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Quantum control of two transmons with tunable coupling

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We analyse the implementation of a fast nonadiabatic CZ-gate through the resonance between the $|11\rangle$ and $|20\rangle$ states of transmon qubits with tunable coupling. We explicitly derive an effective Hamiltonian for the low-energy eigenstates. This allows us to identify different sources of error and design controls based on the theory of dynamical invariants, which has been proven to be particularly attractive due to their reduced leakage and robustness against decoherence. Our results show that these protocols achieve gate fidelities higher than the fast quasiadiabatic dynamics within times that approach the theoretical limit. This study paves the way for large-scale implementation of high-fidelity quantum operations.

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