THE UNIVERSITY OF ARIZONA
Wyant College of Optical Sciences

INDUSTRIAL AFFILIATES WORKSHOP

STUDENT SPEAKER PROFILE

KEVIN KUPER, PH.D. STUDENT

Wyant College of Optical Sciences
Advisor: Poul Jessen

Tuesday, February 15, 2022 | 11:17 a.m.

Title: "Disentangling Sources of Error on a Quantum Simulator"

Abstract: Noisy, intermediate-scale quantum (NISQ) processors are improving rapidly but remain well short of requirements for fault tolerant computation. In the meantime, much effort has focused on the development of quantum simulators that operate without error correction. So-called “digital” processors can simulate non-native Hamiltonians through Trotterization, wherein the evolution is broken into discrete steps using a Trotter-Suzuki expansion. When simulating the evolution over a total time T, this introduces Trotter errors that scale inversely with the number of time steps. For optimal performance, this must be weighed against the native errors inherent to the processor hardware implementation, which scale roughly in proportion with the number of time steps. Notably, the optimal step size can be affected by the appearance of chaos in the Trotterized dynamics, which leads to hypersensitivity to both Trotter and native errors. We investigate each of these error regimes in quantum simulations running on a small, highly-accurate quantum processor based on the combined electron-nuclear spins of a Cs-133 atom. As a concrete example, we focus on the Lipkin-Meshkov-Glick Hamiltonian, which when Trotterized becomes the Quantum-Kicked-Top – a well-studied system that exhibits chaos and dynamical instability. Finally, we show that OTOC measurements can be implemented and used to identify the presence of chaos and instabilities as they appear and disappear with changing Trotter step size.

Bio: Kevin is a Ph.D. student at the Wyant College of Optical Sciences at the University of Arizona. He works with Professor Poul Jessen and other researchers in the Center for Quantum Information and Control (CQuIC). He is currently studying quantum control, particularly how Trotterization can lead to the onset of chaos. He examines ways of detecting errors and chaos by using a cold-atom quantum simulator based on the nuclear and electron spins of Cesium-133 atoms. Through his research, he has become acquainted with the fundamentals of quantum information, quantum computing, and quantum optics. He has acquired skills in coding (primarily using MATLAB, though he has experience with other languages), processing large sets of data, and running a 16-dimensional quantum simulator (equivalent to 4-quantum bits). He is approaching the end of his degree and is looking for jobs, especially in the field of quantum information/computation. Before pursuing his Ph.D., he graduated Summa Cum Laude with a B.S. in Physics at California State University in Fullerton (CSUF). There, he did research with Professor Geoffrey Lovelace using supercomputers to simulate gravitational waves emanating from binary black hole collisions.

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