

# Zain Shabeb

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## EDUCATION

### Georgia Institute of Technology

PhD Chemical and Biomolecular Engineering | Advisor: Dr. Vida Jamali

Thesis: AI for Nanoscience

Minor: Data Science for the Chemical Industry

Atlanta, GA

Aug 2022 – Present

GPA: 3.86/4.00

### The University of Manchester

MSc Advanced Process Integration and Design - Advisor: Dr. Nan Zhang

Thesis: Modeling & Optimization of Electrodeionization process for water-treatment | Grade: Distinction

Manchester, United Kingdom

Sep 2018 – Sep 2019

### Newcastle University

BS Chemical Engineering (transferred from NUST, Pakistan in 2016) | Grade: First Class Honors

Newcastle, United Kingdom

Aug 2014 – June 2018

## WORK EXPERIENCE

### Georgia Institute of Technology

*Graduate Research Assistant, Jamali Lab*

Atlanta, GA

Sep 2022 – Present

- Developed a physics-informed deep learning model to learn and simulate nanoparticle motion in liquid-phase Electron Microscopy (LPEM) videos, achieving 95%+ accuracy on generated trajectories by training on collected experimental data (*Nature Communications*)
- Designed SAM-EM, a finetuned version of Meta's Segment Anything Model (SAM2) for LPEM videos, achieving ~50× higher accuracy in LPEM video segmentation compared to current state-of-the-art (*AI4Mat Neurips 2025*)
- Targeting 8x resolution enhancement in AI based super-resolution electron microscopy for protein imaging, via diffusion (*ongoing*)

*Graduate Teaching Assistant*

Sep 2022 – Present

- Structured 6 Jupyter assignments and guided AI projects, enhancing students' practical skills in "AI for Chemical Engineering" course
- Took initiative to lead first implementation of high-performance computing cluster in a ChemE course; trained 20 students to use it
- Communicated with faculty to design "AI for Chemical Engineering" course, curating content for department-wide data science training
- Collaborated with professors to structure final-year Capstone Design project for 30+ Chemical Engineering undergraduates

### Fatima Group

*Supply Chain Management Trainee Officer*

Lahore, Pakistan

Sep 2021 – Aug 2022

- Created price forecasting tool in R to predict prices of commodities covering 90% of company spend
- Implemented PowerBI and OracleBI dashboards for data visualization and communicating insights to 5 cross-functional teams

## PUBLICATIONS

- Shabeb, Z**; Goyal N; Nantogmah, P; Jamali, V; "Learning the Diffusion of Nanoparticles in Liquid Phase TEM via Physics-informed Generative AI", *Nature Communications*: doi.org/10.1038/s41467-025-61632-1 (2025)
- Shabeb, Z**; Jamali, V; "LEONARDO: A Physics-Informed Generative Model for Stochastic Nanoparticle Dynamics in Liquid-Phase TEM", *NeurIPS 2025 AI for Science Workshop*
- Wang, A; Xu, M; Goel, R; **Shabeb, Z**; Panicker, I; Jamali, V; "SAM-EM: Real-Time Segmentation for Automated Liquid Phase Transmission Electron Microscopy", *NeurIPS 2025 AI for Accelerated Materials Design Workshop*
- Goel, R; **Shabeb, Z**; Panicker, I; Jamali, V; "Segment Anything Model for Zero-shot Single Particle Tracking in Liquid Phase Transmission Electron Microscopy", *arxiv 2501.03153* (2025)
- Shabeb, Z**; Goyal N; Nantogmah, P; Jamali, V; "Learning the Physics of Liquid Phase TEM Nanoparticle Trajectories Using Physics-informed Generative AI", *Microscopy and Microanalysis 30* (2024)
- Shabeb, Z**; Goyal N; Jamali, V; "Determining Diffusion Characteristics of Nanoparticles in Liquid Phase TEM Using Deep Learning", *Microscopy and Microanalysis 30* (2024)

## TALKS

- "AI-Assisted LPTEM: A Unified Framework for Nanoparticle Tracking and Physics-Informed Generative Modeling" Nov 2025  
*2025 AIChE Annual Meeting*
- "Learning Diffusion of Nanoparticles in Liquid Phase TEM Using Generative AI" Feb 2025  
*37th ChBE Georgia Tech Annual Graduate Research Symposium*
- "Learning Surface Diffusion of Nanoparticles in Liquid Phase TEM Using Physics-informed Generative AI" Jun 2024  
*98th ACS Colloids and Surface Science Symposium*

## AWARDS

- Eckert Graduate Fellowship (ChBE) - \$5000 stipend awarded for potential for highly creative research by Georgia Tech (2025)
- Exemplary Academic Achievement (4.0 GPA) by Georgia Tech (2023)

## SKILLS

**Programming:** Python, R, MATLAB

**Deep Learning Frameworks:** Pytorch, TensorFlow Keras, Scikit-Learn, CUDA

**Microscopy & Image Processing:** Electron microscopy of proteins, condensates, nanoparticles; image segmentation with deep learning

**Structural Biology:** Software: CryoSPARC, CryoDRGN, ModelAngelo; Protein Databases: EMDB, PDB, UniProt

**Data Analysis & Visualization:** NumPy, Pandas, Matplotlib, Seaborn, Statistical modeling, PowerBI, OracleBI