Dynamic Autler-Townes effect, decoherence, and dark states in a phase qubit

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When a three-level quantum system is irradiated by an intense coupling field resonant with one of the two possible transitions, the absorption peak of an additional probe field with frequency close to the remaining transition is split (Autler-Townes effect). This phenomenon has been experimentally demonstrated by us in a phase qubit[1]. We present a theoretical modeling of this effect, including decoherence, cross-couplings, and leaking to higher excited states (up to the fifth level). Numerical simulations and analytical results for the stationary state based on this model allow us to extract the decoherence parameters and they provide excellent agreement with the Autler-Townes experiment[2]. We then demonstrate experimentally by pulsing the coupling field that the system can be operated dynamically, as a quantum switch that produces on-demand dark states with high fidelity[3]. Time-dependent numerical simulations of the model described above are in good agreement with the experiment.

[1]M. A. Sillanpää *et. al.*, Phys. Rev. Lett. **103**, 193601 (2009).
[2]J. Li *et. al.*, arXiv:1103.2223.
[3]J. Li *et. al.*, arXiv:1103.2631.