Curriculum Vitae

PERSONAL INFORMATION

Name: SHAHINA
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EDUCATION

University of Notre Dame, Notre Dame, IN
Ph.D., Department of Physics and Astronomy — Expected Spring 2024
Dissertation: Stellar neutron sources for the s-process nucleosynthesis
Advisor: Prof. Michael Wiescher

University of Notre Dame, Notre Dame, IN
M.S., Department of Physics and Astronomy — 2018-2020

Indian Institute of Science Education and Research (IISER), Mohali, India
M.S., Department of Physics — 2017-2018
Thesis: Air-shower Multi-Mesh Proportional Counter
Advisor: Prof. Satyajit Jena

Indian Institute of Science Education and Research (IISER), Mohali, India
B.S., Department of Physics — 2013-2017

RESEARCH INTERESTS

My research interests lie at the intersection of experimental and theoretical low-energy nuclear physics, with a particular focus on the following areas:

- **Nuclear reactions important for astrophysical processes** Slow (s-process nucleosynthesis) and fast neutron capture (r-process) reactions. I am highly specialized in the study of radiative capture (e.g., (α,γ) and (p,γ)) and (α,n) reactions, which act as important neutron sources for the s-process nucleosynthesis.
- **High-energy density plasmas** Using High-energy density plasmas (HEDPs) to study nuclear reactions, which can recreate conditions similar to those found in stars, reducing the need for extrapolation and providing a better understanding of nuclear reactions in realistic environments.
- **Machine Learning Applications in Nuclear Data Analysis** Utilizing machine learning algorithms for nuclear data analysis (e.g., neutron spectrum unfolding using convolutional neural networks) and understanding nuclear structure.
- **Low Energy Nuclear Spectroscopy** Conducting precise and detailed low-energy nuclear spectroscopy using gamma-ray and neutron detectors. Designing and executing accelerator-based experiments for the measurement of nuclear resonances. Performing R-matrix and Hauser-Feshbach analyses for obtaining cross-sections of astrophysically important nuclear reactions.

- **Nuclear Structure** α-clustering in light nuclei, nuclear levels of compound nuclei formed in the radiative capture and (α,n) reactions.

TECHNICAL SKILLS

Programming Languages: C, C++, Python, Fortran

Software: SRIM, ROOT, Matlab, Solid works, Labview, LATEX

Detector Modeling Software: GEANT4, Garfield, MCNP

Nuclear Database: ENSDF, EXFOR, NNDC

PUBLICATIONS

First author refereed publications

- *Direct measurement of the low-energy resonances in* $^{22}\mathrm{Ne}(\alpha,\gamma)^{26}\mathrm{Mg}$ *reaction*
  Shahina, J. Görres, D. Robertson, M. Couder, O. Gomez, A. Gula, M. Hanhardt, T. Kadlecek, R. Kelmar, P. Scholz, A. Simon, E. Stech, F. Strieder, and M. Wiescher
  Phys. Rev. C 106, 025805 (August 2022)
- *Strength measurement of the 830 keV resonance in* $^{22}\mathrm{Ne}(\alpha,\mathrm{n})^{25}\mathrm{Mg}$ *reaction using a stilbene detector*
  Shahina, R.J. deBoer, J. Görres, R. Fang, M. Febbraro, R. Kelmar, M. Matney, K. Manukyan, J.T. Natress, E. Stech, and M. Wiescher
  Submitted to PRC

Publications in preparation

- *Low energy measurement of the* $^{25}\mathrm{Mg}(\alpha,\mathrm{n})^{28}\mathrm{Si}$ *reaction via neutron spectroscopy*
  Shahina, A. Boeltzig, K.T. Macon, R.J. deBoer, M. Febbraro, S. Aguilar, T. Anderson, S.P. Burcher, Y. Chen, A. Clark, A. Dombos, C. Dulal, B. Frentz, G. Gilardy, O. Gomez, J. Görres, A. Gula, S. Henderson, K. Howard, J.M. Kovoor, K.L. Jones, J. Kelley, R. Kelmar, J.M. Kovoor, Q. Liu, A. Majumdar, K. Manukyan, L. Morales, S. Mosby, S. Moylan, A. Nelson, S. Pain, C. Reingold, M. Renaud, N. Sensharma, C. Seymour, R. Toomey, B. Van de Kolk, J. Wilkinson, and M. Wiescher

