

Summation theorem and its application to exact non-equilibrium full counting statistics of tunnel current in quantum-point contacts

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The central physical achievement of this study is exact analytical formula for time-dependent cumulant generating functional [1], which contains all information about quantum fluctuations in electron tunneling through arbitrary Luttinger liquid tunnel junction in the framework of Full Counting Statistics (FCS-) ideology [1-3]. In fact, this central result represents a first known exact analytical generalization of famous Levitov-Lesovik formula which was known previously only for the non-interacting electrons in tunnel junctions [3] - on the case of arbitrary electron-electron repulsion in one-dimensional Luttinger liquid quantum wires out of the equilibrium [1]. Exact analytical derivation [1] of this general formula makes use of the theorem about exact re-exponentiation of Keldysh-contour ordered T-exponent for Luttinger liquid tunnel junction, proven by the author (S-theorem) in Refs.[1,2]. The performed proof is the equivalent of exact microscopic proof of detailed balance theorem [3] for tunnel current of interacting electrons, which has never been performed in the literature before. Moreover, in a sufficiently broader context of nonequilibrium dynamics of interacting quantum fields in generic open quantum systems the exact and mathematically elegant re-exponentiation formula for fluctuating bosonic quantum field [1] - represents an important example of rigorous proof of very common and fundamental Jarzynski equality [4] in the real-time domain for quasi-one dimensional mesoscopic quantum systems out-of-the equilibrium [1]. As the important practical consequence of all mentioned general results the explicit picture of real-time quantum fluctuations decay in the process of the equilibration of tunnel current in arbitrary Luttinger liquid tunnel junction is performed.

[1] G.A.Skorobagatko, arXiv:1808.03569 (2018).

[2] G.A.Skorobagatko, Phys.Rev.B, 98, 045409 (2018).

[3] L.S.Levitov, M.Reznikov, Phys.Rev.B, 70, 115305 (2004).

[4] C.Jarzynski, Phys.Rev.Lett., 78, 2690 (1997).