (DOE-INFN) Summer Exchange Program *Summer 2023*
  Title: Study of the performance of a Near Detector for the DUNE experiment at FNAL
  Location: Laboratori Nazionali del Sud, Catania, Italy

Conference, Workshops and Seminars

- Vibe Coding Hackathon *Jun. 2025*
  Argonne National Laboratory, United States
- PSE AI Hackathon *Jan. 2025*
  Argonne National Laboratory, United States
- ESCAPE Data Science for Astronomers, Astroparticle & Particle Physics Summer School *Jun. 2021*
  Laboratoire d'Annecy De Physique Des Particules, Annecy, France
  English translation: Annecy Particle Physics Laboratory, Annecy, France
- IV Joint ICTP-Trieste/ICTP-SAIFR School on Cosmology
  Challenges for the Standard Cosmological Model *Jan. 2021*
  ICTP-ICTP South American Institute for Fundamental Research, São Paulo, Brazil
- 7^{th} School on LHC Physics *Aug. 2018*
  National Centre for Physics, Islamabad, Pakistan
- Workshop on Information, Black Holes and Quantum Theory *Mar. 2018*
  Abdus Salam School of Mathematical Sciences, Lahore, Pakistan

Teaching Experience

Teaching Assistant Fall 2021 - Spring 2023
Illinois Institute of Technology *Chicago, United States*

- **PHYS 123**: General Physics I: Mechanics
- **PHYS 221**: General Physics II: Electricity and Magnetism

Teaching Assistant Spring 2017 - Spring 2021
Lahore University of Management Sciences *Lahore, Pakistan*

- **PHY 100**: Experimental Physics Lab–I
- **PHY 5313**: Atomic and Laser Physics
- **PHY 312**: Quantum Mechanics–II
- **PHY 505**: Computational Physics
- **PHY 104**: Modern Physics
- **PHY 305/EE 330**: Electromagnetic Fields & Waves
- **PHY 323/PHY 522/MATH 3410**: Mathematical Methods for Physics and Engineering–II
- **PHY 404/504**: Relativistic Electrodynamics
- **PHY 501**: Quantum Mechanics–III *(twice)*
- **PHY 517**: Electrodynamics
- **PHY 104**: Modern Physics in Modern Times

Visiting Lecturer Physics Fall 2019, Fall 2020
FAST National University of Computer and Emerging Sciences *Lahore, Pakistan*

- **EE 117**: Applied Physics

Visiting Lecturer Physics Fall 2019 - Spring 2021
University of Sahiwal *Sahiwal, Pakistan*

- **PHYS 04801**: Relativity and Cosmology
- **PHYS 301**: Statistical Physics
- **PHYS 209**: Quantum Physics
- **PHYS 306**: Thermal & Statistical Physics
- **PHYS 405**: Electromagnetic Theory–I
- **PHYS 423**: Digital Electronics Laboratory

National Outreach Programme July 2019
Lahore University of Management Sciences *Lahore, Pakistan*

- **Physics' Instructor**: SAT Physics to the students of National Outreach Programme Summer Coaching Session

Poster Presentations

- Everpresent Λ in the Closed Universe *Jan. 2020*
  Poster Presentation Session of SBASSE Graduate Students with the School's Advisory Board
  DOI: 10.13140/*RG*.2.2.30779.36641

Professional Affiliations

- **American Physical Society** United States of America
  Member *August 2023 – Present*
- **APS Inclusion, Diversity, and Equity Alliance (APS IDEA)** Chicago, United States of America
  Member *August 2023 – August 2024*
- **Spectra Magazine** Lahore, Pakistan
  Editor (Urdu Section) *May 2021 – June 2022*
- **Khwarizmi Science Society** Lahore, Pakistan
  Life Member *Mar. 2021 – Present*
- **Particle Physics and Science Communicator in Khwarizmi Science Society** Lahore, Pakistan
  Volunteer for Large Hadron Collider Interactive Tunnel *Jan. 2020*
- **Numud: LUMS's Annual Bilingual Student Magazine** Lahore, Pakistan
  Editor *Volume 8, 2019*
- **Zauq: Annual Magazine of LUMS Literary Society** Lahore, Pakistan
  Editor–in–Chief *Jun. 2018 – Jul. 2019*
- **STEAM Ed Change Makers Initiative** Lahore, Pakistan
  Member *Jul. 2018 – Present*
- **Lahore Science Mela** Lahore, Pakistan
  Volunteer *Jan. 2018*
- **Numud: LUMS's Annual Bilingual Student Magazine** Lahore, Pakistan
  Editor *Volume 7, 2018*
- **LUMS Literary Society** Lahore, Pakistan
  Member and Advisor *Sep. 2017 – Present*
- **Moarrakh: Govt. Postgraduate College's Magazine** Sahiwal, Pakistan
  Sub–Editor *Sep. 2015 – Feb. 2017*
- **History Society: Govt. Postgraduate College** Sahiwal, Pakistan
  Lifetime Member *Jun. 2014 – Present*

Volunteer Work

- Illinois Mathematics and Science Academy Interns at Argonne National Laboratory — *Fall 2023*
  Assistant to Prof. Dr. Zelimir Djurcic — Lemont, United States
- Regional Bridge Building (Breaking) Contest — *Feb. 2022*
  Checkin Judge — Chicago, United States

Awards & Honours

- Mentor in Scipy2020 Scientific Computing with Python *2020*
- Best Paper Award in 2020 Research Symposium at University of Sahiwal *2020*
- Token of Appreciation for Editor–in–Chief *Zauq* by LUMS Literary Society *2019*
- 1^{st} position in project presentation in 7^{th} LHC School at NCP, Islamabad *2018*
- Position recognition certificate, from GPGCS, on getting highest marks in M.Sc Physics *2017*
- Student Member of The College Council in Govt. Postgraduate College, Sahiwal *2015*

General Publications

- Azam, Muhammad Bilal. "Why do we need Quantum Gravity?". *Spectra Magazine*. Published 21 April 2021, from https://spectramagazine.org/physical-sciences/why-do-we-need-quantum-gravity/
- Azam, Muhammad Bilal. "A Success Story of Riazuddin: The Self-Effacing Quintessential Physicist of Pakistan". *The Sahiwal*, 2019, pp. 40–42.
- Azam, Muhammad Bilal. "An Interview with Dr. Muhammed Sameed (CERN, Switzerland)". *HumSub*. Published 05 April 2018, from http://en.humsub.com.pk/258/muhammad-bilal-azam/
- Azam, Muhammad Bilal. "Dr. I. H. Usmani: The Common Heritage of All Mankind". *Technology Times* 2015. Web. 15 July 2016, from https://www.technologytimes.pk/dr-ih-usmani-the-common-heritage-of-all-humanity/

Skills and Interests

- **Laboratory**: Dimensional Analysis, Logger Pro, Mach–Zehnder Interferometer, Fabry–Perot Interferometer, alpha-SE Ellipsometer, Oscilloscope, Notebook Skills.
- **Programming Languages**: C, C++, Python, Julia, ROOT, LaTeX, MATLAB, Mathematica, Maple, Java, JavaScript, Bash.
- **AI and Machine Learning**: Deep Learning, Large Language Models, NLP/NLU, Neural Networks, Gen AI, pyTorch, TensorFlow, CUDA, HPC.
- **Software and Tools**: Microsoft Office, NI Multisim, Edraw Max, Adobe Photoshop, Mendeley.