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Path integral approach to work beyond the two-point measurement scheme

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The conventional approach to characterize work statistics in driven quantum systems is the two-point measurement scheme (TPMS), where work is defined as the difference between two projective energy measurements performed at the beginning and end of an evolution protocol. This scheme has been shown to be consistent with classical stochastic thermodynamics [1], and to enable the identification of a work functional that converges to its classical counterpart in the semiclassical limit [2].

Despite its importance, since the initial projective energy measurement suppresses coherences in the initial state, the TPMS is not suited to assess the role of initial coherence in quantum thermodynamics. In this work we present a path integral formulation of two alternative schemes that preserve initial coherences and are consistent with the TPMS for incoherent states described by quasi-probability distributions: i) the Margenau-Hill (MH) scheme [3], where the explicit introduction of the initial projective measurement is avoided by introducing an estimation of the initial Hamiltonian based on projective measurements at the end of the protocol only, and ii) the so-called full counting statistics scheme [4], where the characteristic function is related to the phase accumulated by a detector coupled to the system.

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[4] Solinas, P., & Gasparinetti, S. (2016). Probing quantum interference effects in the work distribution. Physical Review A, 94(5), 052103.

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