Abstract Submitted
for the MAR15 Meeting of
The American Physical Society

Entangling quantum gates using extended Hilbert space DMITRY SOLENOV, St. Louis University — Quantum information is traditionally represented in qubits, which are set entangled by quantum gates as prescribed by algorithms. Multi-state quantum bits (qudits) have also been considered to facilitate algorithm development. Here we explore the potential of additional quantum states available during entangling operations. Unlike in the concept of a qudit, the higher-energy states we consider do not belong to each qubit, but may naturally span over several physical qubit systems. We demonstrate that utilization of such states in an entangling operation involving multiple qubits can lead to significant reduction of its overall time. Such states, which naturally occur in a system of superconducting qubits coupled to a cavity mode, can potentially enable reduction of complexity class of some multi-qubit operations.

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Date submitted: 13 Nov 2014 Electronic form version 1.4