A 29: Atomic Systems in External Fields II

Time: Friday 14:00–16:00 Location: B 302

A 29.1 Fr 14:00 B 302

A database for bound-bound transitions using a Hartree-Fock-Roothaan method for atoms and ions in neutron star magnetic fields — •Christoph Schimeczek and Günter Wunner — 1. Institut für Theoretische Physik, Universität Stuttgart, 70550 Stuttgart

In the immediate vicinity of neutron stars very strong magnetic fields in the range of 10^8 T exist. To acquire information about the composition of the atmosphere of such neutron stars, observed spectra have to be analyzed using numerically calculated atomic data. Applying a Hartree-Fock-Roothaan scheme, we have calculated a comprehensive data base for bound-bound transitions and spectra for atoms in different ionization states up to Fe.

A 29.2 Fr 14:15 B 302

Production of Antihydrogen via Double-Charge-Exchange — •Andreas Müllers[1], Robert McConnell[3], Jochen Walz[1], Eric Hessels[2], Cody Storry[2], Andrew Speck[4], and Gerald Gabrielse[3] — [1]Johannes Gutenberg Universität, Institut für Physik, 55099 Mainz — [2]York University, Canada — [3]Harvard University, USA — [4]Rowland Institute at Harvard, USA

Comparison of the 1s-2s transitions in hydrogen and antihydrogen will provide an accurate test of CPT symmetry. While production of antihydrogen using the three-body-recombination (TBR) scheme is an established technique at CERN's Antiproton Decellerator facility (AD), trapping these atoms for spectroscopy has not yet succeeded. Therefore, the ATRAP collaboration has developed a different scheme to produce much colder anti-atoms more suitable for trapping. Cesium atoms are laser-excited to Rydberg-states and travel through positrons stored in a Penning-trap. A collisional charge exchange reaction produces positronium, which is no longer confined by the Penning-trap fields. It can therefore interact with nearby stored antiprotons, creating antihydrogen. The principle was demonstrated in 2004. Since then, ATRAP has developed a new apparatus providing larger particle numbers and a quadrupole Ioffe-trap for neutral atoms. Furthermore, a new solid state laser-system for Cesium excitation has been developed. During the past AD-beam-run, the excitation of cesium to various high-n-states within the $1\,T$ bias field of the Penning trap has been demonstrated.

A 29.3 Fr 14:30 B 302

Sub-Poissonian atom number fluctuations by three-body loss in mesoscopic ensembles — •Shannon Whitlock, Caspar Ockeloen, and Robert Spreeuw — Van der Waals-Zeeman Institute, University of Amsterdam, The Netherlands

We show that three-body loss of trapped atoms leads to sub-Poissonian atom number fluctuations. We prepare hundreds of dense ultracold ensembles in an array of magnetic microtraps on a permanent-magnet atom chip. We observe rapid losses due to three-body recombination. The resulting shot-to-shot fluctuations of the number of atoms per trap are sub-Poissonian, for ensembles comprising 50–300 atoms. The measured relative variance or Fano factor $F = 0.53 \pm 0.22$ agrees very well with the prediction by an analytic theory ($F = 3/5$) and numerical calculations. Density dependent loss such as three-body recombination can thus be used to prepare small and well-defined numbers of atoms in each microtrap. These results will facilitate studies of quantum information science with mesoscopic ensembles.

A 29.4 Fr 14:45 B 302

Coupled electronic and nuclear fluxes in molecules — •Kenfack A.[1], Banerjee S.[1], Barth I.[1], Hege H. C.[2], Ikeda H.[3], Koppitz M.[2], Lasser C.[4], Manz J.[1], Marquardt F.[2], Paulus B.[1], and Paramonov G. K.[1] — [1]Inst. Chem. Bio., FU Berlin — [2]Zuse Inst. Berlin — [3]Dept. of Applied Chemistry, Osaka Prefecture University, Japan — [4]Fachbereich Mathematik, FU Berlin

We propose a new approach for evaluating nuclear and electronic fluxes in molecules. This is based on the Born-Oppenheimer approximation which, though excellent for densities and time dependent molecular properties, is not appropriate for electronic fluxes computed from the flux density equation. However making use of the Gauss's theorem and the continuity equation, we successfully solved this problem by formulating fluxes in terms of integrals of densities[1]. This new approach, applied to coherent vibrations of small molecules, agrees quite well with the accurate one[2]. With H2+ and D2+, we find that the electronic flux is no longer zero and, that the electron does not always adapt quasi-instantaneously to the nuclear motion. Moreover we show that the initial state preparation matters[3]. In particular, the nuclear flux exhibits high frequency oscillations when the process starts in the inner turning point in contrast to the outer one. Considering H2, the effect of electronic correlation has been investigated by comparison of the Hartree-Fock and the full configuration interaction methods.

