A 17: Atomic Systems in External Fields III

Zeit: Mittwoch 14:00–16:00 Raum: VMP 6 HS-C

Hauptvortrag A 17.1 Mi 14:00 VMP 6 HS-C

Atoms and Clusters in Intense Laser Fields — •Dieter Bauer — Max-Planck-Institut für Kernphysik, Postfach 103980, 69029 Heidelberg, Germany

Analytical descriptions of intense laser atom interaction are commonly based on the so-called strong field approximation (SFA). In this approach, the effect of the laser field on the electron motion after ionization is treated exactly while the effect of the binding potential is neglected. However, there are several well-documented features in photoelectron spectra which can hardly be explained within the standard SFA approach without taking Coulomb-effects into account. Recently we proposed to use quantum trajectories to incorporate Coulomb-effects into the SFA and demonstrated the power and versatility of this approach in Refs. [1–3]. Many of the interesting phenomena in strong field physics rely on the rescattering of electrons. We have identified two novel recollision pathways, namely the simultaneous recombination of two electrons [4] and the excitation of plasmons in collective multi-electron systems such as C_{60} [5]. New results on the generation of energetic electrons and ions in the interaction of intense laser beams with clusters and droplets will be also discussed.

[1] S.V. Popruzhenko et al., Phys. Rev. A **77**, 053409 (2008), [2] S.V. Popruzhenko, D. Bauer, J. Mod. Opt. **55**, 2573 (2008), [3] S.V. Popruzhenko et al., Phys. Rev. Lett. **101**, 193003 (2008), [4] P. Koval et al., Phys. Rev. Lett. **98**, 043904 (2007), [5] M. Ruggenthaler et al., Phys. Rev. A **78**, 033413 (2008).

A 17.2 Mi 14:30 VMP 6 HS-C

Parity Violating Berry Phases for Hydrogen in an Atom Interferometer — •Martin-Isbjörn Trappe, Thomas Gasenzer und Otto Nachtmann — Institut für Theoretische Physik, Philosophenweg 16, 69120 Heidelberg

Wir behandeln geometrische Phasenfaktoren, die in longitudinalen Atomstrahl-Spinecho (lABSE) Experimenten auftreten. Die Propagation von Wasserstoffatomen in statischen elektrischen und magnetischen Feldern führt zu geometrischen (Berry-)Phasen, in denen sich aufgrund ihrer Verbindung zur schwachen Wechselwirkung eine neue Form der Paritäts-(P-)Verletzung in der Atomphysik zeigt. Auf der Grundlage von Berechnungen P-verletzender und P-erhaltender geometrischer Phasen für Atome in Ruhe untersuchen wir das Verhalten der metastabilen 2S Zustände von Wasserstoff in lABSE Experimenten mit analytischen und numerischen Methoden. Hierzu diskutieren wir die an geeignete Feldkonfigurationen gestellten Bedingungen, welche die adiabatische Entwicklung der atomaren Eigenzustände sicherstellen. Wir berechnen abelsche geometrische Phasen in Wasserstoff und konstruieren Observablen, die sensitiv auf P-Verletzung sind und den Erfordernissen von lABSE Experimenten entsprechen. Die entwickelten Methoden liefern die theoretische Basis zur Untersuchung möglicher lABSE Experimente für die Messung von P-Verletzung in Wasserstoff.

A 17.3 Mi 14:45 VMP 6 HS-C

Heating dynamics in ion traps — Mathieu Marciante, Annette Calisti, Caroline Champenois, and •Martina Knoop — CNRS/Université de Provence, Centre de St Jerome, Case C21, 13397 Marseille Cedex 20, France

Molecular Dynamics simulations are carried out to evaluate the dynamics of ions in radiofrequency traps of different geometry, using the pseudo-potential approximation or the exact time oscillating description. Doppler laser cooling is taken into account by momentum kicks on absorption and emission of a photon by an ion. This detailed description allows to analyze the efficiency of the laser cooling depending on the direction of propagation of the laser and to quantify the role of Coulomb repulsion for the thermalization of the different degrees of freedom, depending on the number of trapped ions.

A 17.4 Mi 15:00 VMP 6 HS-C

Correlation function Monte Carlo studies for medium-heavy atoms in neutron star magnetic fields — •Dirk Meyer, Jörg Main, and Günter Wunner — 1. Institut für Theoretische Physik, Universität Stuttgart, 70550 Stuttgart

We present the correlation function Monte Carlo method and apply it to the calculation of excited state energies and transition probabilities of atoms with nuclear charges up to iron ($Z = 26$) for magnetic field strengths relevant for neutron stars [1].

The method extends the released-phase diffusion quantum Monte Carlo method, which is only suited to the calculation of ground state energies [2], and provides an alternative interpretation of the latter.

