

UMAR SOHAIL QURESHI

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EDUCATION

Vanderbilt University, Nashville, TN

Aug. 2021 – May 2025

Bachelor of Science in Physics (Honors), Mathematics (Honors) & Computer Science (Honors)

GPA: 4.000/4.000

- Minors in Anthropology & Scientific Computing.

RESEARCH EXPERIENCE

High Energy Physics Group, Vanderbilt University + Large Hadron Collider, CERN

Nashville, TN

Undergraduate Research Assistant | Advisor: Professor Alfredo Gurrola

Sep. 2021 – Present

- Conduct research in high-energy particle physics. Developing beyond-the-standard model phenomenology for the LHC [1-2].
- Developing novel machine learning methods for fast simulation, tagging, reconstruction, and signal-background discrimination.
- Directly mentored new team members and Research Experience for Undergraduates (REU) students onboarding the group.

RKE Group, Vanderbilt University

Nashville, TN

Undergraduate Research Assistant | Advisor: Professor Raghav Kunnawalkam Elayavalli

Aug. 2023 – Present

- Conducting research in high-energy heavy-ion physics.
- Developed the “Nashville” tune for the Herwig7 Monte Carlo event generator for $\sqrt{s} = 200$ GeV and higher energies [3].
- Developed a novel machine learning framework for identifying medium-quenched jets in heavy-ion collisions [4].
- Developing a generative neural network approach to reconstruct parton-level jets from hadron-level jets [6-7].

Compact Muon Solenoid Experiment, Large Hadron Collider, CERN

Geneva, Switzerland

Summer Research Fellow | Advisor: Professor Alfredo Gurrola, Professor Andres Florez

Jun. 2024 – Present

- Probing for new physics from proton-proton collisions at LHC.
- Experimental study on $\mathcal{O}(\text{GeV})$ compressed-mass spectrum supersymmetry using vector boson fusion and machine learning.

Machine Intelligence and Neural Technologies (MINT) Lab

Nashville, TN

Undergraduate Research Assistant | Advisor: Professor Soheil Kolouri, Professor Akram Aldroubi

Aug. 2022 – Sep. 2023

- Conducted research in geometric deep learning and optimal transport.
- Expository study on the theory and applications of optimal transport-based distances for spherical signals.

Vanderbilt Astrophysics Group + LIGO Observatory

Nashville, TN

Undergraduate Research Assistant | Advisor: Professor Karan Jani

Sep. 2022 – Jun. 2023

- Conducting research in gravitational wave astrophysics using numerical relativity simulations of binary black holes.
- Investigating gravitational waves as a function of momentum, orbit shape, and mass ratios for flybys and mergers.
- Building a catalog of binary black hole systems and associated gravitational wave waveforms to aid in observation.

Vanderbilt Institute of Nanoscale Science and Engineering

Nashville, TN

Undergraduate Research Assistant | Advisor: Professor Kalman Varga

Jun. 2022 – Feb. 2023

- Research in computational nanoscale physics, electronic structure, and density functional theory light-matter simulations.
- Implemented the stochastic variational method using deformed explicitly correlated Gaussians for computing state energies, high harmonic generation, and non-linear susceptibilities.

HONORS & AWARDS

Vanderbilt Research Travel Grant (\$1,000)	Oct. 2024
Vanderbilt School of Engineering Travel Grant (\$750)	Oct. 2024
Immersion Vanderbilt Research Grant (\$2,000)	Sep. 2024
Nancy and William McMinn Award (Full-Tuition Merit Scholarship; ~\$280,000)	Jun. 2024
Vanderbilt Undergraduate Summer Research Fellowship (\$6,000 Stipend)	May 2024
Ernest A. Jones Award (\$6,000 Stipend)	May 2023
Vanderbilt Undergraduate Summer Research Fellowship (\$6,000 Stipend)	May 2023
Cornelius Vanderbilt Scholarship (Full-Tuition Merit Scholarship; ~\$280,000)	Apr. 2021

PREPRINTS & PUBLICATIONS

- [1] **U. S. Qureshi**, A. Flórez, A. Gurrola, and C. Rodriguez. Probing Light Scalars and Vector-like Quarks at the High-Luminosity LHC. *Under Review at European Physical Journal C*, 2024. [\[ArXiv\]](#)
- [2] **U. S. Qureshi**, A. Flórez, and A. Gurrola. Probing Compressed Mass Spectrum Supersymmetry at the LHC with the Vector Boson Fusion Topology. *Under Review at European Physical Journal C*, 2024. [\[ArXiv\]](#)
- [3] **U. S. Qureshi**, R. K. Elayavalli, L. Mozarsky, H. Caines, and I. Mooney. A New Herwig7 Underlying Event Tune: from RHIC to LHC Energies. *Under Review at Physical Review D*, 2024. [\[ArXiv\]](#)
- [4] **U. S. Qureshi** and R. K. Elayavalli. Model-Agnostic Tagging of Quenched Jets in Heavy-ion Collisions. *Submitted to Physical Review Letters*, 2024. [\[ArXiv\]](#)

TECHNICAL AND COMPUTING SKILLS

Languages: Python (Advanced), C++ (Advanced), Java (Intermediate), Fortran (Intermediate), SQL (Basic).
Libraries: PyTorch, Scikit-learn, TensorFlow, XGBoost, Jax, NumPy, Pandas, Scipy, Seaborn, Matplotlib, Keras.
HEP Tools: MadGraph, MadAnalysis, Herwig, Pythia, Jewel, Delphes, Professor, ROOT, Combine, RIVET, NanoAOD.

