Q 30: Quanteneffekte

Time: Tuesday 14:00–16:00 Location: V7.03

Q 30.1 Tue 14:00 V7.03

Steady-state properties of a one dimensional spin chain under dissipation — •Heike Schwager, Ignacio Cirac, and Geza Giedke — Max-Planck-Institut für Quantenoptik, 85748 Garching

We study the steady state properties of local one dimensional spin Hamiltonians under different types of dissipation. We find that under certain conditions the steady state depends discontinuously on system parameters in the limit of weak dissipation and give an explanation for the appearance of this phase transition. Moreover, we discuss state preparation with this spin chain under dissipation and discuss physical implementations of this system.

Q 30.2 Tue 14:15 V7.03

Landau-Zener Tunneling in the Presence of Dephasing — •Felix Lucas[1,2] and Klaus Hornberger[2] — [1]Max-Planck-Institut für Physik Komplexer Systeme Dresden — [2]Institut für Physik, Universität Duiburg-Essen

We study transitions at an avoided level crossing for systems subject to decoherence as described by a Lindblad master equation. This constitutes the simplest possible extension of the ubiquitous Landau-Zener problem to the realm of open systems. The time evolution is expanded in terms of quantum jumps, of which the most relevant ones are used to construct an effective description covering the whole range from the adiabatic to the nonadiabatic regime. This method provides an excellent approximation of the numerically exact transition probabilities. As an application, we discuss the possibility of incoherent control of molecular dynamics by non-selective measurements.

Q 30.3 Tue 14:30 V7.03

Stimulated Raman adiabatic passage in nuclear systems — •Wen-Te Liao, Adriana Pálffy, and Christoph H. Keitel — Max Planck Institute for Nuclear Physics, Saupfercheckweg 1, 69117 Heidelberg, Germany

Coherent population transfer between nuclear states using x-ray laser pulses is investigated. The laser pulses drive two nuclear transitions between three nuclear states in a setup reminding of stimulated Raman adiabatic passage used for atomic coherent population transfer [1]. With the astonishing breakthrough of operational x-ray free electron lasers (XFEL), photon energies reach already 10 keV [2] such that some low-lying nuclear transitions can already be laser-driven. However, most nuclear levels require higher photon energies.

To bridge the gap between x-ray laser frequency and nuclear transition energies, we envisage accelerated nuclei [3] interacting with two copropagating or crossed x-ray laser pulses. The parameter regime for nuclear coherent population transfer using fully coherent light generated by future XFEL facilities and moderate or strong acceleration of nuclei is determined. We find that the most promising case requires laser intensities of 10^{17}-10^{19} W/cm^2 for complete nuclear population transfer. As relevant application, the controlled pumping or release of energy stored in long-lived nuclear states is discussed.

[1] Wen-Te Liao, Adriana Pálffy, Christoph H. Keitel, Phys. Lett. B 705, 134 (2011).
[2] M. Altarelli *et al.*, XFEL Technical Design Report, DESY (2006).
[3] T. J. Bürvenich *et al.*, Phys. Rev. Lett. 96, 142501 (2006).

Q 30.4 Tue 14:45 V7.03

Exact Energy-Time Uncertainty Relation for Arrival Time by Absorption — •Andreas Ruschhaupt — Institut für Theoretische Physik, Leibniz Universität Hannover, Appelstr. 2, 30167 Hannover

We prove an uncertainty relation for energy and arrival time, where the arrival of a particle at a detector is modeled by an absorbing term added to the Hamiltonian. In this well-known scheme the probability for the particle's arrival at the counter is identified with the loss of normalization for an initial wave packet. Under the sole assumption that the absorbing term vanishes on the initial wave function, we show that $\Delta T \Delta E \geq \sqrt{p}\hbar/2$ and $\langle T\rangle \Delta E \geq 1.37\sqrt{p}\hbar$, where $\langle T\rangle$ denotes the mean arrival time, and p is the probability for the particle to be eventually absorbed. Nearly minimal uncertainty can be achieved in a two-level system, and we propose a trapped ion experiment to realize this situation.

