Modular computation architecture based on locally controlled logical systems

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We consider quantum computer architectures based on logically encoded systems consisting of multiple qubits that interact via some always-on, long-ranged coupling, and utilize solely single qubit control. We show that one can remotely mediate entanglement between different subsystems without any quantum control using one logical system [1]. Using multiple logical systems allows one to selectively mediate interactions between systems, and obtain a programmable quantum simulator or processor [2]. Furthermore, the encoding can serve to make the effective interaction between logical systems resilient against position fluctuations of the components, thereby providing a novel way to deal with imperfections, e.g. in cooling or heating of systems due to moving atoms or ions around [3]. We demonstrate a significant improvement of achievable gate fidelities in several scenarios, including collective and individual position fluctuations , and classical and quantum treatment thereof. We show how to use such a setup to obtain a modular computational architecture that utilizes multipartite entanglement generated between modules to implement sets of gates or non-local parts of whole circuits between modules [4].

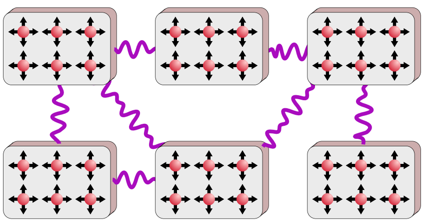

Fig. 1: Logical systems consisting of multiple qubits that interact via a long-ranged coupling. Effective interactions between logical qubits are controlled locally via proper choice of the internal states, which allows selective coupling and resilience against position fluctuations.

References

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