On the identifiability of response functions from fluctuations away from equilibrium

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In this talk we present recent results on a class of fluctuation-response relationships in non-equilibrium systems. We consider general stochastic systems described as semi-martingales, which include conventional Langevin dynamics, jump Markov processes as well as non-Markovian systems. An important property of semi-martingales is that they can be decomposed in terms of a predictable drift part, and an unpredictable martingale part. The path-space density for such systems can be expressed as an exponential martingale, which can be used to relate the response function of an observable to a correlation between this observable and another martingale. We show that for systems with detailed balance or local detailed balance, this martingale simplifies to the martingale component of the observable itself (i.e., its "noise term"), rendering such response functions measurable in principle. For general active systems, the correlation between the observable and its martingale component reveals only the response to an effective pseudo-force, whose dependence on the actual perturbation can be complex and model-dependent. We demonstrate our results using several discrete- and continuous stochastic systems, including non-Markovian ones. We furthermore show, how our results connect to existing response theory in non-equilibrium systems. In summary, our work opens new ways to investigate non-equilibrium systems theoretically as well as experimentally.

Reference:

[1] Di Bello C, Zechner C and Jülicher F, in preparation.