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Quantum computation using electron wave packets

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Abstract

Standard approaches to quantum computing require significant overhead to correct for errors. The hardware size for conventional quantum processors in solids increases linearly with the number of physical qubits, such as for transmon qubits in superconducting circuits, or electron spin qubits in quantum dot arrays. We propose an alternative approach that utilizes flying electronic wave packets propagating in solid-state quantum semiconductor circuits. Using a novel architecture for the electronic wave packets, hardware requirements are drastically reduced because qubits can be created on-demand and manipulated with a common hardware element, unlike the localized approach of wiring each qubit individually. We also present our recent experiment in this direction, where we realize electronic interference at the level of a single quantized mode that can be used for manipulation of electronic wave packets.