Control strategies for static ZZ coupling in flux-tunable transmon coupler systems

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Flux-tunable transmon couplers are widely used to implement two-qubit gates between superconducting qubits. However, connecting qubits through such couplers induces a ZZ coupling, an energy shift conditioned by the qubits' state which limits the performance of both one- and two-qubit gates. The performance limitation for two-qubit gates can be comparable to that from decoherence. In this talk, we present strategies to mitigate and control the ZZ coupling in devices based on fixed-frequency transmon qubits and flux-tunable transmon couplers. These strategies, which are based on numerical and analytical modeling, provide information on how to choose the frequencies, anharmonicities, and coupling strengths of the qubit systems [1]. This allows us to create several parameter regions with mitigated ZZ coupling that can be accessed by current technology without major redesigns. We also describe the underlying reasons for the existence of these regions inferred from new diagrammatic perturbation theory [2].

References

[1] S. P. Fors, J. Fernández-Pendás, A. F. Kockum, in preparation.
[2] S. P. Fors, J. Fernández-Pendás, A. F. Kockum, in preparation.

Figures

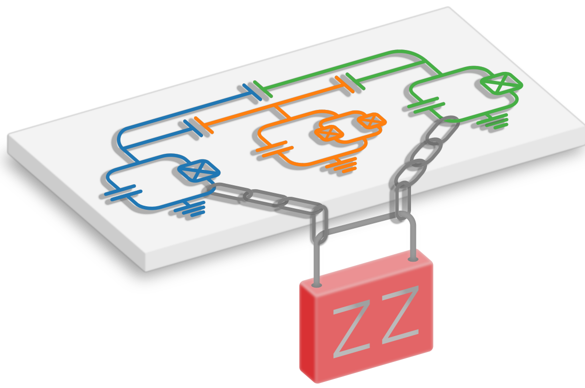

Figure 1: Circuit diagram for two fixed-frequency qubits (blue and green) coupled through both a direct capacitive coupling and a flux-tunable coupler (orange). The direct capacitive coupling and the coupler together generate an effective ZZ coupling between the qubits (symbolized as a red padlock) limiting the performance of one- and two-qubit gates.