Quantum links between quantum computers

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We have proposed [1] a realistic setup, inspired by already existing experiments [2], within which we develop a general formalism for the implementation of distributed quantum gates. Mediated by a quantum link that establishes a bidirectional quantum channel between distant nodes, our proposal works both for inter- and intra-node communication and handles scenarios ranging from the few to the many modes limit of the quantum link. We can design fast and reliable state transfer protocols in every regime of operation, which, together with a detailed de scription of the scattering process, allows us to engineer two sets of deterministic universal distributed quantum gates. Gates whose implementation in quantum networks does not need entanglement distribution nor measurements. By employing a realistic description of the physical setup, we identify the most relevant imperfections in the quantum links as well as optimal points of operation with resulting infidelities of $1 - F \approx 10^{-2} - 10^{-3}$.

References

[1] G. F. Peñas, R. Puebla, T. Ramos, P. Rabl, JJGR, arXiv:2110.02092
[2] P. Magnard, et al. Phys. Rev. Lett. 125,260502 (2020).

Figures

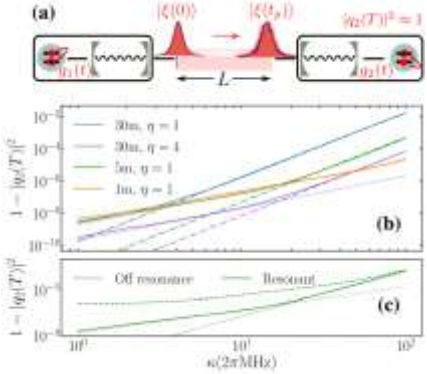

Figure 1: Quantum state transfer between two interlinked quantum computers. (b) Infidelity of the process for commercial waveguides of different lengths. (c) Infidelity in the limit in which free spectral range is too long to formally define traditional controls.

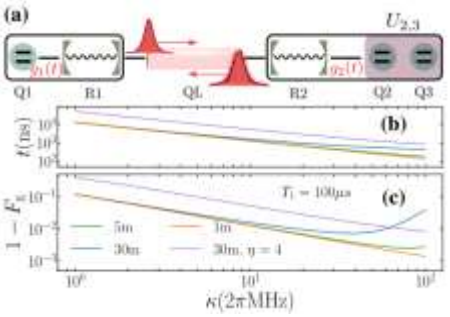

Figure 2: Deterministic quantum gate between two interlinked quantum computers. (a) Duration of the gate for different separations, and (b) infidelity of the gate for qubit with losses.