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Bohmian solution to the measurement of many-body systems: Sequential current in mesoscopic electron devices

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Electronic industry is pushing devices into the few-nanometer (mesoscopic) limit, where mainly pure quantum e_ects determine the current owing through them. However, the accurate prediction of their multi-time current correlations is a very challenging problem from, both, the computational and the theoretical point of view [1]. First, computing the time-dependent behavior of electron devices (at Terahertz frequencies) implies dealing with conduction plus displacement currents. The explicit consideration of the displacement current requires, in turn, the time-dependent solution of the (Coulomb) many-particle Schrodinger equation, i.e. the many-body problem. Second, understanding the multi-time current correlations (such as AC, transients, noise, etc.) in mesoscopic systems requires the ability to reproduce sequential measurements by describing the unitary (between measurements) and non-unitary (during measurements) evolutions of such mesoscopic systems, i.e the wave-function collapse problem.
In this workshop, we will present a solution to these problems through the use of conditional wave-functions, which are natural entities within Bohmian mechanics [2]. In particular, many-body Bohmian trajectories can be computed from a coupled system of single-particle conditional wave-functions. Such conditional wave-functions are solutions of a time-dependent pseudo-Schrodinger equations with a complex potential energy [3]. The previous many-particle Bohmian trajectories can be used to compute the sequential current measurement with a POVM modeling of the ammeter. In addition, under the assumption of a non-overlapping evolution of the di_erent \channels" of the conditional wave-functions, a very simple procedure for the computation of the sequential current measurement of mesoscopic systems can be obtained through the auxiliary use of Bohmian trajectories. The Bohmian solution mentioned above, apart from its application to quantum electron transport [4,5,6] (see also the BITLLES simulator [7] available for public use), can be straightforwardly adapted to many other _elds where one has to face the many-body and
wave-function collapse problems.

References

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