Control of Collective Dark States in Waveguide QED

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Propagating microwave photons in waveguides couple extremely well to superconducting qubits due to their large dipole moment and mediate long-range interactions between distant qubits causing the emergence of collective states due to interference effects [1]. Of particular interest are dark or subradiant states, which are protected from decoherence as they decouple from the waveguide environment and thus exhibit long lifetimes. This makes them promising candidates for photon storage, excitation transfer and photon-photon gates [2].
However, the protection from decoherence comes with a caveat that the control of such states is challenging. Only recently, a global dark state formed by two transmon pairs, each exhibiting local dark and bright states, was probed experimentally by exciting the local dark states selectively through individual drive ports in a rectangular waveguide [3].
To extend the system to larger arrays of transmon qubits [2,4], we are working on a planar implementation.

References

[1] Sheremet, A. S., et al. Rev. Mod. Phys. 95, 015002 (2023)
[2] Holzinger, R., et al., Phys. Rev. Let. 129, 253601 (2022)
[3] Zanner, M., et al., Nature Physics 18, 538-543 (2022)
[4] Orell, T., et al. Phys. Rev. A 105.6, 063701 (2022)

Figures

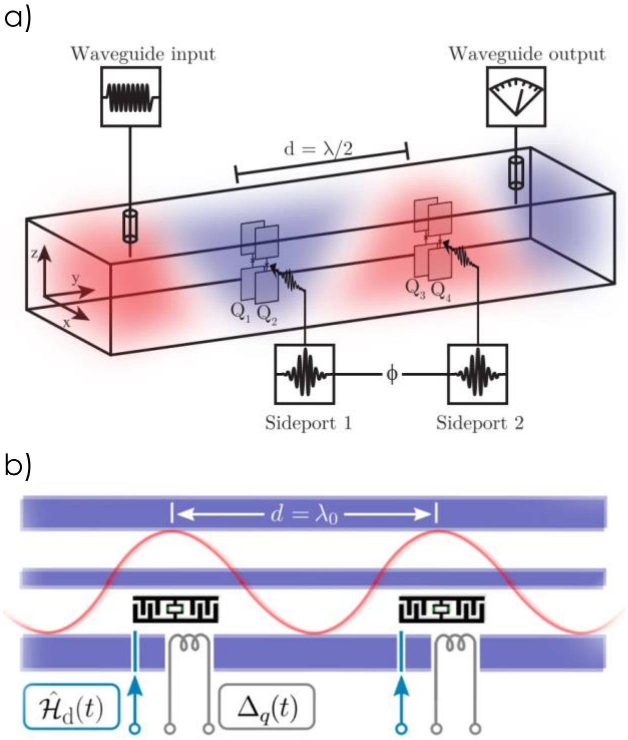

Figure 1: Waveguide QED setups.
a) 3D [3] and b) planar [2].

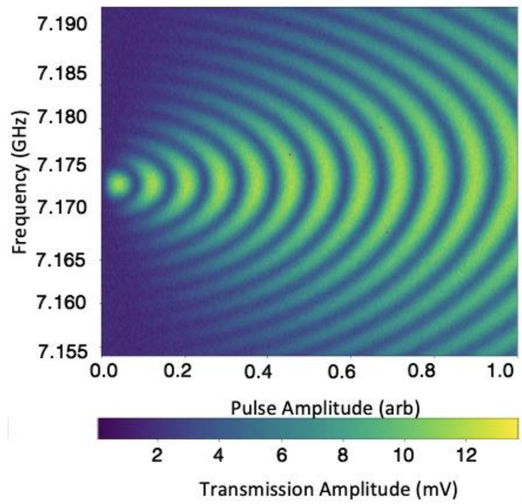

Figure 2:
Rabi oscillations of a dark state formed by a local transmon qubit pair as seen in Fig. 1a)