

Tushar Pandey, PhD

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EDUCATION

Texas A&M University, Ph.D., Mathematics, Quantum Topology, Topological QFT (Advisor: Prof. Tian Yang) | Aug 2024

Indian Institute of Technology (IIT) Kanpur, B.S., Mathematics and Scientific Computing | Jul 2019

SELECTED PUBLICATIONS (FIRST / SOLE AUTHOR UNLESS NOTED)

- *Fair Decoder Baselines and Rigorous Finite-Size Scaling for Bivariate Bicycle Codes on the Quantum Erasure Channel*, arXiv:2603.19062 (2026). Rigorous protocol for quantum-advantage threshold assessment under erasure noise.
- *Fixed-Reservoir vs. Variational Quantum Architectures for Chaotic Dynamics*, arXiv:2604.23743 (2026). Benchmarking QRC and QPINN on the Lorenz system.
- *Quantum Kernels for Parity-Structured Classification*, IEEE DCAS (2026), arXiv:2605.05625. *ML-Driven Quantum Hacking of CHSH-Based QKD: Exploiting Entropy Vulnerabilities*, QUEST-IS'25 (Springer).
- *Topological Phases of Matter, Quantum Error Correction, and Topological Twists*, APL Quantum 2(3):031501 (2025). *Efficient VQE Methodologies on Quantum Processors*, arXiv:2407.16107 (2024).
- *Generalized BWY Volume Conjecture I: Figure-Eight Knot Complement*, arXiv:2402.04483 (w/ K.H. Wong, 2024). *BWY Volume Conjecture for the 4-Puncture Sphere*, arXiv:2311.13151 (**sole author**, 2023).
- *Geometry of Fundamental Shadow Link Complements and the 1-loop Conjecture*, arXiv:2308.06643 (**submitted to Journal of Topology**). *Topological Characterization with a Twist, Condensation, and Reflection*, arXiv:2209.11126 (w/ E. Dumitrescu, 2022).
- *On the Asymptotic Expansion for Relative Reshetikhin–Turaev Invariants of Fundamental Shadow Link Pairs*, arXiv:2105.08805 (w/ K.H. Wong, 2021). *Modeling Sea Level Rise Using Ensemble Techniques*, Analytics 3(3):276–296 (2024).

RESEARCH EXPERIENCE

Summer Researcher (NSF–MSGI Fellow), Oak Ridge National Laboratory (ORNL), mentor: Eugene Dumitrescu | Summers 2021 & 2022

- Designed end-to-end **fault-tolerant Quantum Error Correction pipeline** for the doubled Semion model (non-abelian topological code); 25% accuracy improvement; lead author on resulting APL Quantum 2025 paper.
- Generalized Hamiltonian models for topological phase transitions and **twist-defect codes**, informing decoder design across topological, surface, color, and bivariate-bicycle architectures.
- Led integration across a 15-scientist collaboration; delivered NSF-MSGI summer-symposium poster on topological data from ground-state Hamiltonians.

Graduate Researcher (Ph.D., Mathematics), Texas A&M University, Advisor: Tian Yang | Aug 2019 – Jul 2024

- Produced **first-author proof of the 1-loop conjecture** for fundamental shadow link complements (submitted, *Journal of Topology*) and **sole-author proof of the BWY volume conjecture for the 4-puncture sphere**; co-author on figure-eight knot complement generalization.
- Developed skein-theoretic methods bridging hyperbolic geometry, Topological QFT, and quantum invariants, foundation for topological QEC, anyonic models, and topological quantum algorithms.
- Founded directed-reading program: mentored 20+ undergrad/grad students in hyperbolic geometry, knot invariants, computational topology, and convex optimization. Volunteer for TAMU Math Derivative/Integral Bees and High School Math Contest.

INDUSTRY EXPERIENCE

Senior Software Engineer, DataRobot (Software Developer II prior, Mar 2025 – Mar 2026) | Mar 2026 – Present

- Drove production certification of **Covalent** for orchestrating GenAI and **hybrid quantum–classical / HPC pipelines**; built multi-tenant inference infrastructure for at-scale model serving.
- Reduced model-deployment latency 30–40% via distributed inference-caching; 300% throughput uplift via container-native serving alternative; integrated customer requirements into the platform.

Research Software Engineer, Agnostiq (Covalent distributed compute) | Jul 2024 – Feb 2025

- Implemented and benchmarked algorithms on **Covalent**, the same distributed-compute substrate used for variational quantum and HPC workloads; reduced cost 99% via federated CPU-first design.
- Authored **Adaptive Graph of Thoughts (AGoT)**, arXiv:2502.05078, 19 citations; test-time reasoning framework with applications to variational ansatz search; shipped 10+ production agentic AI blueprints.

SERVICE, LEADERSHIP & SELECTED TALKS

- **Organizer**, AMS Fall Eastern Sectional 2025: *Special Session on New Horizons for Quantum Error Correction, Categorical Approaches to Topological Codes*.
- **Invited talks / participation**: JMM 2024, QCTIP Oxford 2026, IBM Quantum Developer Conference 2025, AIM Pasadena, ICTP, ICERM, ICMAT, ICMS Edinburgh, Yale, UCSB, Rutgers, Michigan State, AMS Sectionals.
- **Reviewer**: Quantum Science and Technology, IOP, Physica Scripta. **Invited mentor**, NYUAD Quantum Hackathon 2025.

SELECTED PROJECTS & AWARDS

- **Projects**: Quantum ODE solver for large-scale linear systems (2026); Toric Code on PennyLane (open-source); NeurotiQ, QSVM for EEG; QMPRS, linear-depth MPS encoding (QHACK, Zenodo); ZX-Live (Quantomatic open-source); EM-ADAPT-VQE / Tetris-ADAPT-VQE with entanglement forging, TREX/ZNE error mitigation on IBM QPUs (BeH₂, arXiv:2407.16107).
- **Awards**: Q-Volution Hackathon 1st Prize (2026); IBM Quantum Developer Conference 2025 Challenge Winner (Schwinger-model hadron dynamics); MIT iQuHACK 1st Prize (Classiq, 2024); **Guseman Prize**, TAMU Math Dept (2023); Top-15 QHACK Quantum Algorithms Challenge (2023); TAMU Graduate Researcher Award (2023).

SKILLS

Quantum Computing: Fault-tolerant QC; Quantum Error Correction (surface, color, bivariate-bicycle, doubled-Semion, topological & twist-defect codes); rigorous finite-size scaling & quantum-advantage assessment; Quantum Simulation (chemistry, dynamics, Hamiltonian simulation); Variational Quantum Algorithms (VQE, QAOA, ADAPT-VQE, Tetris-ADAPT-VQE); entanglement forging; error mitigation (TREX, ZNE); Quantum Machine Learning; Tensor Networks; ZX-calculus; quantum–classical hybrid pipelines; Qiskit, PennyLane, Cirq, Covalent

Mathematics: Topological Quantum Field Theory (TQFT), Quantum Topology, Hyperbolic Geometry, Volume Conjectures, Skein Theory, Category Theory, Representation Theory, Asymptotic Analysis

Engineering: Python, Go, Java, SQL; PyTorch, NumPy/SciPy; Docker, Kubernetes, CI/CD, AWS / Azure / GCP