Quantum transduction with atomic three-level systems

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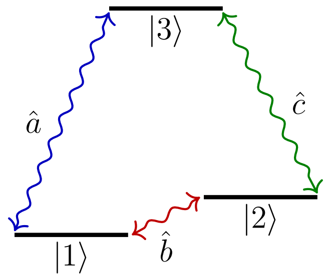

Figure 1: A three-level system coupled to three electromagnetic modes.

We investigate a scheme for microwave-to-optical transduction using atomic three-level systems. We consider an atomic three-level system whose configuration is shown in Fig. 1. This scheme is based on Ref. [1]; hyperfine ground states are separated by a microwave frequency energy splitting, and both states have an allowed optical frequency transition to a common excited state. In addition, there are three electromagnetic modes: each of which are coupled to one of the three transitions in the atom.

Using quasi-degenerate perturbation theory we derive an effective Hamiltonian description for the conversion process between optical and microwave photons. In particular, we consider the regime where the optical transitions are coupled to the same cavity. The cavity is then driven at resonance with one of the two optical transitions. We find that the conversion in this regime is limited by off-resonant effects like unintended biphoton emission of microwave and optical photons.

[1] Lewis A. Williamson, Yu-Hui Chen, and Jevon J. Longdell. Magneto-optic modulator with unit quantum efficiency. *Phys. Rev. Lett.*, 113:203601, Nov 2014.