A 12: Atomic Clusters I

Time: Wednesday 14:00–16:00 Location: F 303

Invited Talk A 12.1 We 14:00 F 303

Sequential two-photon double ionization of atoms in intense FEL radiation — •Stephan Fritzsche[1,2], Alexei N. Grum-Grzhimailo[3], Elena V. Gryzlova[3], and Nikolay M. Kabachnik[3] — [1]Department of Physics, University of Oulu, Finland — [2]GSI Helmholtzzentrum für Schwerionenforschung, Germany — [3]Institute of Nuclear Physics, Moscow State University, Russia

Recent progress in the generation of intense FEL radiation has opened a new avenue for studying non-linear processes of atoms and molecules in the XUV and x-ray regime. Among these processes, the two-photon double ionization (TPDI) has received much interest since it enables one to explore in detail the transition from a 'sequential' towards the 'simultaneous' emission of two or more electrons. In this talk, I shall discuss this process for different noble gases and for its parametrization in terms of the alignment and dynamical behaviour of the photoions in their intermediate and final states. Results from different computational models [1] are presented and compared with recent experiments [2,3]. Apart from modifications on the (individually) observed photo-electron distributions due to multi-photon absorption, emphasis is placed also on the electron-electron correlation (function) if the two photo-electrons are detected in coincidence.

[1] S. Fritzsche *et al.*, J. Phys. B **41** (2008) 165601; B **42** (2009) 145602.
[2] M. Braune *et al.*, *Intern. Conf. on Photonic, Electronic and Atomic Collisions (ICPEAC 2007)*, Freiburg, Germany, Abstract Fr034.
[3] M. Kurka *et al.*, J. Phys. B **42** (2009) 141002(FT).

Invited Talk A 12.2 We 14:30 F 303

Few-body physics with ultracold atoms — •Selim Jochim[1,2], Thomas Lompe[1,2], Martin Ries[1,2], Friedhelm Serwane[1,2], Philipp Simon[1,2], Andre Wenz[1,2], and Gerhard Zürn[1,2] — [1]Physikalisches Institut, Universität Heidelberg — [2]Max-Planck-Institut für Kernphysik, Heidelberg

During the past years, ultracold atoms have been a fantastic playground to study few-body physics in the universal regime, in which the properties of bound states do not depend on particular details of the interatomic potential, but only on a few numbers, such as the scattering length. The major ingredient in current experiments is the tunabilty of the scattering length using an externally applied magnetic field using Feshbach resonances. In 2003, this allowed the creation of diatomic Feshbach-molecules, which have been an important starting point for many important milestones, such as the realization of the BEC-BCS crossover, or the controlled preparation of ultracold ground state molecules. Associated with every universal two-body bound state is an infinite series of three-body bound states, as was predicted in 1970 by Vitaly Efimov. Such Efimov states have first been observed in 2006 with ultracold bosonic Cs atoms in the form of three-body scattering resonances. More recently, our group has found evidence for universal three body bound states between three distinguishable fermionic ^{6}Li atoms. Such a three-component system offers the possibility to study many body physics which because of its SU(3)-symmetry could resemble the simplest models of QCD.

A 12.3 We 15:00 F 303

Clusters in XUV laser pulses: Electron emission and nanoplasma dynamics — •Mathias Arbeiter und Thomas Fennel — Institute of Physics, University of Rostock

The excitation mechanisms of clusters exposed to intense laser fields in the VUV and XUV domain strongly differ from the response behavior in the near-infrared wavelength range. Whereas the heating of delocalized electrons in the nanoplasma is the dominant energy capture mechanism in optical fields, energy absorption due to the excitation of localized electrons, i.e. by the inner ionization processes itself, becomes increasingly important at high photon energy. Further, the formation of a nanoplasma is substantially delayed because of direct electron excitation into the continuum. The resulting signatures in electron energy spectra[1] can be described by a multi-step ionization scheme[2].

In addition, future prospects will be addressed for XUV pump-and-probe experiments, e.g. for monitoring nanoplasma built-up, cluster expansion and dark plasmon modes.

[1] C. Bostedt et al., Phys. Rev. Lett. 100, 133401 (2008)
[2] M. Arbeiter, Th. Fennel, in preparation

A 12.4 We 15:15 F 303

Dichte Xenon- und Silbernanoplasmen in starken Laserfeldern — •Paul Hilse[1], Thomas Bornath[2], Max Moll[1] und Manfred Schlanges[1] — [1]Ernst-Moritz-Arndt-Universität Greifswald — [2]Universität Rostock

Die Wechselwirkung intensiver Laserstrahlung mit Xenon- und Silberclustern mit Größen im nm-Bereich wird im Rahmen eines modifizierten Nanoplasma-Modells [1] untersucht. Von besonderem Interesse ist die Ionisationsdynamik im lasererzeugten dichten Plasma. Es zeigt sich, dass sich die Dynamik, d.h. die zeitliche Entwicklung von Dichte und Temperatur - und damit verbunden - die Plasmazusammensetzung, der untersuchten Elemente bei gleichen Laserparametern stark voneinander unterscheidet [2].

