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**Investigating the speed limit of two-qubit entangling gates with superconducting qubits** JOEL HOWARD, Colorado School of Mines, JUNLING LONG, MUSTAFA BAL, RUICHEN ZHAO, TONGYU ZHAO, DAVID PAPPAS, National Institute of Standards and Technology, Boulder, ZHEXUAN GONG, MEENAKSHI SINGH, Colorado School of Mines — Fast two-qubit entangling gates are essential for quantum computers with finite coherence times. Due to the limit of interaction strength among qubits, there exists a theoretical speed limit for a given two-qubit entangling gate. This speed limit has been explicitly found only for a two-qubit system and under the assumption of negligible single qubit gate time. We seek to demonstrate such a speed limit experimentally using two superconducting transmon qubits with a fixed capacitive coupling. Moreover, we investigate a modified speed limit when single qubit gate time is not negligible, as in any practical experimental setup. Finally, we discuss the generalization to multiple qubit systems where the coupling to additional qubits can significantly increase the speed limit of a two-qubit entangling gate, thus requiring the co-design of the quantum computer from both theorists and experimentalists for optimal gate performance.

Joel Howard
Colorado School of Mines

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