[1] I. Barth et al. Chem. Phys. Lett.481, 118 (2009) [2] Chelkowsky et al. Phys. Rev. A 52, 2977 (1995), G. K. Paramonov, Chem. Phys. Lett. 411, 350 (2005) [3] Kenfack et al. (in preparation) (2008)

A 29.5 Fr 15:00 B 302

Charge Breeding with Dresden EBIS/T systems — •Alexandra Thorn[1], Alexey Sokolov[2], Gleb Vorobjev[2], Frank Herfurth[2], Oliver Kester[2], Erik Ritter[1], Falk Ullmann[3], and Günter Zschornack[1] — [1]Institut für Angewandte Physik, Technische Universität Dresden, Germany — [2]Gesellschaft für Schwerionenforschung, Darmstadt, Germany — [3]Dreebit GmbH, Dresden, Germany

High-precision atomic mass measurements or nuclear fusion reaction studies are two examples for projects which rely on the availability of highly charged ions (HCI) from a broad spectrum of elements or exotic isotopes. However, the desired HCI often cannot be provided directly from one source. Thus, initially low charged ions have to be converted or "bred" to higher charge states. We have performed simulations as well as x-ray and ion extraction measurements to investigate the possibilities of charge breeding with the SPARC-EBIT, a compact room-temperature electron beam ion trap of the Dresden EBIT type. K^{1+} ions produced by a surface ion source were injected into the EBIT and bred to charge states as high as K^{19+}. Continuous as well as pulsed injection methods were tested revealing details about the process of filling the electrostatic trap of the EBIT with externally produced ions. Experimentally achieved capture and breeding efficiencies for various charge states are summarized and the application of advanced charge breeding techniques with the Dresden EBIT are discussed.

A 29.6 Fr 15:15 B 302

Spontaneous emission of light from atoms — •Nikodem Szpak[1] and Piotr Marecki[2] — [1]Fakultät für Physik, Universität Duisburg-Essen — [2]Institut für Theoretische Physik, Universität Leipzig

We investigate (non-relativistic) atomic systems interacting with quantum electromagnetic field (QEF). The resulting model describes spontaneous emission of (single) photons from a two-level atom. By conducting the analysis on a general level we allow for an arbitrary initial state of the QEF (which can be for instance: the vacuum, the ground state in a cavity, or the squeezed state). We derive a Volterra-type equation which governs the time evolution of the amplitude of the excited state. In the vacuum case we analytically determine the asymptotics of its solutions: exponential decay at intermediate times and power-law decay at very late times. We also solve this equation numerically.

A 29.7 Fr 15:30 B 302

***k*-Photon Decay Rates from Complex Dilated Floquet Hamiltonians** — Celsus Bouri, Andreas Buchleitner, Pierre Lugan, Sören Roerden, Maximilian Schmidt, and •Klaus Zimmermann — Physikalisches Institut, Universität Freiburg

Complex dilation is known as an efficient tool for the extraction of total decay rates of atomic systems under strong external perturbations. This method is however believed to be unsuited to access partial decay rates into specific decay channels. We show that the latter indeed can be derived from the eigenstates of complex dilated Hamiltonians. As a specific example we demonstrate our novel approach to quantify the decay rates of periodically driven Rydberg systems into well defined k-photon ionisation channels.

A 29.8 Fr 15:45 B 302

Frozen planet states in helium with non-zero angular momentum — •Celsus Bouri[1,2], Johannes Eiglsperger[3], Javier Madronero[3,4], and Andreas Buchleitner[1] — [1]Quantum Optics and Statistics, Institute of Physics, University of Freiburg, 79104 Freiburg, Germany — [2]CEPAMOQ, University of Douala, B.P. 8580 Douala, Cameroon — [3]Physik Department, Technische Universität München, 85747 Garching, Germany — [4]Laboratoire de Physique Atomique, Moléculaire et Optique (PAMO), Université catholique de Louvain, 1348 Louvain-la-Neuve, Belgium

We demonstrate the existence of frozen planet states (FPS) in helium for total angular momenta $L = 1$ and $L = 2$. The calculations are conducted for the planar (2D) and for the full 3-dimensional (3D) helium. The simplified planar model reproduces the reproduces qualitavely well the results of our full 3D appraoch. The identification of the FPS is achieved through the localitation properties of their wavefunction in configuration space. The small magnitude of their decay rates and the large value of $\langle \cos\theta_{12} \rangle$, θ_{12} being the mutual angle between the two electrons, characterize $L = 1$ FPS. These two quantities can be used to identify these states. These simple criteria do not apply for D states. Here, the localization properties of the wave functions both in configuration and phase space need to be analyzed.