Canadian Association of Physicists

Association canadienne des physiciens et physiciennes

Contribution ID: **4208** Type: **Oral not-in-competition (Graduate Student) / Orale non-compétitive (Étudiant(e) du 2e ou 3e cycle)**

(G) Flying-cat parity checks for quantum error correction and quantum communication

Monday 27 May 2024 16:45 (15 minutes)

Multi-qubit parity checks are a crucial requirement for many quantum error-correcting codes. Long-range parity checks compatible with a modular architecture would help alleviate qubit connectivity requirements as quantum devices scale to larger sizes. In this work, we consider an architecture where physical (code) qubits are encoded in stationary degrees of freedom and parity checks are performed using state-selective phase shifts on propagating light pulses, described by coherent states of the electromagnetic field. We optimize the tradeoff between measurement errors, which decrease with measurement strength (set by the average number of photons in the coherent state), and the errors on code qubits arising due to photon loss during the parity check, which increase with measurement strength. We also discuss the use of these parity checks for the measurement-based preparation of entangled states of distant qubits. In particular, we show how a six-qubit entangled state can be prepared using three-qubit parity checks. This state can be used as a channel for controlled quantum teleportation of a two-qubit state, or as a source of shared randomness with potential applications in three-party quantum key distribution.

Keyword-1

Distributed quantum computing

Keyword-2

Quantum networks

Keyword-3

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Session Classification: (DQI) M3-9 Quantum Error Correction | Correction des erreurs quantiques (DIQ)

Track Classification: Technical Sessions / Sessions techniques: Division for Quantum Information / Division de l'information quantique (DQI / DIQ)