Co-authored refereed publications

- *Measurement of the* $^{13}\mathrm{C}(\alpha,\mathrm{n})^{16}\mathrm{O}$ *differential cross section from 0.8 to 6.5 MeV*
  R.J. deBoer, M. Febbraro, D. Bardayan, C. Boomershine, K. Brandenburg, C. Brune, S. Coil, J. Derkin, S. Dede, F. Fang, A. Fritsch, A. Gula, Gy. Gy urky, B. Hackett, G. Hamad, Y. Jones-Alberty, R. Kelmar, K. Manukyan, M. Matney, J. McDonaugh, Z. Meisel, S. Moylan, J. Nattress, D. Odell, P. O'Malley, D. Robertson, **Shahina**, N. Singh, K. Smith, M. Smith, E. Stech, W. Tan, and M. Wiescher
  Phys. Rev. Lett. 132, 062702
- $^{10}B + \alpha$ *reactions at Low Energies*
  A. Gula, R.J. deBoer, S. Aguilar, J. Arroyo, C. Boomershine, B. Frentz, J. Görres, S. Henderson, R. Kelmar, S. McGuinness, K.V. Manukyan, S. Moylan, D. Robertson, C. Seymour, **Shahina**, E. Stech, W. Tan, J. Wilkinson, and M. Wiescher
  Phys. Rev. C 107, 025805 (February 2023)
- *First near-threshold measurements of the* $^{13}\mathrm{C}(\alpha,\mathrm{n})^{16}\mathrm{O}$ *reaction for low-background-environment characterization*
  R.J. DeBoer, A. Gula, M. Febbraro, K. Brandenburg, C.R. Brune, J. Görres, Gy. Györky, R. Kelmar, K. Manukyan, Z. Meisel, D. Odell, M.T. Pigni, **Shahina**, E. Stech, W. Tan, and M. Wiescher
  Phys. Rev. C 106, 055808 (November 2022)
- *Performance of neutron spectrum unfolding using deuterated liquid scintillator*
  M. Febbraro, B. Becker, R.J. deBoer, K. Brandenburg, C. Brune, K.A. Chipps, T. Danley, A. Di Fulvio, Y. Jones-Alberty, K.T. Macon, Z. Meisel, T.N. Massey, R.J. Newby, S.D. Pain, S. Paneru, **S. Shahina**, M.S. Smith, D. Soltesz, S.K. Subedi, I. Sultana, R. Toomey
  Nucl. Instrum. Meth. A, 989, 164824 (February 2022)

- *Light Response of Poly(ethylene 2,6-napthalate) to Neutrons*
  Brennan Hackett, Richard deBoer, Yuri Efremenko, Michael Febbraro, Jason Nattress, Dan Bardayan, Chevelle Boomershine, Kristyn Brandenburg, Stefania Dede, Joseph Derkin, Ruoyu Fang, Adam Fritsch, August Gula, Gyurky Gyorgy, Gula Hamad, Yenuel Jones-Alberty, Beka Kelmar, Khachatur Manukyan, Miriam Matney, John McDonaugh, Shane Moylan, Patrick O'Malley, **Shahina**, and Nisha Singh
  arXiv:1811.12756 (April 2022)

- *Determination of hexadecapole β_4 deformation of the light-mass nucleus ^{24}Mg using quasi-elastic measurement*
  Y. K. Gupta, B. K. Nayak, U. Garg, N. Sensharma, **Shahina**, R. Gandhi, D. C. Biswas, M. Senyigit, K. B. Howard, W. Tan, P. D. O'Malley, K. Hagino, M. Smith, O. Hall, M. Hall, Richard J. deBoer, K. Ostdiek, Q. Liu, A. Long, J. Hu, T. Anderson, M. Skulski, W. Lu, E. Lamere, S. Lyons, B. Frentz, A. Gyurjinyan, B. Van de Kolk, and C. Seymour
  Proceedings of the DAE Symp. on Nucl. Phys. 58 (2018)

