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## Bryce Kobrin and Trond Anderson - Towards new applications with hybrid analog-digital quantum simulators

Monday 13 January 2025 16:30 (1 hour)

Quantum simulators offer the potential to explore correlated quantum phenomena with greater flexibility and control than found in the natural world. In this two-part talk, we present an overview of recent theoretical and experimental advances in quantum simulation. We first discuss the development of microscopic holographic models and efforts to probe gravitational-like dynamics via many-body quantum teleportation in the so-called traversable wormhole circuit. We outline connections between many-body teleportation and operator growth, identify distinct mechanisms that enable teleportation, and comment on recent experiments that realize the teleportation protocol in digital quantum processors. In the second part, we present the recent development of a hybrid analog-digital quantum simulator comprising 69 superconducting qubits which supports both universal quantum gates and high-fidelity analog evolution. We compare the performance of the hybrid simulator to a digital quantum processor and demonstrate beyond-classical performance in crossentropy benchmarking experiments. Leveraging the great versatility of this hybrid platform, we also probe thermalization dynamics, energy transport, and critical phenomena in the XY-model, revealing a breakdown of the Kibble-Zurek mechanism. Taken together, our discussion highlights the possibilities and challenges of simulating interacting quantum systems, including dynamical phenomena inspired by quantum theories of gravity.

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