A 20 Poster II: Atomare Systeme in starken Laserpulsen und statischen Feldern

Zeit: Donnerstag 16:30–18:30 Raum: Labsaal

A 20.1 Do 16:30 Labsaal

Relativistic classical and quantum dynamics in intense crossed laser beams — •M. Verschl and C. H. Keitel — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg

The dynamics of an electron in crossed laser fields is investigated analytically. Two different standing wave configurations are considered which have the property that they posses certain axes where the Lorentz force of the magnetic field vanishes. If the electron moves along these axes, the electron drift which occurs in strong single laser beams [1] is avoided. This is useful because the drift motion reduces the effectiveness of recollision processes in atomic systems [2].

The laser configurations are given by two counter-propagating waves that are linearly polarized in the first and circularly polarized in the second case.

Depending on the laser field strength different approaches are implemented to describe the electron wave packet. In the non-relativistic limit the electron dynamics can be described quantum mechanically. Relativistic effects are discussed by considering the lowest order relativistic correction term of the Klein-Gordon equation. A fully relativistic description is given by a classical wave packet approach. Significant differences of the two configurations are shown to appear only in the relativistic regime.

[1] M. Verschl, C.H. Keitel,
Laser Physics **15**, 529-535 (2005)
[2] D.B. Milosevic, F. Ehlotzky,
Advances in Atomic, Molecular and Optical Physics **49**, 373-532 (2003)

A 20.2 Do 16:30 Labsaal

Laserassistierter Elektronentransfer in p-Ne Stößen — •Tom Kirchner — Institut für Theoretische Physik, TU Clausthal, 38678 Clausthal-Zellerfeld

Ein vielversprechendes Szenario für die Untersuchung zeitaufgelöster Elektronendynamik ist die Einbettung eines atomaren Stoßes in einen Laserpuls. Erste theoretische Studien für Prototyp-Einelektronen-Stoßsysteme deuten eine Reihe signifikanter Effekte an, namentlich einen stark erhöhter Elektronentransfer in langsamen asymmetrischen Ion-Atom-Stößen [1,2].

In diesen Beitrag wird der Elektronentransfer in dem Mehrelektronenproblem p-Ne untersucht. Die vorgestellten Rechnungen beruhen auf der Basis Generator Methode zur quantenmechanischen Beschreibung der Elektronendynamik in den klassisch betrachteten Feldern der Kerne und des Lasers. Auch in diesem System ist der totale Transferquerschnitt in langsamen laserassistierten Stößen signifikant größer als im feldfreien Fall. Bei etwas höherer Projektilenergie kann durch die Polarisation der Laserfeldes die Ausrichtung der aktiven Ne(2p) Orbitale abgetastet werden.

[1] T. Kirchner, Phys. Rev. Lett. **89** 093203 (2002)
[2] T. Kirchner, Phys. Rev. A **69** 063412 (2004)

A 20.3 Do 16:30 Labsaal

The Role of Rescattering in the Multiphoton Detachment of Br^- in a Strong Linearly Polarized Laser Field — •Boris Bergues, Hanspeter Helm, and Igor Yu. Kiyan — Department of Optical and Molecular Physics, Universität Freiburg, Stefan-Meier-Str. 19, 79104 Freiburg, Germany.

Negative bromine ions are exposed to strong linearly polarized infrared laser pulses of approximately 100 fs duration with a peak intensity on the order of 10^{13} to 10^{14} W/cm^2. The photodetached electrons are projected onto a 2D position sensitive detector. Taking advantage of the axial symmetry with respect to the polarization axis, the full 3D information is recovered by a back projection algorithm, yielding the angular resolved energy spectrum of the photoelectrons. In our previous experiments using linearly as well as circularly polarized light, we showed that the KFR theory of direct electrons qualitatively describes all the features of the measured potodetachment spectra. The extended KFR theory which takes into account the rescattering of the photodetached electron from its parent core predicts a plateau of hot electrons in the photoelectron spectrum. In the present work, we investigate the role of the rescattering effect for negative bromine ions. This work is supported by the Deutsche Forschungsgemeinschaft, Grant No. KI 865/1-1.

