A 21: Atomic systems in external fields

Zeit: Donnerstag 11:00–13:00 Raum: 3D

Hauptvortrag A 21.1 Do 11:00 3D

Helium und die Tripelkollision - neue Skalierungsgesetze in Zweielektronenatomen — Chang Woo Byun[1], Nark Nyul Choi[1], Min-Ho Lee[1] und •Gregor Tanner[2] — [1]School of Natural Science, Kumoh National Institute of Technology, Korea — [2]School of Mathematical Sciences, University of Nottingham, UK

Im Jahre 1940 untersuchte Carl Ludwig Siegel den Dreierstoss (bzw die Triplekollision) im Detail und fuehrte die Dynamik in der Naehe der Kollision auf charakteristische Exponenten zurueck. Etwa ein Jahrzehnt spaeter nutzte Gregory H Wannier aehnlich Methoden um die Energieabhaengigkeit des Wirkungsquerschnitts fuer den Dreiteilchenaufbruch in Atomen vorherzusagen.

Wir werden in diesem Beitrag demonstrieren, dass uns Siegels Exponenten in Zweielektronenatomen oberhalb und unterhalb (!) der Doppelionisationsschwelle auf Schritt und Tritt begegnen - nicht nur in der von Wannier angegebenen Kombination. Wir werden insbesondere totale und partielle Wirkungsquerschnitte fuer Einfach- Photoionisation an der Dreiteilchenaufbruchschwelle behandeln und Mithilfe semiklassischer Methoden charakteristische Skalierungsgesetze herleiten. Dies ermoeglicht es grundlegende Aussagen ueber doppelt hochangeregte Zustaende und ihre Zerfallskanaele an der Schwelle zu machen.

C L Siegel, 'Der Dreierstoss', Ann of Math 42, 127 (1941)
G H Wannier, Phys Rev 90, 817 (1953)
C W Byun et al, Phys Rev Lett 98, 113001 (2007)

A 21.2 Do 11:30 3D

Non-hydrogenic Rydberg atoms in crossed electric and magnetic fields — •Celsus Bouri[1], Javier Madroñero[2,3], Thomas Gorin[4], and Andreas Buchleitner[1] — [1]Quantum Optics and Statistics, Institute of Physics, Albert-Ludwigs-Universität Freiburg, Freiburg, Germany — [2]PAMO, Université Catholique de Louvain, Louvain-la-Neuve, Belgium
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Fluctuations of the ionization cross section for non-hydrogenic Rydberg atoms in crossed electric and magnetic fields are considered - in a regime where strongly overlapping resonances dominate the fragmentation process. We address some open issues concerning the identification of this scenario as an examplary case of Ericson fluctuations in a deterministic Hamiltonian systems - which stem from the multielectron core as well as from the mixedness and high dimensionality of the underlying classical phase space.

A 21.3 Do 11:45 3D

Complex electron dynamics in integrable systems — •Tobias Kramer[1], Christian Bracher[2], and John Delos[3] — [1]Institut I: Theoretische Physik, Universität Regensburg, Germany — [2]California State University, Long Beach, USA — [3]College of William and Mary, Williamsburg, USA

The classical dynamics of photoionization and detachment in the presence of external fields is in general very complex, even for integrable systems. The corresponding quantum mechanical cross section and spectra show strong fluctuations due to interference of returning orbits. We present analytic classical and quantum mechanical results for atoms in magnetic and electric fields which allow to study in detail sequences of bifurcation points, caustics, and failures of a primitive semiclassical expansions. The statistical analysis of the spectrum shows that classical chaotic and integrable systems are not always distinguishable by looking at spectral correlation functions.

References:

[1] Electron dynamics in parallel electric and magnetic fields C. Bracher, T. Kramer, and J. Delos Phys. Rev. A, 73, 062114-1-21, (2006)

A 21.4 Do 12:00 3D

Quantum Monte Carlo studies of heavy atoms in neutron-star magnetic fields — •Dirk Meyer, Steffen Bücheler, Dirk Engel, Jörg Main, and Günter Wunner — 1. Institut für Theoretische Physik, Universität Stuttgart, 70550 Stuttgart

We have adapted the "released-phase"diffusion quantum Monte Carlo method to calculate the ground state energies of atoms and ions with nuclear charges from $Z = 2, 3, 4, \cdots, 26$ for magnetic field strengths relevant for neutron stars [1]. The novel feature of our study is the use of adiabatic approximation wave functions, augmented by a Jastrow factor, as guiding wave functions to initialize the quantum Monte Carlo prodecure. The calculations are motivated by the discovery of broad features in the thermal spectra of isolated neutron stars, which may be due to heavy atoms. Our results confirm previous results for nuclear charge numbers up to 10, and are the most accurate ones available in the literature to date for $Z > 10$. We also discuss the extension of the calculations to excited states and transition probabilities by using the correlation function Monte Carlo method [2].

