Gate-tunable transmon qubit in 2-dimensional Germanium hole gas

Elyjah Kiyooka
Chotivut Tangchingchai, Leo Noirot, Axel Leblanc, Boris Brun-Barriere, Simon Zihlmann, Romain Maurand, Vivien Schmitt, Etienne Dumur, Jean-Michel Hartmann, Francois Lefloch, and Silvano De Franceschi

Université Grenoble Alpes, CEA, GrenobleINP, IRIG, PHELIQS, 38000 Grenoble, France

Elyjah.kiyooka@cea.fr

Gatemons are superconducting qubits similar to transmons, with a gate-tunable semiconducting weak link as the Josephson element. Here, we present the realization of a gatemon device obtained by an aluminum microwave circuit on a Ge/SiGe heterostructure embedding a Ge quantum well [1]. Owing to the superconducting proximity effect, the high-mobility two-dimensional hole gas confined in this well provides a gate-tunable superconducting weak link between two Al contacts. We perform Rabi oscillation and Ramsey interference measurements, demonstrate the gate-voltage dependence of the qubit frequency, and measure the qubit anharmonicity. We find relaxation times T_1 up to 119 ns, and Ramsey coherence times T_2^* up to 70 ns, and a qubit frequency gate-tunable over 3.5 GHz. The reported proof-of-concept reproduces the results of a very recent work [2] using similar Ge/SiGe heterostructures, thereby validating a novel platform for the development of gatemons and parity-protected cos(2φ) qubits.

References

[1] Kiyooka et al. *Nano Lett.* 2025, 25, 1, 562–568
[2] Sagi et al. *Nat. Commun.* 2024, *15*, 6400

Figures

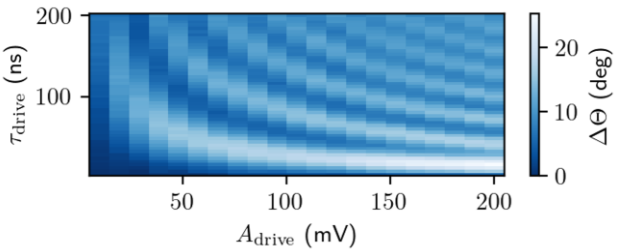

Figure 1: Gatemon qubit Rabi oscillations, with the applied drive frequency on resonance at 6.7 GHz, as a function of either the pulse drive time (τ_{drive}) or the pulse amplitude (A_{drive}).

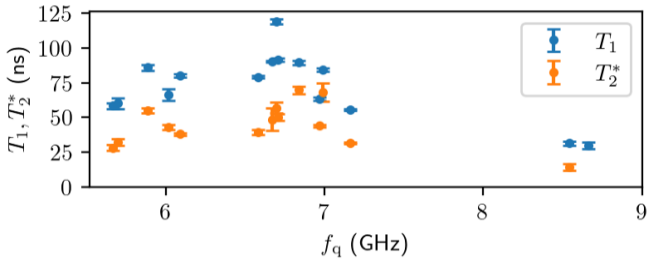

Figure 2: Measured gatemon relaxation times (T_1) and coherence times (T_2^*) as a function of the qubit frequency changed with an electrostatic gate voltage over the Ge weak link.