Reference: J. Kiukas, A. Ruschhaupt, P. O. Schmidt and R. F. Werner, arXiv:1109.5087

Q 30.5 Tue 15:00 V7.03

Energy flow through open, driven quantum systems — •Matthias Langemeyer and Martin Holthaus — Institute of Physics, Carl von Ossietzky University, 26111 Oldenburg, Germany

Recently, there has been some interest in quantum systems which are driven by an external time-periodic force on the one hand, and in thermal contact with a heat bath on the other [1,2,3]. Such systems are conveniently described by a Pauli-type master equation formulated in a basis of Floquet states. After briefly reviewing the basic formalism, we consider a particularly simple example which allows one to calculate the energy flow through the system analytically.

[1] H.-P. Breuer, W. Huber, and F. Petruccione, Phys. Rev. E 61, 4883 (2000)
[2] W. Kohn, J. Stat. Phys. 103, 417 (2001)
[3] R. Ketzmerick and W. Wustmann, Phys. Rev. E 82, 021114 (2010)

Q 30.6 Tue 15:15 V7.03

Wigner function for the orientation state — •Timo Fischer[1], Clemens Gneiting[2], and Klaus Hornberger[1] — [1]Fakultät für Physik, Universität Duisburg-Essen, 47057 — [2]Institut für Physik, Albrecht-Ludwigs Universität Freiburg, 79104

A new quantum phase space representation for the rotational degrees of freedom will be presented, which is closely analogous to the Wigner-Weyl formalism for the Cartesian case. We discuss the explicit form of the Wigner function and the basic Weyl symbols, as well as the associated quantum Liouville equation. For macroscopically extended states the latter turns into the classical Liouville equation up to quantum corrections.

Q 30.7 Tue 15:30 V7.03

On the Electrons in the Quantum Free-Electron Laser — •Rainer Endrich[1], Enno Giese[1], Paul Preiss[1,2], Roland Sauerbrey[2], Wolfgang P. Schleich[1], and M. Suhail Zubairy[3] — [1]Institut für Quantenphysik, Universität Ulm, 89069 Ulm — [2]Helmholtz-Zentrum Dresden-Rossendorf, 01314 Dresden — [3]Institute for Quantum Studies, Texas A&M University College Station, TX 77843-4242. USA

Free-Electron Lasers (FEL) provide coherent and widely tunable radiation of high brilliance. Most theoretical descriptions are based on classical physics in agreement with the experimental results. However, an FEL working in the quantum regime is within reach at the Research Center Dresden-Rossendorf. Substantial theoretical progress has been made to understand quantum effects which are usually suppressed in the classical regime and therefore ignored. This includes two-level behavior, recoil effects, phase diffusion and much more. Based on our earlier work, we take a closer look at the density matrix of the joint system of laser field and electron beam. By this way we will analyze the dynamics of the sub-system of the electrons, in particular, the momentum and position distribution, respectively.

Q 30.8 Tue 15:45 V7.03

Photon Statistics in the Quantum Free-Electron Laser — •Paul Preiss[1,2], Rainer Endrich[2], Enno Giese[2], Roland Sauerbrey[1], Wolfgang P. Schleich[2], and Suhail Zubairy[3] — [1]Helmholtz-Zentrum Dresden Rossendorf, D-01328 Dresden — [2]Institut für Quantenphysik, Universität Ulm, D-89069 Ulm — [3]Institute for Quantum Studies, Texas A&M University

The free-electron laser (FEL) is an alternative laser device with a widely tunable wavelength of the emitted radiation. Usually, FEL's operate in the so-called classical regime where quantum effects can be neglected. Recent developments in accelerator and laser physics permit the realization of a FEL in the quantum regime. We discuss the effects emerging in a quantum FEL and compare the photon statistics to the one in an atomic laser.