Ultrafast dynamics of strongly correlated finite fermion systems

Michael Bonitz

Institute for Theoretical Physics and Astrophysics, Universiy Kiel, Germany, Leibnizstr. 15, 24098 Kiel, Germany

The correlated dynamics of fermions following an external excitation is of interest in many fields, in particular strongly correlated materials, dense plasmas and ultracold atoms. Excitations include laser pulses, rapid changes (quenches) of confinement potentials or the impact of charged particles. The situation is even more complex if the system is finite and spatially inhomogeneous.

During the past decade we have systematically developed nonequilibrium Green functions (NEGF) simulations for such problems [1, 2]. Combined with the use of advanced selfenergy approximations [3], computational optimization and GPU computing long propagations of quite large systems of any geometry are possible where other methods fail or are unreliable.

I will present three examples. The first concerns the dynamics of ultracold fermionic atoms following a confinement quench where we observe excellent agreement with experiments [4]. The second is the stopping of energetic ions in correlated finite graphene-type clusters [5, 6]. The third is laser pulse excitation of graphene nanoribbons where nontrivial correlation effects, such as carrier multiplication are observed [7].

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