Lasing and Transport in a Quantum Dot-Resonator System

P.-Q. Jin[a], M. Marthaler[a], J.H. Cole[a,b], A. Shnirman[c,d], and **G. Schön**[a,d]

[a] Institut für Theoretische Festkörperphysik, Karlsruhe Institute of Technology, Germany
[b] Applied Physics, School of Applied Sciences, RMIT University, Australia
[c] Institut für Theorie der Kondensierten Materie, Karlsruhe Institute of Technology, Germany
[d] DFG Center for Functional Nanostructures (CFN), Karlsruhe Institute of Technology, Germany

Circuit quantum electrodynamics (cQED), one of the applications of quantum information processing with solid state devices, allows exploring quantum optics effects in new parameter regimes, incl. strong coupling and low temperature, where qualitatively novel behavior has been observed. An example is lasing with a single superconducting qubit which is strongly coupled to an oscillator, where quantum noise influences the linewidth of the emission spectrum in a characteristic way. We propose a different cQED setup, where the role of an artificial atom is played by a semiconductor double quantum dot. A current through the dot system can create a population inversion in the dot levels and, within a narrow resonance window, a lasing state in the resonator. The lasing state correlates with the transport properties. On one hand, it allows probing the lasing state via a current measurement, which may be easier to perform in an experiment. On the other hand, the resulting narrow current peak opens perspective for applications of the setup for high resolution measurements. The effects survive for realistic strength of the disspative processes.
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