[1] S. Bücheler, D. Engel, J. Main, and G. Wunner, Phys. Rev. A **76**, 032501(2007)
[2] M. D. Jones, G. Ortiz, and D. Ceperley, Phys. Rev. E **55**, 6202 (1997)

A 21.5 Do 12:15 3D

Evidence for quasi Penning resonances in exact quantum spectra of the hydrogen atom in crossed electric and magnetic fields — •Holger Cartarius, Jörg Main, and Günter Wunner — 1. Institut für Theoretische Physik, Universität Stuttgart, 70550 Stuttgart

The ionization mechanism of the hydrogen atom in crossed magnetic and electric fields has been investigated, e.g. by application of transition state theory [1], however, a complete physical picture is still lacking. In particular, the existence of transition states localized in the vicinity of the Stark saddle point or so-called "quasi Penning resonances" [2] obtained by quantization using a simple expansion of the potential around the saddle point is unclear. We perform quantum mechanically exact calculations of resonances in the spectrum of the hydrogen atom in crossed external fields. By varying the external field strengths structures are revealed which are surprisingly similar to quasi Penning resonances. We investigate the connection between the approximate solutions and the exact quantum resonances.

[1] C. Jaffé, D. Farrelly, and T. Uzer, Phys. Rev. Lett. **84**, 610 (2000); Phys. Rev. A **60**, 3833 (1999)
[2] C. W. Clark, E. Korevaar, and M. G. Littman, Phys. Rev. Lett. **54**, 320 (1985)

A 21.6 Do 12:30 3D

The Installation of the HITRAP Cooler Trap — Frank Herfurth[1], Oliver Kester[1], Heinz-Jürgen Kluge[1], •Stephen Koszudowski[1], Christophor Kozhuharov[1], Giancarlo Maero[1], Wolfgang Quint[1], and Stefan Schwarz[2] — [1]GSI, 64291 Darmstadt, Germany — [2]NSCL/MSU, East Lansing, USA

With the HITRAP facility the means are given to trap and cool heavy highly charged ions up to U92+ in order to perform experiments on atomic properties. These include collision studies, precision measurements and hyperfine spectroscopy. Within the Cooler Trap 10e5 particles will be cooled by electron and resistive cooling down to 4K. the particles in the trap will be detected nondestructively by FT-ICR. Right now the Cooler Trap is being installed at GSI. We give a status overview and show results of the commissioning.

A 21.7 Do 12:45 3D

Particle motion in rapidly oscillating potentials: The role of the potential's initial phase — •Armin Ridinger[1] and Nir Davidson[2] — [1]Laboratoire Kastler Brossel, Ecole Normale Supérieure, Université Pierre et Marie-Curie-Paris 6, CNRS — [2]Department of Physics of Complex Systems, Weizmann Institute of Science, Rehovot 76100, Israel

Rapidly oscillating potentials with a vanishing time average have been used for a long time to trap charged particles in source-free regions. It has been argued that the motion of a particle inside such a potential can be approximately described by a time independent effective potential, which does not depend upon the initial phase of the oscillating potential. However, we show that the motion of a particle significantly depends upon this initial phase for arbitrarily high frequencies of the potential's oscillation. We demonstrate that this phenomenon can be used to manipulate a particle's motion in a controlled fashion by simply changing the phase of the potential (a phase hop). For a particle in an ideal one-dimensional Paul-trap we show that a phase hop can—in

the framework of classical mechanics—reduce the particle's energy to less than 30% of its original energy independently of its original energy and the frequency of the potential's oscillation. We confirm all our theoretical findings by numerical simulations.

Reference: A. Ridinger and N. Davidson, Phys. Rev. A 76, 013421 (2007).