# Old Dominion University
# Department of Physics
# Colloquium

## Tuesday, February 13, 2024

## "Realizing the Nishimori Transition at the Intersection of Quantum Error Correction and Statistical Physics"

**Dr. Edward Chen**
IBM

**Abstract**:
Preparing quantum states across many qubits is necessary to unlock the full potential of quantum computers. However, a key challenge is to realize efficient preparation protocols which are stable to noise and gate imperfections. Here, using a measurement-based protocol on a 127 superconducting qubit device, we study the generation of the simplest long-range order -- Ising order, familiar from Greenberger-Horne-Zeilinger (GHZ) states and the repetition code -- on 54 system qubits. Our efficient implementation of the constant-depth protocol and classical decoder shows higher fidelities for GHZ states compared to size-dependent, unitary protocols. By experimentally tuning coherent and incoherent error rates, we demonstrate stability of this decoded long-range order in two spatial dimensions, up to a critical point which corresponds to a transition belonging to the unusual Nishimori universality class. Although in classical systems Nishimori physics requires fine-tuning multiple parameters, here it arises as a direct result of the Born rule for measurement probabilities -- locking the effective temperature and disorder driving this transition. Our study exemplifies how measurement-based state preparation can be meaningfully explored on quantum processors beyond a hundred qubits.

*Key contributions made together with Guo-Yi Zhu (University of Cologne) and Ruben Verresen (University of Chicago, previously Harvard University)

Presentation: OCNPS 200 @ 3:00 pm
Refreshments: OCNPS Atrium @ 2:30 pm

**All interested persons are cordially invited to attend.**