Highlights

Fundamental Properties - 2016

Energy Exchange in Driven Open Quantum Systems at Strong Coupling

M Carrega*; P Solinas*; M Sassetti†*; U Weiss‡

∗CNR-SPIN Institute for Superconductors, Innovative Materials and Devices, Genova, Italy
†Dept. Physics, Università di Genova, Genova, Italy
‡II. Institut für Theoretische Physik, Universität Stuttgart, D-70550 Stuttgart, Germany

PHYSICAL REVIEW LETTERS **116**, 240403 (2016)

A deep understanding of how the concepts of work and dissipated heat are extended to quantum system would allows us to envision efficient quantum machines to store, manipulate and transfer energy at quantum level. In many interesting situations the quantum systems are strongly coupled to an environment. In this case, the standard approaches and techniques fails since the system and environment cannot be clearly separated.
We study the time-dependent energy transfer in a driven quantum system strongly coupled to a heat bath within an influence functional approach. Exact formal expressions for the statistics of energy dissipation into the different channels are derived. The general method is applied to the driven dissipative two-state system. It is shown that the energy flows obey a balance relation, and that, for strong coupling, the interaction may constitute the major dissipative channel. This means that the dissipated heat related to the coupling interaction cannot be neglected as done in the standard perturbative (weak coupling) approach.
Results in analytic form are presented for the particular coupling of strong Ohmic dissipation. The energy flows show interesting behaviors including driving-induced coherences and quantum stochastic resonances.

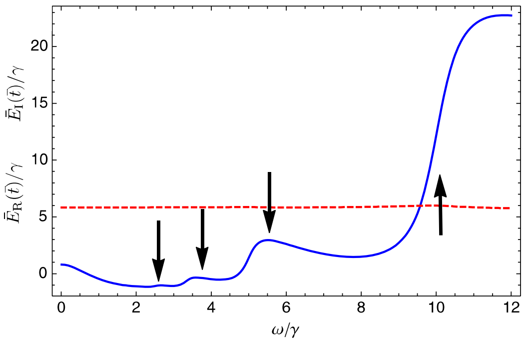

Figure 1. A snapshot of dissipated heat in the environment (solid curve) and the one related to the coupling energy (dashed curve) plotted versus the drive frequency. The time is fixed to 50 times the dissipative coupling γ. The arrows denote the positions of the ground and side frequencies.

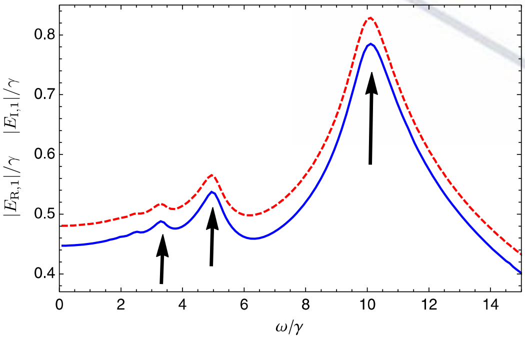

Figure 2. The absolute values of the amplitudes of the first harmonic of dissipated heat in the environment (solid curve) and the one related to the coupling energy (dashed curve) as a function of the drive frequency. Both curves show resonances (indicated by the arrows).