Arman Duha

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Professional Summary

Computational condensed matter and AMO physicist, specializing in quantum many-body dynamics, quantum simulation, and metrologically useful entanglement generation. Experienced in designing and simulating quantum systems such as Floquet-engineered spin models, to advance applications in quantum sensing and computing. Proficient in leveraging high-performance computing (HPC) clusters for scientific computing tools (Python, C++, Mathematica).

Education

Ph.D. in Physics (GPA: 3.9), Oklahoma State University, Stillwater, OK   **Expected December 2025**
Master of Science in Physics, Oklahoma State University, Stillwater, OK   **May 2022**
Bachelor of Science in Physics, University of Dhaka, Dhaka, Bangladesh   **September 2018**

Technical Skills

- **Programming & Scientific Computing:** Python, C++, Mathematica, MATLAB, Bash/Shell scripting
- **Numerical Modeling:** Monte Carlo simulation, Differential equation solvers, Fourier transforms, time-evolution algorithms, tight-binding model, quantum transport
- **High-Performance Computing (HPC):** Experience with HPC clusters, batch scheduling systems (Slurm), parallelization concepts (MPI), job automation
- **Data Science & ML:** Scikit-learn, NumPy, SciPy, Pandas, Matplotlib, Seaborn, random forest and symbolic regression, feature extraction, compressed sensing
- **Materials Modeling Tools:** DFT, molecular dynamics, UCSF ChimeraX (molecular visualization)
- **Development Tools:** Git, Jupyter Notebooks, Microsoft Excel, Latex

Professional Experience

Mathematical Modeling Intern   **May 2025 – July 2025**
Nettle LLC
- Developing a mathematical model to optimize data processing within a distributed real-time database similar to Apache Kafka.

Graduate Research Assistant (Atomic, Molecular, and Optical Physics)   **May 2023 – Present**
Co-advisor: Dr. Thomas Bilitewski, Oklahoma State University
- **Nonequilibrium Universality of a Squeezing Phase Transition**   **2024 – 2025**
  Developed a Python-based framework of partial differential equation solvers for spin dynamics within a Monte Carlo simulation to demonstrate novel dynamical phase transitions of spin squeezing states. This work establishes the universal scaling of non-equilibrium squeezing dynamics and explores its applications in quantum simulation and sensing *(arXiv ⬈)*.
- **Floquet Engineering of cold-atomic systems for quantum sensing**   **2023 – 2024**
  Numerically investigated the non-equilibrium spin dynamics of power-law interacting spin systems using Python within HPC to implement a semiclassical phase space method known as the discrete truncated Wigner approximation (dTWA), and achieved Heisenberg scaling of sensitivity by engineering the Hamiltonian with a Floquet protocol *(published in PRA ⬈)*.

Graduate Research Assistant (Solid-State Physics)   **June 2020 – Present**

Co-advisor: Dr. Mario Borunda, Oklahoma State University

○ **Molecular Dynamics of Catalytic Surface**   **2024 – 2025**
  Performed DFT simulations of Co doped ZnO surface to analyze atomic interactions and surface energetics, providing insights into catalytic efficiency for syngas-based clean energy applications *(manuscript)*.

○ **Machine Learning for Materials Property Prediction (GitHub [↗])**   **2023 – 2025**
  Developed symbolic regression-based machine learning models to predict radiation damage, enhancing predictive accuracy for threshold displacement energy, validating the results with real-world data *(published in PR Materials [↗])*.

○ **Defect-Induced Conductivity Analysis**   **2023 – 2024**
  Analyzed the impact of defects on electronic and thermal transport based on a finite difference method implemented through C++ codes for Matrix operations. Identified critical metal-insulator phase transitions in 2D materials, crucial for semiconductor device reliability *(published in PRB [↗])*.

○ **Design and Optimization of Solar Cell**   **2021 – 2022**
  Collaborated with external research teams to design a high-efficiency (31%) perovskite solar cell as part of a NASA-funded project on space energy applications by performing device simulations to analyze defect behavior and charge dynamics *(published in Optical Materials [↗])*.