GRADUATE RESEARCH EXPERIENCE

University of Notre Dame, Notre Dame, IN
Graduate Research Assistant, Department of Physics and Astronomy August 2018 – Present

Direct Measurement of the low energy resonances in ^{22}Ne$(\alpha,\gamma)^{26}$Mg reaction

- Performed measurement of the low energy resonances in ^{22}Ne$(\alpha,\gamma)^{26}$Mg reaction at CASPAR (Compact Accelerator System for Performing Astrophysical Research), located 4850 ft. underground at the Sanford Underground Research Facility (SURF), South Dakota, focusing on (E_{lab} = 650, 830 keV) resonances, providing key contributions to the understanding of stellar neutron sources.
- Utilized HECTOR(γ-summing detector) for this measurement.

Low energy measurement of the ^{25,26}Mg$(\alpha,n)^{28,29}$Si reaction via neutron spectroscopy

- Performed precise measurements of ^{25,26}Mg$(\alpha,n)^{28,29}$Si reaction cross-sections at the University of Notre Dame's nuclear science laboratory.
- Employed neutron spectroscopy techniques using ORNL Deuterated Spectroscopic Array (ODeSA) and MLEM Algorithm for neutron spectrum unfolding.

Measurement of the 830 keV resonance in ^{22}Ne$(\alpha,\mathrm{n})^{25}$Mg reaction

- Successfully measured the 830 keV resonance in ^{22}Ne$(\alpha,\mathrm{n})^{25}$Mg reaction using a stilbene scintillator detector, contributing to the understanding of neutron sources for the s-process nucleosynthesis.

UNDERGRADUATE RESEARCH EXPERIENCE

Indian Institute of Science Education and Research (IISER) Mohali, India
M.S., Department of Physics, Advisor: Prof. Satyajit Jena 2017 – 2018

- Worked on the simulation and design of an Air shower Multi-Mesh Proportional Counter (Large area detector that can veto external particles present in cosmic radiation).

Bhabha-Atomic Research Center (BARC) Mumbai, India
Experimental Nuclear Physics, Advisor: Dr. Y.K. Gupta Summer 2017

- Performed detailed analysis of the data of experimentally extracted barrier distributions in the context of the fusion of heavy nuclei.
- Obtained a quantitative understanding of the entrance channel effects induced by the target and the projectile by performing high-precision measurements of the fusion excitation functions.

Inter-University Accelerator Centre (IUAC) New Delhi, India
Experimental Nuclear Physics, Advisor: Dr. Jagdish Gehlot Summer 2016

- Worked on the assembly and characterization of a gas detector.

- Used a radioactive sample of Americium-241 as an alpha source for the position extraction of ions detected by a Multi-wire Proportional Counter (MWPC).
- Received hands-on experience of making an MWPC in lab.

Centre for Theoretical Physics (JMI) New Delhi, India
Classical Mechanics, Advisor: Prof. Ratin Adhikari Summer 2015

- Worked on the construction of Lagrangian from its equations of motion (an inverse problem of the calculus of variation) and transformation of generalized coordinates.

TEACHING EXPERIENCE

University of Notre Dame, Notre Dame, IN

Lead Instructor, Physics Teaching Practicum Spring 2023

- Took lectures under the observation of another instructor for Physics for Life Sciences course for undergraduates.

Lead Lab Teaching Assistant, Physics for Life Sciences Lab Fall 2018 - Spring 2020

- Took lectures during the fall and spring semesters demonstrating experiments and data analysis to undergraduate students in the Physics for Life Sciences Lab.
- Helped with setting up experiments and troubleshooting.

