Cornell Quantum Days
Book of Abstracts

(Nov 3-4, 2026)

Oral Presentations

Speaker: Abhilash Dharmavarapu
Advisor(s): Jayadev Acharya
Title: Breaking the Linear Barrier in Fidelity Estimation with Pauli Measurements
Abstract: Recent experiments have successfully prepared multipartite entangled states in superconducting-qubit processors, trapped-ion systems, and neutral-atom arrays. With the rapid advancement in state preparation, it is becoming increasingly more important to certify that the physical systems are realized as anticipated. Fidelity is the gold-standard for measuring the quality of realization of these systems, motivating the interest in protocols that estimate it with measurements that are easy to implement in the laboratory. One of the simplest forms of measurement is a Pauli measurement, in which each qubit is measured in X,Y, or Z bases. Seminal work by Flammia and Liu provides an efficient protocol to estimate the fidelity between a known target pure state and an unknown lab-prepared state using only linear (in Hilbert dimension) number of Pauli measurements. Since then, it was unclear whether the linear copy-complexity was the fundamental barrier for fidelity estimation with Pauli measurements. In this work, we show that sublinear copy-complexity is possible. We present a protocol that estimates the overlap between any known target state and unknown lab prepared state with d^{0.9675} Pauli measurements, where d is the Hilbert space dimension.

Speaker: Dongbeom Kim
Advisor(s): Nick Rivera
Title: Squeezing Quantum Noise of Intense Light with Multimode Fibers
Abstract: Creating a quantum light source that is both bright and low-noise is important for broad quantum science applications. Yet, it has been challenging to achieve these two criteria simultaneously. In this talk, I will focus on intensity-squeezed light sources in multimode fibers. I will discuss how we use our theoretical framework, quantum sensitivity analysis, to predict and design squeezing at or above the 100 mW level, and share some of our recent preliminary experimental results.

Speaker: Lingda Kong
Advisor(s): Valla Fatemi
Title: Niobium and Tantalum Superconducting Quantum Devices
Abstract: Superconducting transmon qubits are a promising platform for quantum computing; however, further development is limited by performance issues linked to the underlying materials. In this work, we aim to resolve this bottleneck by using material science to investigate methods of improving device fabrication, yielding state-of-the-art niobium (Nb) and tantalum (Ta) resonators, as well as state-of-the-art tantalum qubits. We focus on the effects of resist stripping, surface oxide loss, and silicon interlayer formation in niobium and tantalum thin films.

Speaker: Greeshma Oruganti
Advisor(s): Mark M. Wilde
Title: Thermodynamics and Information in Quantum Many-Body Systems
Abstract: Understanding the thermodynamic and information-theoretic properties of interacting quantum many-body systems poses fundamental challenges, especially in strongly coupled and far-from-equilibrium regimes. In this talk, I will discuss my research at the intersection of quantum thermodynamics, quantum many-body physics, and quantum simulation. I will begin with consistent definitions of thermodynamic quantities for strongly coupled open quantum systems, emphasizing their compatibility with the first law of thermodynamics and the conditions under which the second law holds during nonequilibrium processes. I will then discuss applications of this framework to lattice gauge theories, where gauge constraints complicate subsystem definitions, and illustrate thermodynamic signatures of phase transitions during quench processes. I will also highlight connections between strong-coupling thermodynamics and the entanglement Hamiltonian, which offer a potential route to experimentally probing thermodynamic quantities using quantum simulators. I will conclude with a brief overview of my ongoing postdoctoral research, which spans quantum information, many-body physics, and quantum simulation. My ongoing work seeks to deepen these connections by drawing on a broader range of quantum-information concepts and methods to investigate questions in quantum thermodynamics and many-body physics, while opening avenues for interdisciplinary collaboration.

Speaker: Purnendu Sen
Advisor(s): Peter McMahon
Title: Experimental quantum-computing-enhanced sensing using Grover's algorithm
Abstract: The combination of quantum sensing with quantum computing to provide an enhancement over conventional quantum sensing has recently emerged as a promising potential application of quantum computing that could give advantages without needing large-scale or fault-tolerant hardware. In this work, we report an experimental demonstration of a recent theoretical proposal to repurpose Grover's search algorithm to improve the ability to detect signals with unknown frequency within a large detection bandwidth. Our experiments were based on a system comprising a single superconducting qubit coupled to a single superconducting cavity, highlighting the modest hardware requirements for realizing the protocol. We found that Grover-based sensing was able to outperform the natural non-Grover baseline for our experimental platform for detection bandwidths >10 MHz, with an advantage that empirically grew superlinearly with the bandwidth beyond that break-even point. The use of the Grover-based protocol reduced the amount of signal that needed to be sensed to make an accurate detection decision by more than 10× for choices of larger detection bandwidth and higher desired detection accuracy. Our results provide a proof-of-principle validation that Grover-based quantum computational sensing can be realized in near-term hardware and provide a metrological advantage well beyond break-even in spite of the additional protocol complexity.

Speaker: Chao Shang
Advisor(s): Greg Fuchs
Title: Fast Single Nitrogen-Vacancy Center Ramsey Characterization using a Physics-Informed Neural Network
Abstract: High-throughput characterization of single NV centers is important for optimizing growth and processing conditions and identifying high-performance NV centers for specific sensing tasks.

