Quantum kinetic theory of ultrafast relaxation processes

M. Bonitz

Institut für Theoretische Physik und Astrophysik,
Christian-Albrechts-Universität, Leibnizstr. 15, D-24098 Kiel,
Germany, E–mail: bonitz@physik.uni-kiel.de

Excitation and subsequent relaxation of quantum many-body systems is an old topic of statistical physics where fundamental contributions came from N.N. Bogolyubov [1]. During the last 15 years this issue has gained considerable new importance due to the development of femtosecond laser sources of intense optical and UV radiation. Their application to atoms and solids has made it possible to initiate and probe electronic relaxation processes on times of the order of a femtosecond or even below. A consistent theoretical description of these processes require the use of quantum kinetic theories which are applicable to times shorter than the correlation time introduced by Bogolyubov.

We have, in recent years, developed a generalized non-Markovian quantum kinetic theory which fulfills these requirements [2]. I give an overview on the two possible concepts which are based on density operators and nonequilibrium Green's functions, respectively [2,3] and present numerical results for dense plasmas, electrons in quantum dots and the photoionization of atoms by a femtosecond laser pulse.

1. N.N. Bogolyubov, Problems of a Dynamical Theory in Statistical Physics, 1946
2. M. Bonitz, Quantum Kinetic Theory, Teubner, Stuttgart/Leipzig 1998
3. Computational Methods for Many-Body Physics, M. Bonitz and D. Semkat (eds.), Rinton Press, Princeton 2006