MS 2: Speicherringe und neue Entwicklungen

Time: Monday 16:30–19:00 Location: F 428

Invited Talk MS 2.1 Mo 16:30 F 428

Cold electron collisions at ion storage rings — •Andreas Wolf — Max-Planck-Institut für Kernphysik, Heidelberg

Cold electron collisions, often driven by Feshbach resonances, are important in a wide range of ionized media and also open efficient pathways for electrons to destroy molecular compounds. Highest precision in their study is reached using merged beams inside ion storage rings. Intense cold electron beams, velocity-matched to the stored ion beams, can realize collision energies as low as a few Kelvin (near 1 meV). The electrons not only initiate reactive collisions, but also cool the internal quantum states of the stored ions and lead to their phase-space compression (beam cooling). Ion beams, moreover, offer powerful tools for coincidence momentum spectroscopy on the products of individual reactions. – Recent beam cooling results and high-resolution atomic and molecular collision studies at the magnetic ion storage ring TSR will be presented, with particular emphasis on the lately introduced intense electron beams from cryogenic semiconductor photocathodes. These sources open the door towards very low electron beam energies (down to a few eV) and offered efficient phase-space cooling already for compounds such as water ions. Few-Kelvin electron collisions will also become available at electrostatic ion storage rings, where the ion energies lie in the range of only a few keV per nucleon. Here, phase-space compression and low-energy merged beams collisions will be applicable to a wide range of heavy molecular ions, heavy singly charged atoms, and slow highly charged ion beams.

Invited Talk MS 2.2 Mo 17:00 F 428

Photodissociation of dipeptide cations in an electrostatic ion storage ring — •Steen Brøndsted Nielsen — Department of Physics and Astronomy, Aarhus University

In photobiology, the aromatic amino acids phenylalanine, tyrosine, and tryptophan are highly important spectroscopic probes for protein conformations and dynamics. They act as markers because of the fact that their photophysics is highly dependent on the chemical environment. To have a proper reference for the intrinsic properties, it is necessary to establish the electronic properties of amino acids without any perturbations from solvent molecules, counter ions, or other amino acids. This requires gas phase experiments on individual molecules. In Aarhus we have developed a setup to record gas-phase absorption spectra of biomolecular ions. It combines an electrospray ion source, a multipole ion trap for pre-storage, an electrostatic ion storage ring, and pulsed tuneable lasers. The technique relies on the measurement of delayed dissociation of photoexcited ions (action spectroscopy). In this talk I will present some of our recent results on dipeptide cations and demonstrate how the electronic structure is linked to peptide conformation. Tagging the positively charged ammonium group with crown ether prevents internal ionic hydrogen bonding and leads to open structures. This influences dissociation lifetimes and channels.

MS 2.3 Mo 17:30 F 428

A mass sensitive imaging detector for storage-ring molecular fragmentation studies — •Christian Nordhorn[1], Henrik Buhr[2,1], Dennis Bing[1], Manfred Grieser[1], Oded Heber[2], Claude Krantz[1], Michael Lestinsky[1], Mario B. Mendes[1], Oldřich Novotný[1], Michael L. Rappaport[2], Roland Repnow[1], Andrey Shornikov[1], Julia Stützel[1], Dirk Schwalm[2,1], Daniel Zajfman[2], and Andreas Wolf[1] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg — [2]Weizmann Institut of Science, Rehovot, 76100, Israel

In astrophysically relevant plasmas dissociative recombination is considered the principal destruction mechanism for molecular ions. Consequently remote probes of interstellar media require extensive comprehension of essential process characteristics, which are investigated in molecular fragmentation studies.

To enhance these studies an energy-sensitive multi-strip surface-barrier detector (EMU) has been developed, which introduces mass identification of individual recombination products and a simultaneous determination of the fragment positions in the detector plane by coincidence imaging. This enables advanced investigations of the final state branching ratios into the different fragmentation channels, the excitation of the molecular fragments and the dissociation kinematics.

Utilizing the capability of the EMU detector a storage-ring experiment on the dissociative recombination of DCO^+ has been performed applying the merged beam technique provided by the Test Storage Ring (TSR) at the Max Planck Institute for Nuclear Physics.

MS 2.4 Mo 17:45 F 428

Exploring superconducting detectors for neutral nanoparticles — •Michele Sclafani[1], Markus Marksteiner[1], Philipp Haslinger[1], Hendrik Hulbricht[1], Markus Arndt[1], Alexander Divochiy[2], Alexander Korneev[2], and Gregory Gol'tsman[2] — [1]Faculty of Physics, University of Vienna, Boltzmanngasse 5, 1090 Vienna, Austria — [2]Department of Physics, Moscow State Pedagogical University, M. Pirogovskaya Street 1, Moscow 119992, Russia

We present the first experimental evidence for the successful detection of neutral nanoparticle beams using Superconducting Single Photon Detectors (SSPD). The detection process relies on the formation of an impact-induced hot spot on a nanostructured superconducting NbN film. When the critical current density is exceeded a measurable resistance builds up across the film and a short voltage peak (20 ns) can be measured. We test the detector with a beam of laser-desorbed and jet-cooled biomolecules. For tryptophan (204 Da) and gramicidin (1884 Da) the arrival time distributions are in agreement with those observed with in VUV-postionization/time-of-flight mass spectrometry. We also observe signals for larger biological molecules such as insulin (ca. 6 kDa), myoglobin (ca. 17 kDa) and hemoglobin (ca. 64 kDa), which still have to be confirmed by independent methods, as photo-ionization does not succeed for these species. We suggest that further developments can turn SSPD chips into devices that may help us overcome current mass limitations in a variety of beam experiments with neutral molecules. We also discuss the options for matter wave interferometry to characterize and finally use SSPD detectors.