CONFERENCE TALKS

Note that while several talks may stem from the same project and even share the same title, the content/perspective can be very different.

- [5] (Upcoming) **U. S. Qureshi** and R. K. Elayavalli. Model-Agnostic Tagging of Quenched Jets in Heavy-ion Collisions. *Quark Matter 2025 – XXXI International Conference on Ultra-relativistic Nucleus-Nucleus Collisions, Goethe University, Frankfurt, Main, Germany*, 2025.
- [6] **U. S. Qureshi** and R. K. Elayavalli. Generative Neural Networks for Reconstructing Parton-Level Jet Showers after Hadronization. *Machine Learning for Jet Physics (ML4Jets), LPNHE, Paris, France*, 2024.
- [7] **U. S. Qureshi** and R. K. Elayavalli. Generative Graph Neural Networks for Reconstructing Parton-Level Jet Showers after Hadronization. *Fall Meeting of the APS Division of Nuclear Physics (DNP), MIT, Boston, MA*, 2024.
- [8] **U. S. Qureshi** and A. Gurrola. Probing the Supersymmetric Standard Model at the Large Hadron Collider through Vector Boson Fusion Processes and Machine Learning. *BOOST 2024 - 16th International Workshop on Boosted Object Phenomenology, Reconstruction, Measurements, and Searches at Colliders, INFN, Genova, Italy*, 2024.
- [9] **U. S. Qureshi** and R. K. Elayavalli. A Herwig7 Underlying Event Tune for $\sqrt{s} = 200$ GeV RHIC and EIC Energies. *2024 Annual RHIC & AGS Users' Meeting, Brookhaven National Lab, Upton, NY*, 2024.
- [10] **U. S. Qureshi** and A. Gurrola. Probing a GeV-scale Scalar Boson in Association with a TeV-scale Vector-like Quark in the $U(1)_{T3R}$ BSM Extension at the Large Hadron Collider using Machine Learning. *Phenomenology Symposium $\times$ APS Division of Particles & Fields (DPF) Meeting 2024, University of Pittsburgh, PA*, 2024.
- [11] **U. S. Qureshi** and A. Gurrola. Probing a GeV-scale Scalar Boson in Association with a TeV-scale Vector-like Quark in the $U(1)_{T3R}$ BSM Extension at the LHC using Machine Learning. *Proceedings of the 31st International Symposium on Lepton Photon Interactions at High Energies, Monash University, Melbourne, Australia*, 2023.
- [12] **U. S. Qureshi** and A. Gurrola. Probing a MeV-scale Scalar Boson and a TeV-Scale Vector-like Quark in the $U(1)_{T3R}$ BSM Extension from gg Fusion, qq Fusion at the LHC using Machine Learning. *XII International Conference on New Frontiers in Physics, Orthodox Academy of Crete, Greece*, 2023.

TEACHING EXPERIENCE

Teaching Assistant, PHYS 2275: Classical Mechanics <i>Department of Physics and Astronomy, Vanderbilt University</i>	Spring 2024/2025 Nashville, TN
Teaching Assistant, PHYS 3651: Quantum Mechanics I <i>Department of Physics and Astronomy, Vanderbilt University</i>	Fall 2023 Nashville, TN
Teaching Assistant, MATH 2610: Honors Ordinary Differential Equations <i>Department of Mathematics, Vanderbilt University</i>	Spring 2023 Nashville, TN
Teaching Assistant, MATH 2410: Methods of Linear Algebra <i>Department of Mathematics, Vanderbilt University</i>	Fall 2022 Nashville, TN

CAMPUS INVOLVEMENT

Pakistani Students Association <i>President</i>	Oct. 2021 – Present
Society of Physics Students <i>Vice President</i>	Jan. 2022 – Present
Sigma Pi Sigma <i>Vice President</i>	Jan. 2022 – Present
Pi Mu Epsilon <i>Vice President</i>	Nov. 2022 – Present
Tau Beta Pi <i>Secretary, Delegate</i>	Oct. 2023 – Present

SELECTED COURSEWORK

Physics: (Graduate) Quantum Field Theory, General Relativity, Statistical Mechanics. **(Undergraduate)** Quantum Mechanics I-II, Electromagnetism, Classical Mechanics, Modern Physics, Mathematical Methods.
Mathematics: (Graduate) Functional Analysis, Harmonic Analysis. **(Undergraduate)** Real Analysis, Differential Geometry, Complex Analysis, Abstract Algebra, Mathematical Physics, Probability & Mathematical Statistics, Numerical Analysis.
Computer Science: (Graduate) Geometric Deep Learning. **(Undergraduate)** Artificial Intelligence, Algorithms, Software Design, Operating Systems, Programming Languages.