Heat-exchange statistics in driven open quantum systems

S. Gasparinetti[1], P. Solinas[2] , A. Braggio[2] and M. Sassetti[2,3]

[1]Low Temperature Laboratory (OVLL), Aalto University, PO Box 15100, FI-00076 Aalto, Finland
[2]SPIN-CNR, Via Dodecaneso 33, I-16146 Genova, Italy
[3]Dipartimento di Fisica, Universitá di Genova, Via Dodecaneso 33, 16146 Genova, Italy

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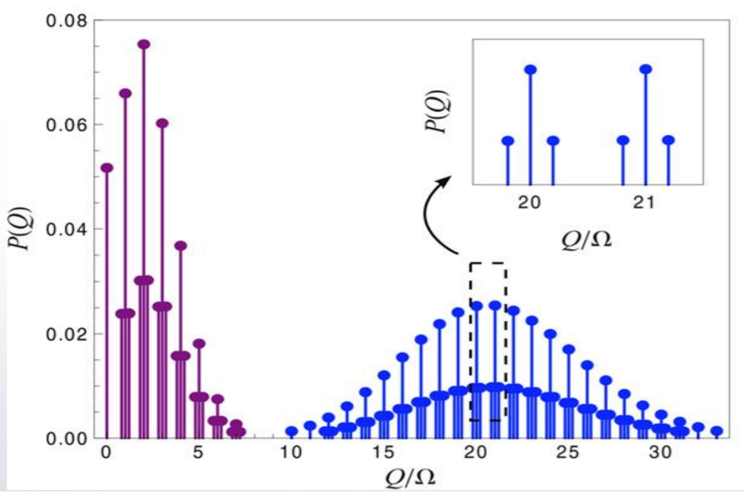
As the dimensions of physical systems approach the nanoscale, the laws of thermodynamics must be reconsidered due to the increased importance of fluctuations and quantum effects. While the statistical mechanics of small classical systems is relatively well understood, the quantum case still poses challenges. Here, we set up a formalism that allows us to calculate the full probability distribution of energy exchanges between a periodically driven quantum system and a thermalized heat reservoir. The formalism combines Floquet theory with a generalized master equation approach. For a driven two- level system and in the long-time limit, we obtain a universal expression for the distribution, providing clear physical insight into the exchanged energy quanta. We illustrate our approach in two analytically solvable cases and discuss the differences in the corresponding distributions. Our predictions could be directly tested in a variety of systems, including optical cavities and solid-state devices. Particularly promising in this direction are the fast thermometry techniques recently developed in the group of Prof. J. Pekola [1].



Probability distribution of the dissipated energy for a driven two level system interacting with the environment. The purple and the blue distribution are for short and long time distribution, respectively. The energy is dissipated in triplet quanta corresponding to the multiple of the drive frequency and the energy gap of the system.

[1] S Gasparinetti *et al* , Physical Review Applied 3 (1), 014007 (2015).