Teaching Assistant, Engineering Physics I Fall 2019

- Taught two undergraduate tutorial sessions of 100 undergraduate students twice a week for an hour during the fall semester, consisting of a review session, group problem-solving, and homework guidance.
- Performed one-on-one mentoring during weekly office hours.

NROTC Tutor, Physics and Calculus Spring 2022-Present

- Taught Naval Reserve Officer Training Corps at Notre Dame twice a week for two hours Physics 1 and 2, Calculus 1 and 2, and Chemistry.

Tutor, Physics Spring 2022-Present

- Acted as a tutor for undergraduate students in Physics courses. Performed one-on-one mentoring and helped with problem-solving.

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CONFERENCES AND SEMINARS

- **Invited Talk:** "Stellar neutron sources for the s-process nucleosynthesis" at the Cyclotron Institute at Texas A&M University, Texas, January 23, 2024.
- **Invited Talk:** "Stellar neutron sources for the s-process nucleosynthesis" at the School-cum-workshop on Low Energy Nuclear Astrophysics at Saha Institute of Nuclear Physics, Kolkata, India from Nov 7-10, 2023.
- **Invited Talk:** "Stellar neutron sources for the s-process nucleosynthesis" at the Nuclear Physics Seminar at University of Notre Dame, September 11, 2023.
- **Invited Talk:** "Measurement of the $^{25}\mathrm{Mg}(\alpha,\mathrm{n})^{28}\mathrm{Si}$ reaction cross-section at low energy " at the 2021 R-matrix Workshop on Methods and Applications held from June 21 - 24, 2021.
- Talk: "Measurement of the $^{25}\mathrm{Mg}(\alpha,\mathrm{n})^{28}\mathrm{Si}$ reaction cross-section at low energy" at the Nuclear Physics Seminar at University of Notre Dame, Aug 24, 2020.
- Talk: "Measurement of the low energy resonances in $^{22}\mathrm{Ne}(\alpha,\gamma)^{26}\mathrm{Mg}$ and $^{22}\mathrm{Ne}(\alpha,\mathrm{n})^{25}\mathrm{Mg}$reaction" at the International Symposium on Nuclear Astrophysics, Manipal, India from October 30- November 3, 2023.

- Talk: "Direct measurement of the low energy resonances in ^{22}Ne$(\alpha,\gamma)^{26}$Mg reaction" at the Nuclei in Cosmos conference held at Institute of Basic Science, Daejeon, South Korea from September 17-22, 2023.
- Talk: "Measurement of the low energy resonances in ^{22}Ne$(\alpha,\gamma)^{26}$Mg and ^{22}Ne$(\alpha,\mathrm{n})^{25}$Mg reaction" at the Fall meeting of the Division of Nuclear Physics of the American Physical Society held in New Orleans from October 27-30, 2022.
- Talk: "Direct measurement of the low energy resonances in ^{22}Ne$(\alpha,\gamma)^{26}$Mg reaction" at the NPA-X (Nuclear Physics in Astrophysics) conference held at CERN, Geneva from 5-9 September 2022.
- Talk: "Direct measurement of the low energy resonances in ^{22}Ne$(\alpha,\gamma)^{26}$Mg reaction" at the 11th European Summer School on Experimental Nuclear Astrophysics held in Catania, Italy from 12-19 June, 2022.
- Talk: "Direct measurement of the low energy resonances in ^{22}Ne$(\alpha,\gamma)^{26}$Mg reaction" at the JINA-CEE Frontiers in Nuclear Astrophysics Meeting held at Notre Dame from May 25-27, 2022.
- Talk: "Direct measurement of the low energy resonances in ^{22}Ne$(\alpha,\gamma)^{26}$Mg reaction" at the Fall meeting of the Division of Nuclear Physics of the American Physical Society held from October 11-14, 2021.
- Talk: "Measurement of the ^{25}Mg$(\alpha,\mathrm{n})^{28}$Si reaction cross-section at low energy" at the Fall meeting of the Division of Nuclear Physics of the American Physical Society held from October 29–November 1, 2020.