Circularly Polarized Driving and Commensurate Pulses for Fast Single-Qubit Gates with Fluxonium

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This work focuses on achieving fast, high-fidelity single-qubit gates. To this end, we introduce two complementary protocols and experimentally demonstrate them with a fluxonium qubit. The first protocol utilizes simultaneous charge and flux drives with a relative phase, enabling arbitrarily polarized qubit drive fields. We demonstrate drive polarization tunability and use a circularly-polarized drive field to avoid counter-rotating effects often neglected in the rotating-wave approximation for Rabi-based gates. The second protocol involves commensurate pulses, where pulse durations match the qubit Larmor precession, reducing coherent errors from non-uniform waveform shapes. Implementing both protocols, we demonstrate state-of-the-art single-qubit gates with fidelities exceeding 0.99997 measured with Clifford randomized benchmarking. Our results offer straightforward methods for increasing gate performance, and are broadly applicable to the fast control of quantum systems in the rotating frame.

References

[1] D. A. Rower*, L. Ding*, (*In Preparation*), 2024

Figures

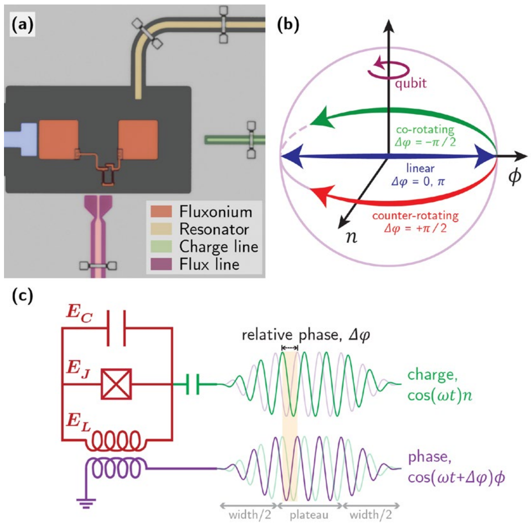

Figure 1: (a) Fluxonium qubit. **(b)** Bloch sphere picture of the qubit Larmor precession and a linear drive, and co/counter-rotating drives. **(c)** Circuit schematic showing simultaneous charge and flux drives applied with a relative phase, enabling the generation of arbitrarily-polarized drive fields.

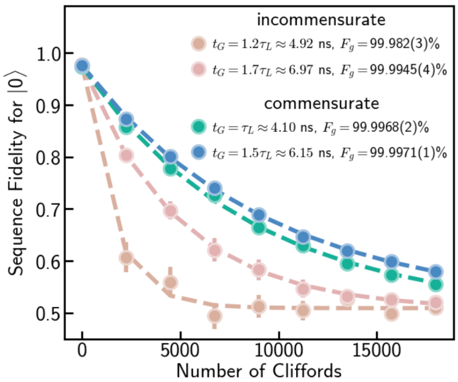

Figure 2: Clifford randomized benchmarking of single-qubit gates utilizing only a flux drive, for gate durations that are commensurate (1 and 1.5 Larmor periods) and incommensurate (1.2 and 1.7 Larmor periods).