QUANTUM COMPUTER ON MULTI-ATOMIC ENSEMBLES IN QUANTUM ELECTRODYNAMIC CAVITY

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Realization of the quantum computer on multi-atomic ensembles of Rydberg atoms was proposed in [1]. We have proposed an effective realization of a complete set of quantum gates in a solid state quantum computer based on macroscopic resonance systems – multi-atomic coherent ensembles, squids or quantum dots in microcavities contained in a common quantum electrodynamic cavity [2, 3]. Here, we use encoding of logical qubits on pairs of macroscopic two-level systems without micro-cavities (Fig. 1). Logical single-qubit gates are realized via the swapping transfer [4, 5] of single-photon excitation in the pair. In the case of two-level systems, logical two-qubit gates are realized via the unequal Lamb frequency shift of transition frequencies in the pair controlled by a third system from another pair. With the use of three-level systems, swapping in the pair is blocked by the transition of operative excitation to an additional level at the direct impact of control pair excitation.

In the proposed architecture we explicitly construct a computation of the Equality function via quantum fingerprinting technique, which is a classical task in many computational and communication scenarios. We present a step-by-step implementation of this algorithm including "low level" transfers of the qubit states from the quantum memory to the processing nodes and backwards. Finally, we estimate the optimal number of qubits stored in the memory and the number of processing nodes for implementation of the aforementioned algorithm.

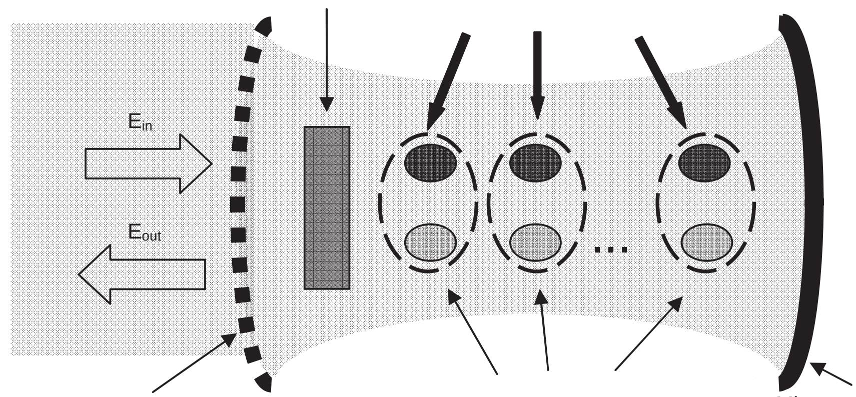

Fig. 1. Quantum computer on multi-atomic systems with logical qubit encoding

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