Eine Methode, die Dynamik des Plasmas gezielt auf der Skala von Femtosekunden zu steuern, ist das sogenannte Pulse-Shaping. In unserem theoretischen Zugang benutzen wir einen genetischen Algorithmus zur Optimierung der Pulsform des Lasers, um die maximale Ausbeute einer bestimmten Ionenspezies zu erzielen [3]. Auch hier zeigt sich ein stark unterschiedliches Verhalten der betrachteten Elemente Xenon und Silber. Es werden Resultate mit optimierten Pulsformen gezeigt und mit Einzel- und Doppelpulsanregungen verglichen.

[1] P. Hilse, M. Moll, M. Schlanges, and Th. Bornath, Laser Physics, **19** 428 (2009) [2] P. Hilse, Th. Bornath, M. Moll, and M. Schlanges, Contrib. Plasma Phys. **49**, 692 (2009) [3] Truong et al., Optimal control of the strong field ionization of silver clusters in helium droplets, Phys. Rev. A (accepted Dec. 9, 2009)

A 12.5 We 15:30 F 303

Electronic Structure of Transition Metal Doped Gold Clusters — •Konstantin Hirsch[1], Jochen Rittmann[2], Vicente Zamudio-Bayer[1], Marlene Vogel[1], Jörg Wittich[1], Silvia Forin[1], Christian Kasigkeit[1], Felix Ameseder[1], Jürgen Probst[1], Thomas Möller[1], Bernd von Issendorff[3], and Tobias Lau[2] — [1]Technische Universität Berlin, Institut für Optik und Atomare Physik, EW 3-1, Hardenbergstraße 36, D-10623 Berlin — [2]Helmholtz-Zentrum Berlin für Materialien und Energie, Wilhelm-Conrad-Röntgen Campus / BESSY II, Institut für Methoden und Instrumentierung der Synchrotronstrahlung, Albert-Einstein-Str. 15, D-12489 Berlin — [3]Albert-Ludwigs-Universität Freiburg, Fakultät für Physik/FMF, Stefan-Meier-Straße 21, D-79104 Freiburg

Small gold clusters show very suprising properties, like highly enhanced catalytical activity. The electronic properties of small clusters can be modified by doping with transition metal atoms. We investigated the local electronic structure of small doped gold clusters (Au_nM n=1-8, M=Sc,Ti,V,Cr) by means of X-ray absorption spectroscopy. The electronic structure is very sensitive to the doping and geometric structure of the cluster. A clear transition from planar to three dimensional geometric structures can be observed, since distinct atomic like features in the spectra vanish if the cluster undergoes the geometric transition. The spectra change dramatically upon successive addition of gold atoms to the cluster. Even electron localization in chromium doped gold clusters can be observed.

A 12.6 We 15:45 F 303

Electronic Properties of Transition Metal Doped Silicon Clusters — •Jochen Rittmann[1], Konstantin Hirsch[2], Christian Kasigkeit[2], Philipp Klar[2], Andreas Langenberg[1], Fabian Lofink[2], Jürgen Probst[2], Marlene Vogel[2], Jörg Wittich[2], Vicente Zamudio-Bayer[2], Thomas Möller[2], Bernd von Issendorff[3], and Tobias Lau[1] — [1]Helmholtz-Zentrum Berlin für Materialien und Energie, Institut für Methoden und Instrumentierung der Synchrotronstrahlung, Albert-Einstein-Str. 15, 12489 Berlin — [2]Technische Universität Berlin, Institut für Optik und Atomare Physik, Hardenbergstr. 36, 10623 Berlin — [3]Universität Freiburg, Fakultät für Physik, Stefan-Meier-Str. 21, 79104 Freiburg

Size selected transition metal doped silicon clusters have been studied with resonant 2p x-ray absorption spectroscopy. Despite the different number of valence electrons, nearly identical local electronic structures are found at the dopant atoms in $TiSi_{16}^+$, VSi_{16}^+, and $CrSi_{16}^+$. Additional measurements of the direct 2p photoionization as well as spectroscopy on the valence electrons of MSi_n^+ clusters, (M=V, Ti, Cr; n=15-17) al-

low us to determine the band gab, which is predicted to be exceptional high for the very symmetric MSi_{16}^{+} clusters (M=V, Ti, Cr). The experimental data can be understood in the spherical potential model. The data indicate strongly interlinked electronic and geometric properties: While the transition metal atoms impose a geometric rearrangement on the silicon cluster, the interaction with the highly symmetric silicon cage determines the electronic structure of the transition metal dopants.