A 20.4 Do 16:30 Labsaal

Mechanismen der Mehrfach-Ionisation von Atomen in intensiven fs Laserpulsen — •Bernold Feuerstein, Artem Rudenko, Thorsten Ergler, Karl Zrost, Claus Dieter Schröter, Robert Moshammer und Joachim Ullrich — Max Planck Institut für Kernphysik, 69117 Heidelberg

Mit Hilfe eines Reaktions-Mikroskops wurden die Impulse von mehrfach geladenen Ionen, die bei der Ionisation von Neon und Argon in intensiven Laserfeldern (25 und 7 fs, 800 nm) erzeugt werden, vermessen. Die gewonnen Daten geben Aufschluss über die zugrunde liegenden Ionisationsmechanismen und ermöglichen erstmals weitergehende Aussagen über die Rolle von sequentiellen und nicht-sequentiellen Ionisations-Pfaden bei der Erzeugung von bis zu 7-fach geladenen Ionen. So wird z.B. die 4-fache Ionisation von Ne bei Intensitäten unterhalb von 2.0 PW/cm^2 im Wesentlichen durch einen einziger Reaktionskanal dominiert, nämlich die gleichzeitige Emission von bis zu vier Elektronen als Folge einer Rekollision des zuerst ionisierten Elektrons mit dem Mutter-Ion. Im Gegensatz dazu treten bei Argon überwiegend Kaskaden von sequentiellen und nicht-seqentiellen Prozessen auf. Durch systematische Untersuchungen konnte gezeigt werden wie sich die Beiträge unterschiedlicher Ionisationskanäle als Funktion der Spitzen-Intensität im Laserpuls verschieben. Die Ergebnisse werden vorgestellt und im Hinblick auf die zugrunde liegenden Mechanismen interpretiert.

A 20.5 Do 16:30 Labsaal

Impact of a static magnetic field on high harmonic spectra — •R. Fischer[1], C. H. Keitel[1], R. Jung[2], G. Pretzler[2], and O. Willi[2] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg — [2]Institut für Laser- und Plasmaphysik, Heinrich-Heine-Universität Düsseldorf, Universitätsstr. 1, D-40225 Düsseldorf, Germany

As an atom is subjected to a linearly polarized laser field, the magnetic field component of the laser beam is able to cause the electrons to drift in the laser propagation direction. Together with the attraction of the nucleus, this electron motion results in a wiggly motion which gives rise to high harmonic radiation. In our numerical study we solved the time-dependent Schrödinger equation beyond the dipole approximation for a two-dimensional model of an He^+ ion subjected to an intense laser beam. We have found that the signal heights of the radiation described above can be affected by a static magnetic field of the order of 30 Tesla which is directed perpendicular to the plane spanned by the laser polarization and propagation direction. The dependence of the signal strength on the external magnetic field suggests a method which might be used to measure strong magnetic fields.

A 20.6 Do 16:30 Labsaal

Relativistic quantum optics in multiply charged ions — •Henrik G. Hetzheim, Guido R. Mocken, and Christoph H. Keitel — Max-Planck Institut für Kernphysik, Heidelberg, Germany

The interaction of ultra-intense laser fields with highly charged ions via multiphoton coupling [1, 2] is known to be the source of a large variety of quantum phenomena. To analyze these, we start with the generation of the energy eigenstates of Ne^{9+} by means of an autocorrelation spectral method. Then, employing a split-operator algorithm, we investigate the time resolved population transfer from the ground state to the various excited states during the interaction with a linearly polarized laser field and its dependence on the laser pulse's length and intensity, as well as on the initial quantum state of the ionic system. The numerical calculations are carried out in the multiphoton regime so that the associated radiation spectrum includes only non-tunneling harmonics [3]. The results are obtained by using the full Dirac equation in 2D, which provides a more precise picture of the occurring multiphoton resonances than other nonrelativistic treatments. The role of relativistic coherence and interference effects will be discussed.

