A 5: Atomic Systems in External Fields I

Zeit: Montag 16:30–18:00 Raum: VMP 6 HS-B

Hauptvortrag A 5.1 Mo 16:30 VMP 6 HS-B

Exceptional points in atomic spectra and Bose-Einstein condensates — •Holger Cartarius, Jörg Main, and Günter Wunner — 1. Institut für Theoretische Physik, Universität Stuttgart, 70550 Stuttgart

In parameter-dependent open quantum systems exceptional points can appear, at which both the complex energy eigenvalues *and* the wave functions describing two or even more resonances of the system pass through a branch point singularity as functions of the parameters, i.e. become identical. A real physical system which is accessible theoretically and experimentally and which exhibits exceptional points is the hydrogen atom in crossed external electric and magnetic fields. We show how exceptional points can be detected in numerical calculations, how they can be described with low-dimensional matrix models, and propose a method to verify their existence in an experiment with atoms. Important phenomena such as the geometric phase for closed loops around the critical parameter sets are demonstrated and the rare case of a connection between three resonances almost forming a triple-degeneracy in the form of a cubic root branch point is presented.

Furthermore, we extend the concept of exceptional points to the nonlinear Gross-Pitaevskii equation describing the stationary states of Bose-Einstein condensates. Here, they appear as bifurcation points at which two stationary states, a stable ground state and an unstable nodeless excited state, are born together in a tangent bifurcation.

A 5.2 Mo 17:00 VMP 6 HS-B

Laser-Induced Channeling of Bethe-Heitler Pairs — •Erik Lötstedt[1], Ulrich D. Jentschura[1,2], and Christoph H. Keitel[1] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, D-69117 Heidelberg — [2]Department of Physics, Missouri University of Science and Technology, Rolla MO65409, USA

A high-energy photon colliding with a nuclear Coulomb field may decay into an electron-positron pair by the Bethe-Heitler process. We investigate the modification of this process by the addition of an assisting laser field [1]. For a subcritical laser field, the total cross section is almost unchanged compared to the laser-free case. In contrast, there is a drastic enhancement of the differential cross section in a certain direction of emission. The additional momentum transferred by the laser field serves to channel the produced pairs, so that they are preferentially ejected in a direction making a small angle with the propagation direction of the laser field. The laser-induced modification of the cross section can be understood by classical arguments.

[1] E. Lötstedt, U. D. Jentschura, and C. H. Keitel, Phys. Rev. Lett. **101**, 203001 (2008).

A 5.3 Mo 17:15 VMP 6 HS-B

Charge breeding in SPARC EBIT — Sabrina Geyer[1], Frank Herfurth[1], Oliver Kester[1], Wolfgang Quint[1], Alexandra Silze[2], •Alexey Sokolov[1], Thomas Stoehlker[1], and Gleb Vorobjev[1] — [1]GSI, Darmstadt, Germany — [2]Institut für Angewandte Physik, Technische Universität Dresden, Germany

Charge breeding experiments are important to increase the variety of elements produced in highly charged ion state by electron beam ion sources/traps (EBIS/T). In our experiment, singly charged ions, created by an external high temperature substrate heater were injected into an EBIT for further ionization. Continuing recent studies using MAXEBIS, charge breeding experiments were performed this time with the new SPARC EBIT. The advantages of this source are it's compact size and application of permanent magnets instead of superconducting coils. In it's low magnetic field of 0.25T on the electron beam axis the singly charged ions could only be trapped due to the electrostatic fields of the drift tube electrodes and the space charge potential of the electrons. The influence of the electron beam potential on the ion confinement was studied in simulations showing an effective potential well of approximately 30 eV (dependent on electron current and energy) and, thus, a good possibility for trapping. Charged species produced in the EBIT were analysed using X-rays spectroscopy and m/q separation techniques. Experimental results showed that the capture is in fact difficult. The absence of magnetic trapping as well as the small trap region of the source are the main reasons for that. Further attempts are currently in preparation using an advanced setup.

A 5.4 Mo 17:30 VMP 6 HS-B

A quantum fluid perspective on electron dynamics — •Mark Thiele and Stephan Kümmel — Physikalisches Institut, Universität Bayreuth, 95440 Bayreuth

The fluid dynamic formulation of quantum mechanics provides an intuitive way to interpret phenomena of many-electron physics. We use this approach to study the dynamics of bound electrons in time-dependent external fields. Comparing exact solutions of the interacting Schrödinger equation and of adiabatic time-dependent density-functional theory, we investigate both nonlinear and linear effects such as strong field excitation and photoabsorption. We find that viscous dissipation is the fluid dynamical mechanism connecting doubly excited states in atoms to the appearance of memory effects in density-functional theory.

A 5.5 Mo 17:45 VMP 6 HS-B

Resonant Dynamics in Time-Dependent Density Functional Theory ? — •Michael Ruggenthaler and Dieter Bauer — Max-Planck-Institut für Kernphysik, Heidelberg

Density functional theory (DFT) [1] and the corresponding time dependent theory (TDDFT) [2] are rigorous reformulations of the quantum many-body problem. The associated nonlinear Kohn-Sham (KS) equations give, in principle, the exact probability density. The crucial point is the approximation of the local exchange-correlation potential describing the internal forces. Resonant dynamics are usually not treated within TDDFT as sufficiently accurate approximations for the exchange-correlation potential do not yet exist. It is assumed that adiabatic approximations derived from groundstate DFT will not be able to reproduce resonant behavior. We investigate Rabi oscillations and show that even simple adiabatic approximations reproduce the dipole of the interacting problem quite well although the charge transfer between the two states involved is not properly described. Moreover we explain why the two-level approximation applied to the noninteracting system leads to unphysical results.

[1] R. M. Dreizler and E. K. U Gross, Density Functional Theory (Springer, Heidelberg, 1990)

[2] M. A. L. Marques et al, Time Dependent Density Functional Theory, Lect. Notes Phys. 706 (Springer, Heidelberg, 2006)