Unfortunately, characterization is bottlenecked by long data averaging times and bespoke fitting. Ramsey interferometry measurements of coherence lifetime and the hyperfine coefficients of environmental nuclear spins form a good benchmark for quantum sensing; however, these quantities are difficult to extract with short data acquisition times. We introduce a physics-informed neural network that jointly denoises and estimates parameters directly from few-shot Ramsey traces. The model is pre-trained on semi-quantum–mechanical simulations with modeled realistic noise, then fine-tuned on experimental data using an uncertainty-aware objective. Given a Ramsey signal with a short acquisition time relative to conventional approaches, the network returns a denoised signal, a calibrated estimate of the detuning associated with nearby hyperfine interactions, and confidence intervals. Across multiple NV centers, predictions agree with reference data acquired with integration times as much as 50 times longer. The approach enables rapid screening of candidate NV centers for sensing, robust operation under mild miscalibration, and seamless integration into adaptive measurement loops.

Speaker: Dylan Sheils
Advisor(s): Or Katz
Title: How faithfully can trapped ions simulate many-body dynamics?: Suppressing Intrinsic Spin-Phonon errors
Abstract: Trapped-ion quantum simulators realize programmable spin models through phonon-mediated interactions. When the target Hamiltonian contains noncommuting terms, however, the same phonon bus generates intrinsic spin-phonon errors that strongly distort the target dynamics and, in relevant regimes, make the simulator give the wrong answer for the intended model. Because these errors are governed by the full time history of the spin-dependent phonon motion, they survive standard loop-closing control, rendering the simulator unreliable precisely where its answer cannot be checked classically. Using a sequence of frame transformations, we identify and isolate the error mechanism and show that it can be strongly suppressed while preserving programmable Ising couplings. Full spin-boson simulations of multi-ion chains demonstrate orders-of-magnitude lower error than both constant-drive and conventional loop-closing protocols. In an adiabatic simulation of a frustrated spin model, conventional driving predicts the wrong ferromagnetic-to-kink phase diagram, whereas our method recovers the target result. These results restore the connection between the quantum hardware and the many-body model it is intended to realize, enabling reliable trapped-ion analog simulation of noncommuting many-body physics.

Speaker: Max Tromanhauser
Advisor(s): Nick Spooner
Title: On Removing Interaction from Quantum Proofs
Abstract: Zero knowledge proofs (ZKP) allow an all-powerful prover to convince a skeptical, computationally-bounded verifier that a claim is true without revealing anything beyond the claim's validity. If these proofs require only a single message, then we say that they are a non-interactive zero-knowledge proof (NIZK). An important goal in quantum cryptography is developing publicly-verifiable NIZKs for QMA, the class of computational problems where positive answers can be verified by a small quantum state. Classically, one can construct NIZKs by compiling an interactive zero knowledge protocol using the Fiat–Shamir transformation in the idealized random oracle model. Although Broadbent and Grilo constructed an interactive ZKP for QMA where the prover's first message is quantum, it is not clear how to compile their construction into a NIZK because the Fiat–Shamir transformation seems to be incompatible with quantum messages. In this work we give formal evidence

that this is indeed the case: we show that if generic "Fiat–Shamir-like" transformations for quantum protocols exist (with small constant completeness error) in the quantum-analog of the random oracle model, then all problems in QMA can be efficiently decided by a quantum computer.

Speaker: Xiao Wang
Advisor(s): Eun-Ah Kim
Title: Quantum aging of identical particles on a quantum simulator
Abstract: A century ago, the founders of quantum mechanics established that a particle's wave packet spreads over time and that exchanging identical particles changes the phase of their wave function. However, a natural question implicit in these two principles remains underexplored: how do identical particles collectively spread through configuration space? Following this evolution experimentally requires recording entire many-body configurations, a capability that programmable quantum simulators now provide. Here we propose stationary multi-particle interferometry to track this "quantum aging" by preparing a row of localized packets and measuring their configuration entropy, the logarithm of the effective number of occupied configurations. Combining analytical arguments and numerical simulations, we identify three stages: an early quadratic rise, a many-body midlife, and late logarithmic growth as the cloud dilutes. For free fermions, the midlife has a linear envelope generated at the row's ends while Pauli exclusion constrains its interior. For composite E_8 mesons, pronounced midlife oscillations signify their momentum-dependent exchange phases. We find the oscillation period is set by the lightest meson's lattice bandwidth, linking the mesons' low-energy identity to the short-distance physics of their lattice realization. We further develop circuits for preparation and readout that enable programmable quantum simulators to follow this evolution through full-register snapshots. These experiments would bring a question rooted in the foundations of quantum mechanics into the laboratory, and reveal how its answer changes when the particles themselves emerge from an interacting many-body system.

Speaker: Chun Yu Weng
Advisor(s): Karan Mehta
Title: Toward Fast, Power-Efficient Raman Gates in an Integrated Trapped-Ion Platform
Abstract: Trapped ions are a promising platform for quantum computing. However, the trade-off between operating speed and optical power remains a challenge, as well as the scaling of the physical system. In this talk, I will discuss the theoretical aspects of the standing wave, Raman two-qubit gate scheme that reduces entangling gate time, lowers laser power requirements, and potentially improves gate fidelity. I will also present our work towards a 300 mm foundry process for integrated photonic ion trap chips and our work characterizing ion trap operation with this platform. Finally, I will describe an experimental scheme for implementing the above two-qubit gate on 40Ca+ with the improved trap chips.

Poster Presentations

Pranjal Praneel (Mueller Group)
“Quantum Simulation of Bose Hubbard Model using transmon arrays”

Daniel Pardo (Mueller Group)
“Excitations of a Bose-Einstein Condensate in a Confocal Optical Cavity: Emergence of Sound”

Kevin Sullivan (Mueller Group)
“Solving the snap-off problem: correcting errors from finite sweep rates in measurements of analog quantum simulators”

Alex He (Wilde Group)
“Canonical Quantization of Neurons”

Michele Minervini (Wilde Group)
“Bose-Einstein thermal operators for semidefinite optimization”