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Implementation of a Controlled-Phase Gate and Deutsch-Jozsa Algorithm with Superconducting Charge Qubits in a Cavity

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Abstract: Based on superconducting quantum interference devices (SQUIDs) coupled to a cavity, we propose a scheme for implementing a quantum controlled-phase gate (QPG) and Deutsch-Jozsa (DJ) algorithm by a controllable interaction. In the present scheme, the SQUID works in the charge regime, and the cavity field is ultilized as quantum data-bus, which is sequentially coupled to only one qubit at a time. The interaction between the selected qubit and the data bus, such as resonant and dispersive interaction, can be realized by turning the gate capacitance of each SQUID. Especially, the bus is not excited and thus the cavity decay is suppressed during the implementation of DJ algorithm. For the QPG operation, the mode of the bus is unchanged in the end of the operation, although its mode is really excited during the operations. Finally, for typical experiment data, we analyze simply the experimental feasibility of the proposed scheme. Based on the simple operation, our scheme may be realized in this solid-state system, and our idea may be realized in other systems.

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Key words: a quantum controlled-phase gate, Deutsch-Jozsa algorithm, superconducting quantum interference device, charge qubit

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