[1] C. H. Keitel, Contemporary Physics, **42**, 353–363 (2001).
[2] S. X. Hu and C. H. Keitel, Phys. Rev. A **63**, 053402 (2001).
[3] S. X. Hu, A. F. Starace, W. Becker, W. Sandner and D. B. Milošević, J. Phys. B: At. Mol. Opt. Phys. **35**, 627–650 (2002).

A 20.7 Do 16:30 Labsaal

e^+e^- -Paarbildung in starken Feldern — •Matthias Ruf, Guido R. Mocken, Carsten Müller, Karen Z. Hatsagortsyan und Christoph H. Keitel — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg

Eine der faszinierendsten Voraussagen der Dirac-Theorie stellt die Elektron-Positron-Paarbildung dar. Dieser Effekt wurde schon 1950 für den Fall eines statischen E-Feldes sowie 1970 näherungsweise für oszillierende E-Felder betrachtet [1,2]. Allerdings waren und sind die vorausgesagten Feldstärken und Frequenzen weit außerhalb des Realisierbaren.
Umstrittene analytische Rechnungen für gegenläufige Laserpulse [3] lassen einen beobachtbaren Effekt bei Laserintensitäten erwarten, welche in naher Zukunft zur Verfügung stehen werden. Durch numerische Propagation [4] eines Dirac-Elektrons wird diese Möglichkeit erneut untersucht.

[1] J. Schwinger, Phys. Rev. **82**, 664 (1951)
[2] E. Brezin, C. Itzykson, Phys. Rev. D **2**, 1191 (1970)
[3] H.K. Avetissian et al., Phys. Rev. E **66**, 016502 (2002)
[4] G.R. Mocken und C.H. Keitel, J. Comp. Phys. **199**, 558 (2004)

A 20.8 Do 16:30 Labsaal

Wave Packet Evolution of Highly Relativistic Electrons — •D. Stiff, G. R. Mocken, and C. H. Keitel — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg

We present the results of a numerical study of highly relativistic electrons with initial γ factors ranging from 2 to 100 in the presence of intense fields. Using both 2 and 3 dimensional models, we investigate the evolution of several properties, such as the shape of the wave packet and the mixture of positive and negative energy states, to look for differences that may be attributed to the reduced dimensionality of the 2D model. The strength of electric field and magnetic field studied range from 0 to 10^{20} V/m and 0 to 10^8 T respectively.

A 20.9 Do 16:30 Labsaal

Simultaneous real-time tracking of wave packets evolving on two different potential curves in H_2^+ and D_2^+ — •B. Ulrich[1,2], A. S. Alnaser[2], X. M. Tong[2], I. V. Litvinyuk[2], C. M. Maharjan[2], P. Ranitovic[2], T. Osipov[2], R. Ali[2], S. Ghimire[2], Z. Chang[2], C. D. Lin[2], and C. L. Cocke[2] — [1]Institut für Kernphysik, Johann Wolfgang Goethe Universtät, Max-von-Laue Str.1, 60438 Frankfurt — [2]J.R.Macdonald Laboratory, Physics Department, Kansas State University, Manhattan, Kansas 66506-2601, USA

In a pump probe experiment with intense few-cycle laser pulses we have measured the simultaneous evolution of wave packets on two different potential curves created when H_2 (D_2) molecules were ionized. Measuring in coincidence the kinetic energy of the proton (deuteron) pairs produced in the Coulomb explosion of the H_2^+ (D_2^+) molecular ions as a function of time delay between the pump and probe pulse allowed us to take experimental "snapshots". The time evolution was sufficient to reveal not only the evolution of the wave paket centroid but also the fundamentally wavelike features of the packets. The observed features of the nuclear motion are in good agreement with full quantum calculation.

A 20.10 Do 16:30 Labsaal

Diatomic molecules in intense laser fields — •Stefan Voss[1,2], A. S. Alnaser[2], X.-M. Tong[2], T. Osipov[2], B. Ulrich[1,2], C. D. Lin[2], H. Schmidt-Boecking[1], R. Doerner[1], and C. L. Cocke[2] — [1]Institut für Kernphysik, Johann Wolfgang Goethe Universität, Max-von-Laue-Str. 1, D-60438 Frankfurt am Main — [2]J.R. Macdonald Laboratory, Physics Department, Kansas State University, Manhattan, KS, 66502, U.S.A.

