Abstract Submitted
for the DAMOP20 Meeting of
The American Physical Society

Overlap measurements of infinite-dimensional quantum states for quantum-enhanced machine learning. CHI-HUAN NGUYEN, KO-WEI TSENG, JAREN GAN, GLEB MASLENNIKOV, DZMITRY MATSUKEVICH, Centre for Quantum Technologies — Estimation of overlap between quantum states is a ubiquitous task in quantum information processing protocols and has great significance for quantum machine learning applications. Implementing the overlap measurement with the standard discrete-variables approach in noisy intermediate-scale quantum computers requires scaling the number of physical qubits and entanglement gates with the dimensions of the Hilbert space. Hybrid quantum computation offers an alternative approach; whereby utilizing both discrete and continuous variables, a gate-based overlap measurement in an infinite-dimensional system with constant circuit depth can be realized. Here, we experimentally demonstrate the overlap measurement using this approach in a system of two trapped Yb 171 ions. We employ the nonlinear interaction between the internal and motional degrees of freedom to enact a controlled-swap gate between two motional modes. To illustrate the versatility of our method, we measure the overlap between a variety of quantum states: Fock states, coherent states, squeezed states, and cat states. We also discuss how to employ the overlap test in an unsupervised quantum-enhanced k-means algorithm.

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Date submitted: 31 Jan 2020 Electronic form version 1.4