A 6 Atomic Clusters and Cold Atoms I

Zeit: Samstag 10:30–12:30 Raum: HU 3075

Hauptvortrag A 6.1 Sa 10:30 HU 3075

On the Interatomic Coulombic Decay — •Simona Scheit, R. Santra, J. Zobeley, and L. S. Cederbaum — Universität Heidelberg, Theoretische Chemie, Im Neuenheimer Feld 229, 69120 Heidelberg

The Interatomic Coulombic Decay (ICD) is the mechanism by which a weakly bound atomic or molecular cluster decays via electron emission following inner valence ionization. The ICD is an electronic decay process of interatomic nature, based on electron correlation between neighboring monomers in a weakly bound cluster, and as such has to be distinguished from the well known Auger decay, which interests core ionized states and is of intraatomic character. In the ICD the inner valence hole, which is localized on one of the monomers building up the cluster, is filled by an outer valence electron of the same monomer; the energy gained by the system in this transition is efficiently transferred to a neighboring monomer and used for the emission of an outer valence electron. The resulting system, which eventually undergoes fragmentation, is a doubly ionized cluster with two outer valence holes localized on two different but neighboring monomers. The relatively large distance between the two positive charges reduces the Coulomb repulsion between them and lowers the threshold for double ionization, rendering a decay via electron emission energetically possible. The ICD process with its underlying dynamics has been theoretically predicted a few years ago and very recently experimentally observed in Ne clusters of various sizes. In this contribution the theoretical description of the ICD with its underlying nuclear dynamics will be presented. As example the ICD in Ne clusters will be discussed.

Hauptvortrag A 6.2 Sa 11:00 HU 3075

Experimental Observation of Interatomic Coulombic Decay in Neon Dimers — •Till Jahnke[1], Achim Czasch[1], Markus Schöffler[1], Sven Schössler[1], Alexandra Knapp[1], Manuel Käsz[1], Jasmin Titze[1], Christine Wimmer[1], Katharina Kreidi[1], Robert E. Grisenti[1], Andre Staudte[1], Ottmar Jagutzki[1], Uwe Hergenhahn[2], Horst Schmidt-Böcking[1], and Reinhard Dörner[1] — [1]Institut für Kernphysik, J. W. Goethe-Universität Frankfurt am Main, Germany — [2]Max-Planck-Institut für Plasmaphysik, Garching, Germany

Two decay channels of excited atoms are commonly known today: the release of energy via emission of a photon or an Auger electron. Recently, Cederbaum et al. predicted a third decay mechanism termed Interatomic Coulombic Decay (ICD). It is anticipated to become the dominant decay route, once the excited atom is placed in an environment of other atoms. In that case, the deexcitation energy is transferred by a virtual photon to a neighboring atom, which releases it by emission of a weakly bound electron.

In the current experimental work the process is unambiguously identified after creating an inner valence hole in a neon dimer. Using an adopted version of the well established COLTRIMS-technique, the momenta of the ICD electron and the two ionic fragments of the dimer are measured in coincidence, allowing for the identification of the ICD process by the sum energy of the measured particles. Experimental results including the kinetic energy release of the dimer's Coulomb explosion and the ICD-electron's energy and angular distribution will be presented.

Hauptvortrag A 6.3 Sa 11:30 HU 3075

Femtosekundendynamik von Metallclustern in Helium-Nanotropfen — •T. Döppner[1], Th. Diederich[2], A. Przystawik[1], J. Tiggesbäumker[1] und K.-H. Meiwes-Broer[1] — [1]Fachbereich Physik, Universität Rostock, Universitätsplatz 3, 18051 Rostock — [2]HASYLAB am DESY, Notkestr. 85, 22607 Hamburg

Metallcluster werden durch die Einlagerung von einzelnen Atomen in einer Pick–up–Zelle in superfluiden Heliumtropfen erzeugt [1]. Nach Anregung durch ultrakurze intensive Laserpulse (bis 10^{16} W/ cm^2) werden die resultierenden Fragmente in einem hochauflösenden Flugzeitmassenspektrometer nachgewiesen. Die Untersuchungen der Aufladungsdynamik mit der Pump-Probe-Technik zeigen einen maximalen Ladungszustand der atomaren Ionen für eine optische Verzögerung von einigen 100 fs. Bei moderateren Intensitäten von $10^{12} \ldots 10^{13}$ W/cm^2 kommt es an Ionen zu einer verstärkten Bildung von Schneeballkomplexen M^+He_N [2]. Für bestimmte N tritt eine erhöhte Stabilität auf, die Schalenabschlüssen zugeordnet werden kann. Dabei stellt man eine signifikante elementspezifische Abhängigkeit fest. In einem Pump–Probe Experiment an Clustern ergibt sich ein Maximum im Schneeballsignal bei einer optischen Verzögerung von etwa 20 ps, die Aufschluss über den Cage-Effekt in Heliumtropfen liefert.

[1] Th. Diederich, J. Tiggesbäumker, and K.H. Meiwes–Broer, J. Chem. Phys. **116**, 3263 (2002)

[2] T. Döppner, Th. Diederich, J. Tiggesbäumker, and K.H. Meiwes–Broer, Eur. Phys. J. D **16**, 13 (2001)

Hauptvortrag A 6.4 Sa 12:00 HU 3075

Ultralong-range interactions in a frozen Rydberg gas — •Markus Reetz-Lamour, Thomas Amthor, Johannes Deiglmayr, Kilian Singer, and Matthias Weidemüller — Physikalisches Institut der Universität Freiburg, 79104 Freiburg, Germany

We review our recent experiments on interaction-induced effects in a gas of ultracold Rydberg atoms excited from a laser-cooled rubidium cloud [1]. The van-der-Waals interaction between a pair of Rydberg atoms separated as far as 100,000 Bohr radii features two important effects: spectral broadening of the resonance lines and suppression of excitation with increasing Rydberg density. The line broadenings observed in high-resolution Rydberg spectroscopy are interpreted in terms of level shifts of Rydberg pairs due to their interaction. The density-dependent suppression of excitation marks the onset of an interaction-induced local blockade. Additional resonances are interpreted in terms of molecular potential crossovers.

[1] Singer *et al.*, Phys. Rev. Lett. **93**, 163001 (2004); Singer et al., J. Phys. B, in press (2004).