Research Statement

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My research focuses on developing trading systems that exploit quantum correlations—such as entanglement and discord—to achieve market advantages unattainable by classical trading systems. Working with collaborators at Duke, the University of Maryland, and NC State, I study how these correlations can give a quantum trader a measurable edge over classical participants while also enabling socially optimal market equilibria when all agents adopt quantum strategies. The long-term vision is a quantum trading platform operating on interconnected quantum computers and emerging quantum networks, where quantum information features can be shared and preserved across machines.

A distinctive aspect of this research is the generation of public quantum signals—classical measurement outcomes carrying the imprint of non-classical correlations. These signals form a new layer of market data, enabling quantum-savvy analysts to extract actionable insights. This opens a research and development frontier in quantum data science and analytics, moving beyond traditional market signals and supporting strategic behavior that classical trading systems cannot achieve.

Our work is grounded in quantum game theory and validated through ion-trap hardware experiments, where quantum players have achieved payoffs above classical benchmarks, providing early evidence of quantum advantage in market design. These proof-of-concept studies suggest that, as quantum networks mature, they could form the foundation for next-generation financial infrastructure.

In parallel, I explore how quantum information can serve as a form of memory in extensive-form games with imperfect recall. In my recent preprint (arXiv:2505.08917), I show that quantum discord, even without entanglement, can allow agents to recover performance lost to limited recall by implicitly encoding contextual information. This connects naturally to networked quantum trading: shared quantum features can carry both data and memory, allowing decentralized agents to coordinate without explicit communication. Such mechanisms illustrate how quantum networks could support decision-making architectures that are fundamentally unavailable to classical systems.

Building on this, I have begun investigating how quantum resources might generalize foundational theorems of game theory to networked settings. In particular, I am exploring whether a quantum analog of Kuhn's Theorem—originally proven for extensive-form games on trees—can be extended to games on general graphs. These structures naturally model quantum networks, where imperfect recall arises not from faulty memory but from structural concurrency or feedback loops. Preliminary insights suggest that quantum correlations (e.g., entanglement or discord) could act as operational memory substitutes, restoring behavioral-strategy equivalence even where classical perfect recall fails. This could form the basis of a new game-theoretic framework for distributed quantum systems.

Alongside theoretical work, I maintain a strong record of applied and collaborative research. At DP World, I developed a quantum annealer-based optimization tool to reduce unproductive port container moves. At Khalifa University, I led projects on secure quantum communication and deployed a quantum random number generator, collaborating closely with hardware teams. Looking forward, I aim to advance three interconnected directions:

1. **Quantum Market Mechanisms and Signals** – modeling and prototyping trading environments where quantum market structures and public signals generate measurable advantages.

2. **Quantum Data Science and Analytics** – developing methods to interpret and act on quantum market signals, supporting decision-making in quantum-enabled financial systems.

3. **Quantum Memory in Networked Decision Systems** – leveraging quantum information features as implicit memory to enhance coordination and performance in distributed, imperfect-recall settings, including the development of quantum generalizations of classical results such as Kuhn’s Theorem, adapted to graph-based decision processes.

My goal is to bridge theoretical market design, quantum decision theory, and applied quantum technologies, helping define how networked quantum capabilities and their signals can generate real economic value.