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Cavity-coupled double-quantum dot at finite bias: analogy with lasers and beyond OVIDIU COTLET, ETH Zurich, MANAS KULKARNI, New York City College of Technology, City University of New York, HAKAN TURECI, Princeton University — We present [1] a theoretical and experimental study of photonic and electronic transport properties of a voltage biased InAs semiconductor double quantum dot (DQD) that is dipole-coupled to a superconducting transmission line resonator. We obtain the Master equation for the reduced density matrix of the coupled system of cavity photons and DQD electrons accounting systematically for both the presence of phonons and the effect of leads at finite voltage bias. We subsequently derive analytical expressions for transmission, phase response, photon number and the non-equilibrium steady state electron current. We show that the coupled system under finite bias realizes an unconventional version of a single-atom laser and analyze the spectrum and the statistics of the photon flux leaving the cavity. In the transmission mode, the system behaves as a saturable single-atom amplifier for the incoming photon flux. Finally, we show that the back action of the photon emission on the steady-state current can be substantial. Our analytical results are compared to exact Master equation results establishing regimes of validity of various analytical models. We compare our findings to available experimental measurements.

[1] M. Kulkarni, O. Cotlet, H. E. Tureci, Phys. Rev. B 90, 125402 (2014)

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