Danish F. Dar

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Education

Doctor of Philosophy (PhD) — *Jena, Germany*
Helmholtz Institute & Friedrich Schiller Universität — *April 2022 – Nov 2025*

- **Thesis:** *Theoretical Study of Atomic Ionization Under Intense Laser Pulses*
- **Advisor:** Prof. Dr. Stephan Fritzsche
- **Research Focus:** Focused on ionization dynamics in strong laser fields, exploring above-threshold ionization (ATI), nonlinear interference, and nondipole effects using the strong-field approximation (SFA) and saddle point methods. Developed computational models for electron dynamics in high-intensity few-cycle laser pulses.
- **Key Techniques:** Strong-field approximation, Jacobi-Anger Expansion, Saddle-point approximation.

Master of Science (*Honours Physics*) — *Amritsar, India*
Guru Nanak Dev University — *July 2019 – Sep 2021*

- **Thesis:** *Effect of Sb-Nd Co-Doping on the Ionic Conductivity of $Li_7La_3Zr_2O_{12}$ Electrolyte*
- **Advisor:** Prof. Dr. Atul Khanna
- **Research Focus:** Conducted the synthesis and detailed characterization of antimony (Sb) and neodymium (Nd) co-doped lithium lanthanum zirconate. Employed various spectroscopic techniques to investigate structural, compositional, and optical properties. Additionally, studied electrochemical performance to assess the material's potential in energy storage and other applications.
- **Key Techniques:** X-Ray Diffraction, Raman Spectroscopy, Differential Scanning Calorimetry, Photoluminescence Spectroscopy, UV-Visible Spectroscopy, Two-Probe Method
- **CGPA:** 7.63/10

Publications

- **Dar, D. F.** and Stephan Fritzsche. Comparison between jacobi–anger and saddle point methods to treat above-threshold ionization. *Journal of Physics B: Atomic, Molecular and Optical Physics*, 58(21):215202, nov 2025. doi: 10.1088/1361-6455/ae187b. URL https://doi.org/10.1088/1361-6455/ae187b

- **Dar, D. F.**, Anne Weber, Shreyas Ramakrishna, and Stephan Fritzsche. Photoionization dynamics in intense few-cycle twisted laser pulses. *Phys. Rev. A*, 111:053113, May 2025. doi: 10.1103/PhysRevA.111.053113. URL https://link.aps.org/doi/10.1103/PhysRevA.111.053113

- **Dar, D. F.** and Stephan Fritzsche. Nonlinear interference and electron dynamics: Probing photoelectron momentum distributions in strong-field ionization. *Phys. Rev. A*, 109:L041101, Apr 2024. doi: 10.1103/PhysRevA.109.L041101. URL https://link.aps.org/doi/10.1103/PhysRevA.109.L041101

- **Dar, D. F.** and Stephan Fritzsche. Pulse cycle dependent nondipole effects in above-threshold ionization. *Atoms*, 11(6), June 2023. ISSN 2218-2004. URL https://www.mdpi.com/2218-2004/11/6/97

- **Dar, D. F.**, Björn Minneker, and Stephan Fritzsche. Nondipole strong-field approximation for above-threshold ionization in a few-cycle pulse. *Phys. Rev. A*, 107:053102, May 2023. doi: 10.1103/PhysRevA.107.053102. URL https://link.aps.org/doi/10.1103/PhysRevA.107.053102

- Mandeep Kaur, **Dar, D. F.**, B.K. Sahoo, and Bindiya Arora. Radiative transition properties of singly charged magnesium, calcium, strontium and barium ions. *Atomic Data and Nuclear Data Tables*, 137:101381, 2021. ISSN 0092-640X. doi: https://doi.org/10.1016/j.adt.2020.101381. URL https://www.sciencedirect.com/science/article/pii/S0092640X20300449

Research Experience

Helmholtz Institute (Research Assistant) *Jena, Germany*
Partial-Wave Expansion to Strong-Field Ionization Processes *Jan 2021– March 2022*

Advisor: Prof. Dr. Stephan Fritzsche

- Developed and applied the partial-wave expansion method to analyze strong-field ionization phenomena. This approach decomposes the wave function into angular momentum components, enabling a more detailed understanding of ionization dynamics under intense laser fields. The method enhances the precision of predictions for photoelectron momentum distributions and provides insight into angular-resolved ionization rates.

SN Bose National Centre for Basic Sciences (Research Intern) *Kolkata, India*
Crystal structure identification in Molecular Dynamic Simulations using Machine Learning *May 2021– Aug 2021*

Advisor: Prof. Suman Chakrabarty

- Applied machine learning techniques to enhance the identification of crystal structures within molecular dynamic simulations. This project focused on automating the recognition of complex crystalline phases, improving accuracy and efficiency in analyzing large-scale simulation data. The integration of machine learning facilitated more robust and rapid structural classifications, offering insights into phase transitions and material properties.

