Repartition of vibrational mode energies in oscillators driven by multiple heat baths

Marco Baiesi*[2,1], Gianmaria Falasco[3], Leo Molinaro[1], Livia Conti[2], and Fulvio Baldovin[1,2]

[2]Istituto Nazionale di Fisica Nucleare, Sezione di Padova (INFN, Sezione di Padova) – Via Marzolo 8, 35131 Padova, Italy

[1]Department of Physics and Astronomy - University of Padova – via Marzolo 8 35131 - Padova, Italy

[3]ITP, Universitat Leipzig – Bruderstr. 16/316b, 04103 Leipzig, Germany

Abstract

Experiments and hydrodynamic theories show that temperature gradients forced by boundary conditions lead to an enhancement of nonequilibrium fluctuations at low wavenumbers, with amplitudes that can be even larger than the level expected from local temperatures. We study analytically the energy repartition when it is rather a whole temperature profile that is imposed by external heat baths displaced along the system. We use a chain of harmonic oscillators as the paradigm of coupled system and as a tool to find explicit solutions. The energy repartition among the modes depends on the concavity properties of the imposed temperature profile and on the boundary conditions. Contrary to a naive expectation, we show that both long and short wavelength modes can either store large amounts of energy or freeze down. A reverse-engineering approach allows also to infer the heat bath temperatures needed to give rise to the observed mode energies. In the frequency domain, the power spectral density of the chain length evidences the nonequilibrium energetics of the modes. These results illustrate, in a transparent and analytically tractable model, how nontrivial deviations from the equipartition of energy may arise in nonequilibrium systems.

*Speaker