Using cold target recoil ion momentum spectroscopy (COLTRIMS) we measured the full momentum vector of Coulomb exploding H^+, N^+ or O^+ fragments generated by double ionized Hydrogen, Nitrogen or Oxygen respectively with laser peak intensities between 1 and $20 \cdot 10^{14}\,\mathrm{W/cm^2}$. We show alignment effects of the inter nuclear axis with respect to the polarisation vector due to the outmost orbital electron configuration. Using linear and circularly polarized light, we identify two mechanisms for the production of theses states, rescattering and sequential ionization. By using 8 fs pulses, we observe that the internuclear distance can be frozen during the pulse.

A 20.11 Do 16:30 Labsaal

Dynamics of gas clusters exposed to VUV-FEL radiation: time-resolved scattering — •Ekaterina Eremina, Christoph Bostedt, Matthias Hoener, Heiko Thomas, and Thomas Möller — TU Berlin, Hardenbergstrass 36, 10623 Berlin

We propose a two colour pump-probe based experimental technique for studying the fragmentation and explosion dynamics of rare gas clusters exposed to vacuum-ultraviolet radiation by the DESY Free-Electron-Laser. Two separated 50-fs FEL pulses of the first and third harmonics are used as the pump and probe correspondingly. The fragmentation processes induced by the first-harmonic pulse at a wavelength around 30 nm can be studied with time-resolved scattering of the third-harmonic at 10 nm.

A 20.12 Do 16:30 Labsaal

Experimente zur Multiphotonen-Ionisation von Atomen in intensiver VUV-FEL Strahlung — •Robert Moshammer[1], Lutz Foucar[2], Claus Dieter Schröter[1], Artem Rudenko[1], Thorsten Ergler[1], Daniel Fischer[3], Stefan Lüdemann[1], Jasmin Titze[2], Markus Schöffler[2], Till Jahnke[2], Thorsten Weber[2], Reinhard Dörner[2], Theo Zouros[4], Thomas Ferger[1], Kai-Uwe Kühnel[1], Karl Zrost[1], Alexander Dorn[1] und Joachim Ullrich[1] — [1]Max Planck Institut für kernphysik, Heidelberg — [2]Institut für Kernphysik, Universität Frankfurt — [3]Stockholm University, Stockholm, Schweden — [4]University of Crete, Heraklion, Greece

Am Freie-Elektronen Laser (FEL) bei DESY in Hamburg wurden erste differentielle Messungen zur Ionisation von Atomen mit intensiver VUV-Strahlung (44 nm bzw. 28 eV) durchgeführt. Hierzu wurde ein Überschall-Atomstrahl in einem Reaktions-Mikroskop mit dem fokussierten FEL Strahl (ca. 50 um Durchmesser) gekreuzt und die bei der Ionisation entstehenden Ionen und Elektronen mit Multi-Hit fähigen Detektoren nachgewiesen. Der im Experiment erfolgte Nachweis von bis zu 4-fach geladenen Ar-Ionen bei Licht-Intensitäten im unteren 10^13 W/cm^2 Bereich ermöglicht erstmals detaillierte Aussagen über die gleichzeitige Absorption (innerhalb eines Laserpulses von ca. 40 fs Länge) von mehreren Photonen. Die gemessenen Impulsverteilungen von Ionen und Elektronen erlauben wichtige Rückschlüsse auf mögliche Ionisationsmechanismen. So kann zum Beispiel geklärt werden, ob mehrere Photonen instantan oder sequentiell von einem einzigen Atom absorbiert werden. Die experimentellen Ergebnisse werden vorgestellt und diskutiert.