Indian Institute of Science Education and Research (Research Intern) *Mohali, India*
Hidden Variables and the Violation of Bell's Inequality *May 2019 – July 2019*

Advisor: Prof. Arvind

- Explored the role of hidden variables in quantum mechanics and their connection to the violation of Bell's inequality. This research examined the implications of quantum entanglement and nonlocality, critically analyzing whether hidden variable theories could account for experimental outcomes that contradict classical assumptions. The project contributes to the ongoing debate regarding the foundations of quantum theory and the nature of reality.

Guru Nanak Dev University (Research Assistant) *Amritsar, India*
Properties of Alkaline Earth Ions *Dec 2018 – Dec 2020*

Advisor: Dr. Bindiya Arora.

- Studied the radiative transition properties of singly charged alkaline earth ions, focusing on magnesium, calcium, strontium, and barium. This research examined transition probabilities, oscillator strengths, and lifetimes of excited states using ab initio methods and theoretical models. The findings contribute to improving atomic data for applications in spectroscopy, astrophysics, and atomic clocks, offering insights into the ionization processes and resonance transitions of these ions.

Research Activity

2024 *Talk at Future of Ultracold and Ultrafast dynamics, Max Planck Institute for the Physics of Complex Systems, Dresden, Germany*
Photoionization dynamics in intense few-cycle twisted laser pulses

2024 *Talk at DoKDoK 2024, Friedrich Schiller University, Suhl, Germany*
Nonlinear Interference and Electron Dynamics: Probing Photoelectron Momentum Distributions in Strong-Field Ionization

2024 *Poster at Photonics Meets AI, Abbe School of Photonics, Jena, Germany*
Nonlinear Interference and Electron Dynamics: Probing Photoelectron Momentum Distributions in Strong-Field Ionization

2024 *Poster at DPG Spring Meeting (SAMOP), University of Freiburg, Freiburg, Germany*
Nonlinear Interference and Electron Dynamics: Probing Photoelectron Momentum Distributions in Strong-Field Ionization

2023 *Poster at Atomic Physics (ATOM23), Max Planck Institute for the Physics of Complex Systems, Dresden, Germany*
Non-Dipole Effects in Strong-Field Ionization using Few-Cycle Laser Pulses

2023 *Poster at the International Conference on Photonic, Electronic and Atomic Collisions (ICPEAC), Shaw Centre, Ottawa, Canada*
Non-Dipole effects in strong field ionization using few-cycle laser pulses

2023 *Poster at the International Conference on Photonic, Electronic and Atomic Collisions (ICPEAC), Shaw Centre, Ottawa, Canada*

Lorentz-Force Shifts in Strong-Field Ionization with Mid-IR Laser Fields

2023 *Poster at DPG Spring Meeting (SAMOP), Leibniz University, Hannover, Germany*

Non-Dipole Effects in Strong-Field Ionization using Few-Cycle Laser Pulses

2021 *Attended Internation Conference on Quantum, Atomic, and Molecular Physics Organized by Institute of Physics (IOP)*

2021 *Attended International Conference on Light Matter Interaction Organized by Indira Gandhi Centre for Atomic Research, Kalpakkam, India*

2020 *Attended Webinar on Quantum Biology Organized by the Science Club GNDU in collaboration with Department of Physics GNDU, Amritsar, India*

2019 *Poster at the 7th IAPT National Student Symposium on Physics, Panjab University, Chandigarh, India*

Hidden Variables and the Violation of Bell's Inequality

2019 *Poster at the National Conference on Non-Linear Phenomena in Physics, UGC-SAP, GNDU, Amritsar, India*

Quantum Defects in Rubidium Atom

Skills

Languages	Kashmiri (Native), English (Fluent), Hindi (Fluent), Urdu (Fluent), Punjabi (Basic)
Programming languages	Julia, C++, C, Fortran, Python
Software Packages	Intel Parallel Studio XE, MATLAB, Mathematica, Origin, LaTeX, SciDAVis, MS Office
Operating Systems	Windows, Linux

Honors & Awards

2022	**RS-APS Graduate Scholarship,** PhD Fellowship by Helmholtz Institute Jena	*Germany*
2022	**HI-Jena-Graduiertenschule Scholarship,** Selected in a Get Involved Program by FAIR/GSI	*Germany*
2020	**Indian Academy of Sciences (IAS) Member,** Selected for a Summer Research Program	*India*
2020	**2nd Prize in Poster Presentation,** National Science Day organised by GNDU	*India*
2019	**Qualified IIT-JAM,** All India level based entrance for Master's	*India*

Teaching

Friedrich Schiller University — *Jena, Germany*

Teaching Assistant in Advance Quantum Mechanics — *Oct 2024 - Feb 2025*

Friedrich Schiller University — *Jena, Germany*

Teaching Assistant in Quantum Theory — *Oct 2023 - Feb 2024*