DY 20 Quantum Dynamics I

Time: Tuesday 09:30–11:00 Room: HÜL 186

Invited Talk DY 20.1 Tue 09:30 HÜL 186

Quantum Computer - dream and realization — •Rainer Blatt — Technikerstrasse 25 A-6020 Innsbruck — Institut für Experimentalphysik, University of Innsbruck

Computational operations always rely on real physical processes, which are data input, data representation in a memory, data manipulation using algorithms and finally, the data output. With conventional computers all the processes are classical processes and can be described accordingly. Theoretically, it is known for several years now that certain computations could be processed much more efficiently using quantum mechanical operations. This requires the implementation of quantum bits (qubits), quantum registers and quantum gates and the development of quantum algorithms. Several approaches for the implementation of quantum computers will be presented, with special emphasis on the ion storage techniques. Experimental realizations of quantum registers and quantum gate operations using strings of trapped ions in a linear Paul trap will be discussed. With a small ion-trap quantum computer based on two and three trapped Ca+ ions as qubits we have generated in a pre-programmed way specific quantum states. In particular, entangled states of two particles, i.e. Bell states, and of three particles, i.e. GHZ and W states, were generated using an algorithmic procedure. With a tomographic method, these states were subsequently analysed and the respective entanglement was characterized using various entanglement measures. With Bell states as a resource, entangled states are applied for teleportation and improved precision measurements.

DY 20.2 Tue 10:00 HÜL 186

Thermal and Nonthermal Relaxation in Spin Environments — •Harry Schmidt and Günter Mahler — Institut für Theoretische Physik 1, Universität Stuttgart

We investigate a small quantum system (the "central system", typically a spin-1/2 particle), coupled to a large environment. The environments considered typically also consist of many spin-1/2 particles. Though large, the environment is not treated by a reservoir approximation but is modeled explicitly and the time evolution of the total system is treated exactly.

We are interested in the equilibrium state of the central system after relaxation from a product state. If the environment is initially in a thermal state with a given temperature and the central system relaxes to a thermal state with the same temperature, the relaxation process is called "canonical" or "thermal". Here we show that not all types of environments exhibit such a canonical relaxation. In particular, we present a method to quantitatively distinguish systems showing canonical relaxation from those that do not. This method is applied to spin environments with and without internal interaction showing a qualitative change in the relaxation behavior due to the interaction.

[1] Schmidt, Mahler: PRE **72**, 016117 (2005)

DY 20.3 Tue 10:15 HÜL 186

Thermal aspects of small spin systems — •Markus Henrich and Günter Mahler — 1. Institut für Theoretische Physik, Universität Stuttgart

With upcoming of nano-technologies there is more and more interest also in thermodynamic properties of nano- and mesoscopic systems. Numerically most accessible are small spin systems. These systems, when combined with appropriate baths, can show interesting thermal properties. Here we investigate spin systems with a Heisenberg interaction coupled to one or two baths under different local conditions. We show how these conditions influence the steady state of the spin system. In addition, for thermal equilibrium we compare different master-equation approaches with the exact Schroedinger-evolution [1].

[1] M. Henrich et al, "'Global and local relaxation of a spin-chain under exact Schroedinger and master equation dynamics"', Phys. Rev. E 72, 026104 (2005)

DY 20.4 Tue 10:30 HÜL 186

Statistical Dynamics in Closed Quantum Sytems? — •Christian Bartsch and Jochen Gemmer — Physics Department, University of Osnabrück, Barbarastr. 7, 49069 Osnabrück, Germany

The time evolution of closed finite quantum systems is strictly given by the Schrödinger equation which itself yields only completely reversible dynamics. Nevertheless, there are calculations by HAM (Hilbert Space Average Method) suggesting that under certain conditions statistical behaviour of appropriate variables can evolve in such systems. For certain classes of few particle systems the numerical solution of the time-dependent Schrödinger equation has been compared with those predictions. The occurrence of statistical dynamics has been analyzed especially with respect to the spatial structure of the potentials which the particles encounter.

DY 20.5 Tue 10:45 HÜL 186

Ultrafast electron dynamics in thin metal films — •Giovanni Manfredi and Paul-Antoine Hervieux — GONLO-IPCMS, 23 rue du Loess, BP 43, F-67034 Strasbourg, France

Self-consistent simulations of the ultrafast electron dynamics in thin metal films were performed using both semiclassical (Vlasov) and quantum (Wigner) phase-space models. Numerical results showed that: (i) heat transport is ballistic and occurs at a velocity close to the Fermi speed; (ii) after the excitation energy has been absorbed by the film, slow nonlinear oscillations appear, with a period proportional to the film thickness, which are attributed to nonequilibrium electrons bouncing back and forth on the film surfaces. These effects are robust and are not suppressed by electron-electron or electron-ion collisions.

When an oscillatory laser field is applied to the film, the field energy is partially absorbed by the electron gas. Maximum absorption occurs when the period of the external field matches the period of the nonlinear oscillations, which, for sodium films, lies in the infrared range. Possible experimental implementations are discussed.