The calculations are motivated by the discovery of broad features in the thermal emission spectra of isolated neutron stars, which may be due to transitions in atoms and ions present in the progenitor star. With reliable atomic data for ground and excited states at hand it should be possible to predict spectra of neutron star atmospheres with intense magnetic fields to high accuracy and to compare with the observational results.

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

A 17.5 Mi 15:15 VMP 6 HS-C

Semiclassical quantization of the diamagnetic hydrogen atom with near action-degenerate periodic orbit bunches — •Jan Gehrke, Jörg Main, and Günter Wunner — 1. Institut für Theoretische Physik, Universität Stuttgart, 70550 Stuttgart

Gutzwiller's trace formula for the semiclassical quantization of classically chaotic systems suffers from the exponential proliferation of periodic orbits, and it is an important question whether semiclassical eigenstates can be obtained with reduced classical input data. It has been shown [1] that the periodic orbits of chaotic systems appear in "bunches". Members of each bunch are reconnected differently at self-encounters in phase space but have nearly equal classical action and stability parameters. We show the existence of periodic orbit bunches for the diamagnetic Kepler problem and demonstrate that the orbits can be grouped already on the level of the symbolic dynamics by application of appropriate reconnection rules to the symbolic code in the ternary alphabet. This allows for the use of one or few representatives of a periodic orbit bunch in Gutzwiller's trace formula. For the diamagnetic hydrogen atom semiclassical spectra obtained with the complete set of periodic orbits and the, up to a factor of 20 reduced, set of bunch representatives agree very well.

[1] Sebastian Müller, Stefan Heusler, Petr Braun, Fritz Haake, and Alexander Altland, Phys. Rev. E **72**, 046207 (2005).

A 17.6 Mi 15:30 VMP 6 HS-C

Entwicklung einer kompakten Anlage für die Polarisation von ^{3}He durch metastabiles optisches Pumpen — •Christopher Hauke, Werner Heil, Sergei Karpuk und Ernst-Wilhelm Otten — Universität Mainz

Durch den Einsatz von kernspinpolarisierten Edelgasen in der Magnetresonanztomografie der Lunge haben sich die neuen nicht-invasiven Methoden zur Diagnose von Schädigungen und zur Lungenfunktionsuntersuchung bereits etabliert. In Mainz wurde schon vor einiger Zeit eine Polarisationsanlage zur Herstellung größerer Mengen ^{3}He-Gas, unter anderem zur zentralen Produktion für medizinische Anwendungen, entwickelt. Die Anlage basiert auf dem metastabilen optischen Austauschpumpen von ^{3}He-Atomen, welches sehr effizient ist bei niedrigen Gasdrücken um etwa 1 mbar und einer schwachen Gasentladung zur Anregung der für den optischen Pumpprozess benötigten Atome in den metastabilen $^3S_1$-Zustand.Eine kompakte und kostengünstige ^{3}He-Produktionsanlage vor Ort bietet Vorteile in der Flexibilität, was die unmittelbare Verfügbarkeit des Gases betrifft. Die Verbesserung der ^{3}He-Polarisationstechnik soll durch Einsatz eines schnell laufenden Kleinkompressors für polarisiertes ^{3}He sowie die Einhausung des magnetischen Führungsfeldes in eine μ-Metall-Abschirmung geschehen. Dadurch ergibt sich ein deutlich größeres nutzbares Volumen mit der geforderten Homogenität des magnetischen Führungsfeldes. Die Neuentwicklung umfasst auch neue Konzepte zur Realisierung der Optik, der optischen Pumpzellen, sowie eines relaxationsarmen, hochreinen ^{3}He-Plasmas. Der Stand der Entwicklung wird vorgestellt.

A 17.7 Mi 15:45 VMP 6 HS-C

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

A dedicated Cooler Trap for the HITRAP facility at GSI has been designed and built. Here bunches of 10^5 heavy, highly charged ions up to U^{92+} can be trapped and cooled for precision experiments in atomic and nuclear physics. The trap is a cryogenic multi-ring cylindrical Penning trap, which enables a nested trap configuration.

Two cooling mechanism are employed: electron and resistive cooling. For the electron cooling 10^{10} electrons from a photoelectron source developed at MPIK Heidelberg will be fed into the trap. Recombination losses in the cooling process are small down to 10eV. To go to lower energies, resistive cooling via a resonant circuit at 4K is employed. Simulations of the resistive cooling have shown fast cooling (within 0.1s) of the center of mass motion down to a few eV. The following tail has a cooling constant of about 3.7s.

We detect the ions from the induced signal in the resonant circuit, which is fed out via a cryogenic amplifier. A second resonant circuit is installed to detect the cyclotron frequency of the ions. This can also be used for monitoring the axial frequency of the electrons. First tests of the trap will take place beginning of 2009. Therefore a H^+ ion source and an EBIT for highly charged ions were bought and set up. The whole set up will be available for experiments later in 2009.