

# Out of equilibrium generalized fluctuation-dissipation relations

*G Gradenigo, A Puglisi, A Sarracino, D Villamaina, and A Vulpiani*

## **Abstract**

We discuss fluctuation-dissipation relations valid under general conditions even out of equilibrium. The response function is expressed in terms of unperturbed correlation functions, where contributions peculiar to non-equilibrium can appear. Such extra terms take into account the interaction among the relevant degrees of freedom in the system. In some cases, the terms contributing to the response function can be associated with two precise quantities, such as entropy flux and dynamical activity. The former is well known and studied since a long time, whereas the latter has received great attentions only in recent years. We illustrate the general formalism with two examples: driven granular systems and anomalous diffusion on comb structures.

Key Words: **Non-equilibrium, Response, Correlation Functions, Entropy Production, Granular Systems, Anomalous Diffusion**