Parametric longitudinal coupling between a semiconductor charge qubit and a RF resonator

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We investigate here a relatively unexplored interaction between a semiconductor charge qubit and a radiofrequency resonator, known as longitudinal coupling [1], which has been recently implemented in the context of superconducting qubits [2]. Such an interaction allows time-multiplexed and quicker measurements of multiple qubits using a single resonator. Furthermore, the longitudinal coupling commutes with the measured qubit observable offering true quantum non-demolition read-out and minimal Purcell decay. Finally, it would allow fast and high-fidelity two-qubit CPHASE gates [3].
We study both dispersive and longitudinal qubit-resonator interactions as a function of the qubit Larmor frequency in the adiabatic regime. We report a conditional parametric displacement of the resonator field (see FIG.1.(a)), and rule out any dispersive contribution (see FIG.1.(b)), demonstrating a purely longitudinal interaction between the qubit and the resonator. Our work paves the way to the longitudinal read-out of spin-qubits in semiconducting hybrid devices [4,5].

References

[1] Didier et al., Phys. Rev. Letters (2015)
[2] Touzard et al., Phys. Rev. Letters (2019)
[3] Schuetz et al., Phys. Rev. B (2019)
[4] Yu et al., Nat. Nano. (2023)
[5] Corrigan et al., Phys. Rev. Appl. (2023)

Figures

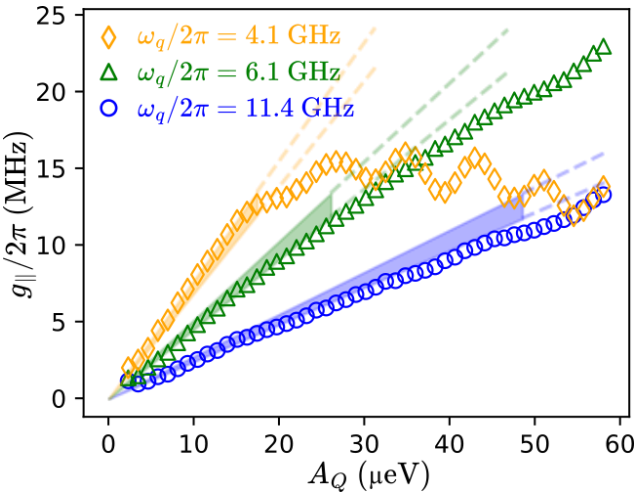

Figure 1: Parametric modulation of the longitudinal coupling with the drive amplitude.

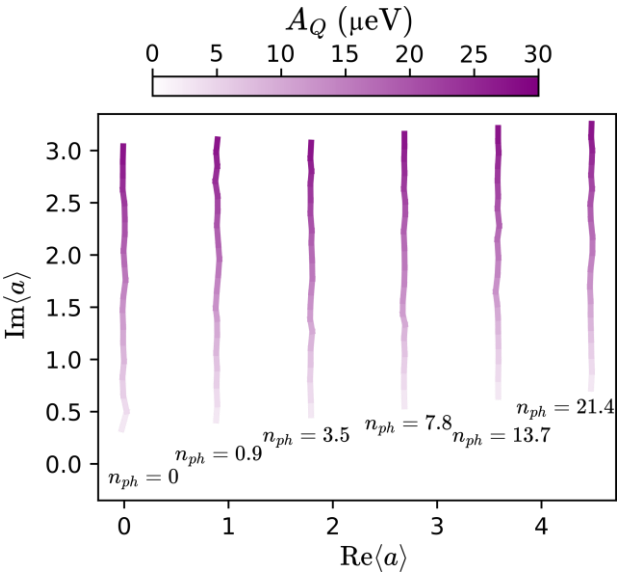

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Figure 2: Linear displacement of the resonator coherent state with the drive amplitude and independence in the resonator population, ruling out dispersive contribution.