Graduate Teaching Assistant (College Physics 1)   **August 2019 – May 2020**
Oklahoma State University, Stillwater, OK

○ Served as physics lab instructor and organized review sessions before exams, supervising groups of over 40 students.

Undergraduate Research (Quantum Mechanics)   **June 2018 – June 2019**
Advisor: Dr. S. Hasibul Hassan Chowdhury, University of Dhaka, Bangladesh

○ Calculated gauge-invariant energy spectra of an electron in 2-dimensional noncommutative quantum mechanics *(published in Annals of Physics [↗])*.

Publications

Journal Articles (total 6): 4 first-author publications *(PRA, PRB, Optical Materials, arXiv)* and 2 co-author publications *(Annals of Physics, PR Materials)*:

○ **Arman Duha**, Samuel Begg, and Thomas Bilitewski. "Nonequilibrium Universality of a Squeezing Phase Transition." arXiv:2503.11802 [↗]

○ Rosty B. Martinez Duque, **Arman Duha**, and Mario F. Borunda. "Machine Learning-Driven Analytical Models for Threshold Displacement Energy Prediction in Materials." Physical Review Materials 9.8 (2025): 085002. [↗]

○ **Arman Duha**, and Mario F. Borunda. "Effect of uncorrelated on-site scalar potential and mass disorder on transport of two-dimensional Dirac fermions." Physical Review B 110.9 (2024): 094205. [↗]

○ **Arman Duha**, and Thomas Bilitewski. "Two-Mode Squeezing in Floquet-Engineered Power-Law Interacting Spin Models." Physical Review A 109, no. 6 (June 26, 2024): L061304. [↗]

○ **Arman Duha**, Borunda M. "Optimization of a Pb-free all-perovskite tandem solar cell with 30.85% efficiency." Optical Materials. 2022 Jan 1. [↗]

○ Chowdhury SH, Chowdhury TA, **Arman Duha** "Gauge invariant energy spectra in 2-dimensional noncommutative quantum mechanics." Annals of Physics 430 (2021): 168505. [↗]

Presentations [↗]

○ Universal scaling of two-mode squeezing in Floquet-engineered power-law interacting spin models, 2025 APS Global Physics Summit, Anaheim, CA.

○ Two-mode squeezing and entanglement dynamics for power-law interactions in two-dimensional bi-layer spin system, 2024 APS DAMOP meeting, Fort Worth, TX.

○ Two-mode squeezing and entanglement dynamics for power-law interactions in two-dimensional bi-layer

spin system, 2024 APS March meeting, Minneapolis, MN.
- Investigating transport properties of Graphene on Boron Nitride, 2023 APS March meeting, Las Vegas, NV.
- Lead-free All-perovskite Tandem Solar Cell, Joint Fall 2022 Meeting of the Texas Section of APS, Houston, TX.
- Lead-free All-perovskite Tandem Solar Cell, 2022 APS March meeting, Chicago.
- EPR Paradox and Bell's Inequality, 2017 Blackboard Lunch Seminar, University of Dhaka, Bangladesh.

Certifications

- *Fast Quantum Interconnects via Constant-Rate Entanglement Distillation*   February 2025
  QuEra Computing Inc.
- *Trained mentor*, Mentor Collective   August 2021
- *Atomic Astrophysics with Computational Workshop*, University of Dhaka   November 2017

Honors and Awards

- 2024 APS DAMOP Student Travel Award   June 2024
- 4th i-CoMSE DFT Workshop Travel Award   June 2023
- 2023 APS GERA Energy Workshop Travel Award   March 2023
- 2022 TSAPS Student Travel Award   October 2022
- 2nd position: Atomic Astrophysics with Computational Workshop   November 2017

Volunteering Experience

- Organizer, AMO journal club for undergraduate and graduate students   2024
- Physics demonstrator, OSU outreach program for middle school   2024
- Mentor, OSU Sophomore Mentor Collective   2021-2022
- Examiner, Bangladesh Physics Olympiad   2017-2019

Professional Associations

- Member, American Physical Society   2021-Present