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Analytical approach to swift non-leaky entangling gates in superconducting qubits[1] SOPHIA ECONOMOU, Naval Research Laboratory, EDWIN BARNES, Condensed Matter Theory Center and Joint Quantum Institute, Dept. of Physics, University of Maryland — We develop schemes for designing pulses that implement fast and precise entangling quantum gates in superconducting qubit systems despite the presence of nearby harmful transitions. Our approach is based on purposely involving the nearest harmful transition in the quantum evolution instead of trying to avoid it. Using analytical tools, we design simple microwave control fields that implement maximally entangling gates with fidelities exceeding 99 percent in times as low as 40 ns. We demonstrate our approach in a two-qubit circuit QED system by designing the two most important quantum entangling gates: a conditional-NOT gate and a conditional-Z gate. Our results constitute an important step toward overcoming the problem of spectral crowding, one of the primary challenges in controlling multi-qubit systems.

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