BLOCH-SIEGERT EFFECT AND CAVITY RENORMALIZATION IN A DISPERSIVE QUBIT-OSCILLATOR SYSTEM

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We study the Bloch-Siegert effect in a superconducting qubit-oscillator system whose cavity is driven strongly. For weak driving a rotating-wave approximation (RWA) can be made for the qubit-oscillator coupling and for the drive. When the drive becomes stronger the RWA results need to be corrected by the inclusion of the counter-rotating terms. This results to a Bloch-Siegert shift in the system's energy levels [1].

We calculate the weak probe absorption spectrum numerically and compare this with our analytic solution derived by using RWA and counter-rotating hybridized rotating-wave approximation (CHRW) [2]. At the high drive power the approximations are shown to be insufficient in describing the power-dependent dispersive shift of the cavity frequency (figure 1).

We compare our numerical simulations with experimental data. We learn that there is a better agreement between the simulations and experiments if instead of using the qubit approximation we include more energy levels in the transmon.

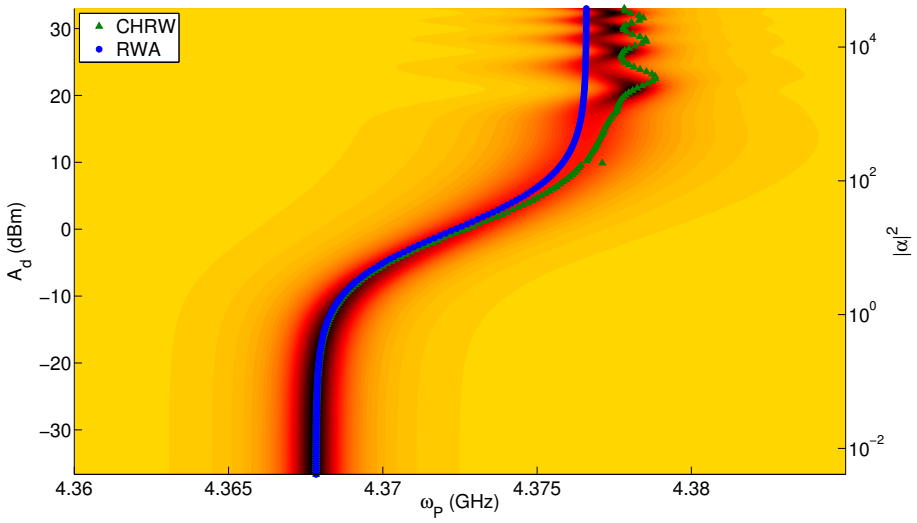

Figure 1: The numerical solution of the cavity spectrum and the analytic approximations.

[1] F. Bloch and A. Siegert, Phys. Rev. **57**, 522 (1940).
[2] Z. G. Lu and H. Zheng, Phys. Rev. A **86**, 023831 (2012). .