A 20.13 Do 16:30 Labsaal

Imaging of Atomic Clusters with Intense Femtosecond XFEL Pulses — •Christian Gnodtke, Ulf Saalmann, and Jan-Michael Rost — Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzerstrasse 38, D-01187 Dresden, Germany

We investigate the possibility of imaging atomic clusters with intense femtosecond laser pulses as will be available from X-ray free electron laser (XFEL) sources in the future. The X-ray diffraction pattern is simulated and a phase-retrieval algorithm using the oversampling method [1] is employed to reconstruct the cluster geometry. Since the image quality is limited by appreciable radiation damage to the cluster (ionization and subsequent expansion) even for femtosecond pulses, we consider the laser-induced dynamics. Using quantum-mechanical transition rates combined with a molecular dynamics simulation of free electrons and ions [2], we investigate the constraints on the experimental parameters for imaging purposes.

[1] J. Miao, D. Sayre and H. N. Chapman. J. Opt. Soc. Am. A **15**, 1662 (1998)
[2] U. Saalmann and J.-M. Rost. Phys. Rev. Lett. **89**, 143401 (2002)

A 20.14 Do 16:30 Labsaal

Probing the cluster dynamics with atto-second VUV and XUV laser pulses — •Ionuţ Georgescu, Ulf Saalmann, and Jan-Michael Rost — Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Str. 38, 01187 Dresden, Germany

First experiments [1] with soft X-Ray (VUV range) radiation coming from a free-electron laser were conducted in Hamburg on Xe clusters. They showed an unexpectedly large energy absorption resulting into fast, highly charged ions.

Although several theoretical models [2-5] manage to explain the large energy absorption and the ionic spectra observed after the explosion, the mechanisms which they propose lead to different charge states of the atoms during the interaction with the laser pulse. We investigate how atto-second probe pulses in the VUV and XUV range can be used for time-resolved studies of the charge states of the atoms, thus, providing

more insight into the energy absorption mechanisms.

[1] Wabnitz et.al., Nature 420, 482 (2002)
[2] R. Santra and C.H. Greene, PRL 91, 233401 (2003)
[3] C. Siedschlag and J.M. Rost, PRL 93, 043402 (2004)
[4] Jungreuthmayer et.al., J. Phys. B 38, 3029 (2005)
[5] M. Rusek and A. Orlowski, PRA 71, 043202 (2005)

A 20.15 Do 16:30 Labsaal

Photoelectron Spectroscopy on Mass–Selected Metal Clusters using VUV-FEL Radiation — •V. Senz[1], T. Fischer[2], J. Stanzel[3], M. Neeb[3], F. Burmeister[4], M. Niemitz[2], T. Weber[5], U. Kramm[1], P. Oelssner[1], E. Rühl[6], M. Martins[7], H. Thomas[8], C. Bostedt[8], A. Czasch[5], W. Eberhardt[3], G. Ganteför[2], T. Möller[8], H. Schmidt-Böcking[5], R. Dörner[5], W. Wurth[7], J. Tiggesbäumker[1], and K. Meiwes-Broer[1] — [1]Universität Rostock — [2]Universität Konstanz — [3]BESSY Berlin — [4]ICM, BMC, Uppsala University — [5]Universität Frankfurt am Main — [6]Universität Würzburg — [7]Universität Hamburg — [8]Technische Universität Berlin

Metal clusters with only a few atoms are known to exhibit new and interesting properties. In particular, the exact number of atoms has a pronounced influence on the electronic structure. The promising method to study the electronic and geometric structure of the clusters is photoelectron spectroscopy after mass-selection. So far, however, no photon source except the VUV free electron laser at HASYLAB/DESY is available, which provides the appropriate radiation of several tens of eV with sufficient intensity and thus allows to investigate the complete valence band and shallow core levels. We report on the status of a dedicated experimental setup and experiences during the first beamtime at the FEL. A BMBF funded consortium of seven groups planned the project and participates in the experiments.

