Fluctuation dissipation theorem and Onsager coefficients in driven diffusion systems

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Linear response theory allows to express the reaction of a system to a small external field by equilibrium correlation functions. Corresponding relations are the fluctuation theorem (FDT), the Green-Kubo relations, and the Onsager reciprocal relations, which express symmetries of response coefficients with respect to different external perturbations.

The FDT can be generalized to disturbances of a non-equilibrium steady state (NESS). Its first generalisation was derived by Agarwal in 1972 [1] by using linear perturbation theory. In the respective NESS correlation function, however, the microstate probabilities enter the conjugate variable. This form is thus not well suited for applications. More recently, other forms of the FDT for NESS were derived [2,3], which allow one to gain insight into the role of entropies as conjugate variables, where these entropies are defined in the framework of stochastic thermodynamics. Furthermore, based on a path probability approach, a form of the conjugate variable could be obtained that does not require the knowledge of the microstate probabilities in the NESS.

Here we analyse the different forms of the FDT for an exactly solvable driven diffusion system, the asymmetric simple exclusion process with two species. In particular, we (i) clarify the role of delta-functions in the path probability expression for the conjugate variable, (ii) demonstrate the equivalence of the NESS correlation functions containing different conjugate variables, see Fig. 1(b), and (iii) discuss implications of the generalized FDT for Onsager coefficients in NESS, see Fig. 1(c).

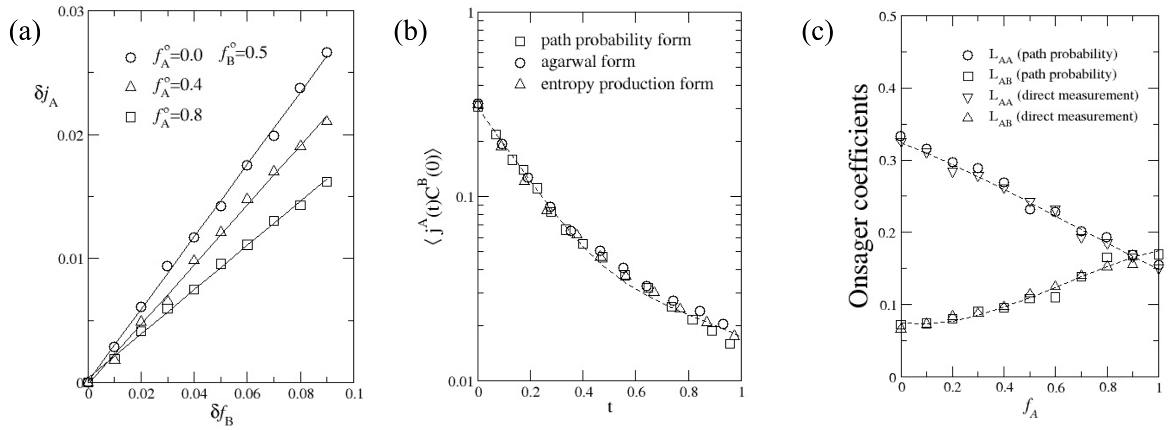

Figure 1: (a) Change of the current of the A particles in response to a change of the bias on the B particles with respect to a NESS reference state of an asymmetric simple diffusion process. (b) Time-dependent correlation functions in the NESS for different conjugate variables corresponding to the type of response exemplified in (a). (c) Comparison of Onsager coefficients as obtained directly from the response to the change of bias and from the integration over the respective NESS correlation functions.

References

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