Statistical properties of energy transport in a set of bending waves

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Energy per mode or per degrees of freedom is a key quantity at equilibrium where it defines unambiguously the temperature of the systems and has well-known properties. Out-of-equilibrium the definition and pertinence of such quantity is still an open question. The aim of this work is to propose two ways of measuring it in a given out-of-equilibrium system: a set of bending waves generated in a thin elastic plate.

The first method relies on the fluctuation theorem. A large electromagnetic shaker sustains a random set of bending waves in thin stainless steel plate. Another small shaker, attached to the moving plate, exchanges a very small among of energy to the plate seen as an out of equilibrium thermostat. From the study of the fluctuations of power provided by the small shaker, smoothed over long time, we deduce an energy per degrees of freedom in plate. We shows that the energy is linear with the rms velocity of the plate [1].

The second approach relies on the wave turbulence (WT) theory applied to a set of bending waves. The WT theory does not predict an inverse cascade in such system. Therefore, an equipartition of energy per modes can be expected for wavelength larger than the forcing wavelength. We confirm experimentally this expectation and deduce the properties of the energy per modes as a function of the forcing parameters [2].

At equilibrium both methods converge to the temperature of the system but the benchmark in our system drives to qualitative and quantitative differences of both characteristic energy. They do not have the same dependency with forcing parameters and orders of magnitude different. This result needs to be confirmed by simultaneous measurements with both method to insure similar experimental conditions although this would imply experimental difficulties. Further work would involve a systematic study of the thermodynamical properties of both characteristic energy determined by these two methods.

References

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