A 20.16 Do 16:30 Labsaal

Ionisation and recombination in atto-second electric field pulses — •Julian Poloczek, Darko Dimitrovski, and John S. Briggs — Theoretische Quantendynamik, Physikalisches Institut, Universität Freiburg, Hermann-Herder-Str. 3, 79104 Freiburg

We study ionisation and excitation of a hydrogenic atom from the ground and first excited states in short electric field pulses of several cycles. A process of ionisation and recombination which occurs periodically in time is identified, both for small and extremely large peak electric field strengths. In the limit of large electric peak fields closed-form analytic expressions for the population of the initial state after single- and few-cycles pulses are derived. These formulae, strictly valid for asymptotically large momentum transfer from the field, give an excellent agreement with the fully numerical calculations for all momentum transfers.

A 20.17 Do 16:30 Labsaal

Effects of weak hyperfine decoupling on metastability exchange optical pumping of ^{3}He — •Marion Batz[1], Pierre-Jean Nacher[2], Geneviève Tastevin[2], and Werner Heil[1] — [1]Johannes Gutenberg-Universität Mainz, Institut für Physik, Staudingerweg 7, 55099 Mainz, Germany — [2]Laboratoire Kastler Brossel, Département de Physique de l'E.N.S., 24 Rue Lhomond, 75231 Paris Cedex 05, France

In order to improve the efficiency of metastability exchange optical pumping of ^{3}He and to obtain a more thorough understanding of the complex relaxation mechanisms in a gas discharge, we set up a ^{3}He optical pumping experiment in magnetic fields up to 30 mT. The gas discharge is the main source of relaxation for the nuclear polarisation of ^{3}He, e.g. due to the emission of circularly polarised fluorescence light in the plasma that is a significant angular momentum loss mechanism. Up to 100 mT, the strong hyperfine coupling in the 2^3S state and the metastability exchange process are almost unaffected by the applied field. In contrast, above 10 mT electronic and nuclear angular momenta in the excited states involved in the radiative cascade are strongly decoupled and this relaxation mechanism is prevented. We present systematic optical pumping measurements, in which the effects of the magnetic field, of the discharge intensity, of the gas pressure, of the pump laser line and power have been investigated. Our first results indicate that applying a moderate field tends to decrease nuclear relaxation and yields a relative increase in nuclear polarisation by 5-10%.

A 20.18 Do 16:30 Labsaal

Optical measurement of nuclear polarisation of ^{3}He gas in arbitrary magnetic field — •Marion Batz[1], Pierre-Jean Nacher[2], Geneviève Tastevin[2], and Werner Heil[1] — [1]Johannes Gutenberg-Universität Mainz, Institut für Physik, Staudingerweg 7, 55099 Mainz, Germany — [2]Laboratoire Kastler Brossel, Département de Physique de l'E.N.S., 24 Rue Lhomond, 75231 Paris Cedex 05, France

Gaseous ^{3}He can be spin polarised by metastability exchange optical pumping, through excitation of the ground state atoms into the 2^3S metastable state by a radiofrequency discharge, and pumping with a 1083 nm-laser on the 2^3S-2^3P transition. In other excited states populated in the plasma, hyperfine interaction transfers nuclear orientation to electronic angular momentum. Monitoring the circular polarisation of a selected He spectral line is a standard optical detection technique, but it is difficult to accurately calibrate and its sensitivity decreases with gas pressure and in high applied magnetic fields (above a few mT, due to hyperfine decoupling in the involved excited states). We present an optical method to measure the nuclear polarisation of ^{3}He based on absorption measurements of a weak probe laser at 1083 nm. It relies on the fact that metastability exchange collisions enforce a spin-temperature-like distribution of populations in the probed metastable state sublevels that reflect the nuclear polarisation of the ground state. We have performed systematic measurements up to 30 mT in various conditions to assess the accuracy of this technique. Very high SNR (up to 10000) can be obtained, and the effects of an intense pumping laser and of the gas pressure have been studied.

