Fluctuation Relations for Spintronics

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The steady-state fluctuation theorem concerns the relative ratio of positive entropy production to negative entropy production. In the context of the full counting statistics, using a variant of the steady-state fluctuation theorem, fluctuation relations which generalize fluctuation-dissipation relations in linear response regime were derived [1]. In the presence of an applied magnetic field B, however, the fluctuation theorem is not valid any more because the micro-reversibility condition is not satisfied in nonequilibrium. Nevertheless, employing the micro-reversibility condition only at equilibrium and probability conservation, a kind of fluctuation relations was derived [2].

Here [3], we examine the role of the spin degrees of freedom in formulating fluctuation relations. The fact that the steady-state fluctuation theorems rely on the assumption of a local balance condition is observed. We then show that in some cases the presence of magnetic interactions violates this local balance condition. For illustrative purpose, we consider a quasilocalized level coupled to chiral and helical edge modes and demonstrate that the fluctuation theorem is not a priori satisfied when magnetic interactions are present. Importantly, nevertheless, we derive the fluctuation relations and verify them in an illustrative case.

References

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