# Stochastic Path Integral Formulation of Full Counting Statistics

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Noise properties of electrical conductors are interesting because they reveal additional information beyond linear response [1]. FCS gives the probability of counting a certain number of particles at a measurement apparatus in a certain amount of time and finds not only conductance and shot noise, but all higher current cumulants as well. Several quantum mechanical [2-5] as well as classical [6] methods have been used in finding this quantity.

We derive a stochastic path integral representation [7] of counting statistics in semi-classical systems. Our approach applies to an arbitrary semiclassical mesoscopic network and it based on a separation of time scales: fast microscopic fluctuations cause variations of conserved quantities (like the charge inside the conductor) on much longer time scales. Such a separation is present in normal-diffusive wires [8], superconducting-normal structures outside the proximity regime [9], as well as in stochastic problems beyond mesoscopic physics [10].

The formalism is introduced on the simple case of a single chaotic cavity with two quantum point contacts, and then further generalized to find the propagator for charge distributions with an arbitrary number of counting fields and generalized charges. The counting statistics is given by the saddle point approximation to the path integral, and fluctuations around the saddle point are suppressed in the semi-classical approximation. We use this approach to derive the current cumulants of a chaotic cavity in the hot-electron regime and consider few other examples.

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