A 20.19 Do 16:30 Labsaal

Relativistic gauge-invariant strong-field approximation for Above-Threshold Ionization — •Michael Klaiber, Karen Z Hatsagortsyan, and Christoph H Keitel — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, D-69117 Heidelberg

A gauge-invariant version of the strong-field approximation is developed for the relativistic treatment of Above-Threshold Ionization (ATI). The gauge invariance is achieved by means of employment of an eigenstate of the physical energy operator for the initial atomic state. Both a comparison and analysis of predictions of the gauge-invariant theory with usual not gauge-invariant results are given for direct ionized electrons. Further we expand the model based on the Klein-Gordon equation by including rescattering of the ionized electron in the relativistic regime.

A 20.20 Do 16:30 Labsaal

Doppelt angeregte Heliumatome in starken Magnetfeldern — •Armin Lühr und Peter Schmelcher — Theoretische Chemie, Im Neuenheimer Feld 229, 69120 Heidelberg

Das Wellenlängenspektrum von Heliumatomen in starken Magnetfeldern ist von großem Interesse für die astrophysikalische Erforschung von magnetischen Weißen Zwergen. Starke Magnetfelder sind bekannt dafür, die Struktur und Dynamik atomarer Systeme grundlegend zu verändern. Im Gegensatz zu gebundenen Heliumatomen, bei denen (dominant) nur ein Elektron angeregt ist, wurde das Verhalten von doppelt angeregten Zuständen im Magnetfeld B bisher noch nicht untersucht. Betrachtungen dieser Zustände für $B = 0$ legen nahe, dass es sich um stark korrelierte Resonanzzustände handelt, welche nicht durch unabhängige Teilchen beschrieben werden können.

Unter Verwendung der complex scaling Metohde wurde die Mangetfeldabhängikeit von doppelt angeregten Heliumatomen für $B = 0-2.355\cdot 10^7$ T berechnet. Daraus ergibt sich, dass die untersuchten Zustände (im Gegensatz zu $B = 0$) für starke Felder $B > 2\cdot 10^5$ T durch Konfigurationen aus einem Heliumion- und einem Wasserstofforbital im Magnetfeld beschrieben werden können. Dies ist ein erster Schritt zum Verständnis und zur Bestimmung des Spektrums von doppelt angeregten Heliumatomen im Magnetfeld.

A 20.21 Do 16:30 Labsaal

Laser-assisted bremsstrahlung — •Erik Lötstedt, Stephan Schnez, Ulrich D. Jentschura, Karen Z. Hatsagortsyan, and Christoph H. Keitel — Max-Planck-Institut für Kernphysik, Heidelberg

The process of spontaneous bremsstrahlung in a laser field is theoretically studied. We present the fully relativistic differential cross section for spontaneous bremsstrahlung from a relativistic electron scattered by a Coulomb potential in a laser field. The electron-laser interaction is taken into account exactly by treating the laser as an external classical field, while the electron-nucleus interaction and the interaction with the

bremsstrahlung radiation are treated in first-order perturbation theory. The full, laser-dressed Green's function of the Dirac equation is used for the propagator.

Numerical results are obtained for the differential cross section integrated over the solid angle of the final electron, for relativistic electron energies and laser intensities of up to the order 10^{22} W/cm^2 and for both linear and circular polarization of the laser.

We focus in particular on the case when high-harmonic generation is possible, that is, when the bremsstrahlung frequency is an (high) integer multiple of the laser frequency. We show that it is possible to obtain bremsstrahlung spectra showing the features of a plateau and a cutoff.

A 20.22 Do 16:30 Labsaal

Muonic atoms in strong laser fields — •Atif Shahbaz[1], Carsten Müller[1], Thomas J. Bürvenich[1,2], and Christoph H. Keitel[1] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany — [2]Johann Wolfgang Goethe University, Max-von-Laue-Str. 1, 60438 Frankfurt am Main, Germany

We study the influence of an intense laser wave on a muonic atom. The large muon mass can be accounted for by separating the centre-of-mass and relative coordinates of motion. Scaling laws in terms of the muon mass are reviewed and applied to strong-field ionization and high-harmonic generation. It is found that the maximum harmonic frequency achievable with an electronic or muonic atom is practically identical, although much stronger fields can be applied to the latter. In addition, we consider the muonic bound-state dynamics in view of possible laser-induced nuclear reactions.