MS 2.5 Mo 18:00 F 428

Marker bands for four-coordinate Fe(III)-heme proteins from absorption spectra of isolated chromophore ions in vacuo — •Jean Wyer — Department of Physics and Astronomy, Aarhus University

Heme proteins are ubiquitous in nature and are responsible for key biological. They are reddish-brown due to the presence of a heme group that is a porphyrin with an iron atom located in the centre. Electronic spectroscopy is used extensively to obtain detailed information on heme proteins such as conformation and dynamics. Importantly, spectral features depend on e.g. the iron oxidation state, axial ligands, and nearby amino acid residues. Often heme is located in hydrophobic protein pockets or crevices with minimal access to water. These pockets are in certain cases well simulated by a vacuum. It requires gas-phase experiments to establish the influence of a nearby environment, determined by the protein folding state. Conventional spectroscopic characterisations of Fe(III)-heme are hampered by the strong affinity of Fe(III) for water and anions. In this talk I will present the first unequivocal spectroscopic characterisation of isolated Fe(III)-heme ions and Fe(III)-heme-histidine complexes. Ions were generated by electrospray ionisation, stored in a pretrap, accelerated to keV energies and injected into the electrostatic ion storage ring in Aarhus, ELISA. Here they were irradiated by visible light. Based on the yield of photoproducts and the lifetimes with respect to dissociation, absorption spectra were obtained. The data are useful in bioanalytical chemistry and for benchmarking quantum mechanical calculations.

MS 2.6 Mo 18:15 F 428

Probing the exotic metastable states of D_2^- at ELISA — •Lutz Lammich, Lars H. Andersen, Aravind Gopalan, and Henrik B. Pedersen — Department of Physics and Astronomy, Aarhus University, Denmark

The rovibrational states of the metastable anionic hydrogen molecule D_2^- were studied in photofragmentation experiments at 532 nm employing a fast (keV) ion beam [1]. By a 3D fragment momentum imaging technique, the photodetachment and the dissociation of the system into neutral atoms was investigated. Employing the electrostatic ion storage ring Aarhus (ELISA) these studies could be performed at different times after production of the molecular ions and thus for different relative populations of their metastable states. The present data are sensitive to both the rotational states and the vibrational wave

functions of the anions, and suggest that the level of rotational excitation, while still exceptionally high, is somewhat lower than estimated in recent theoretical predictions.

[1] L. Lammich, L.H. Andersen, G. Aravind and H.B. Pedersen, *Phys. Rev. A* **80**, 023413 (2009)

MS 2.7 Mo 18:30 F 428

Mass Selective Acceleration at the Test Storage Ring — •Felix Laux[1], Robin Bastert[1], Henrik Buhr[2], Manfred Grieser[1], Claude Krantz[1], Mario Mendes[1], Andreas Wolf[1], and Klaus Blaum[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg — [2]Weizmann Institute of Science, Rehovot, Israel

The Test Storage Ring (TSR) at the Max-Planck-Institut für Kernphysik in Heidelberg has recently been successfully used for mass selective acceleration. This newly developed method renders the possibility of effective separation of ion species with small relative mass differences. We report on an experiment in which we were able to separate the desired $DCND^+$ from nearly isobaric N_2D^+ and DCO^+ with mass selective acceleration, although the relative mass differences of the two neighbouring species are as small as $\Delta m/m \sim 4 \cdot 10^{-4}$. The composition of the accelerated beam was analyzed by collisional fragmentation measurements.

MS 2.8 Mo 18:45 F 428

Das CSR Projekt — •Florian Fellenberger, Klaus Blaum, Michael Froese, Manfred Grieser, Robert von Hahn, Dirk Kaiser, Michael Lange, Felix Laux, Sebastian Menk, Roland Repnow, Andrey Schornikov und Andreas Wolf — Max-Planck-Institut für Kernphysik

Am Max-Planck-Institut für Kernphysik in Heidelberg wird derzeit ein kryogener elektrostatischer Speicherring (CSR) aufgebaut, mit dem Experimente mit niederenergetischen Ionen (20-300keV pro Ladungszustand) geplant sind. Der Ring besitzt eine große Akzeptanz (±40mm) und ermöglicht die Elektronenkühlung niederenergetischer Ionenstrahlen. Die Vakuumkammern werden auf Temperaturen von unter 10K gekühlt, was es ermöglicht, ein Vakuum unter 10^{-13}mbar und damit lange Speicherzeiten für langsame Ionenstrahlen zu erreichen. Die Kühlung ermöglicht es auch, die Anregung innerer Schwingungs- und Rotationszustände durch Wärmestrahlung zu unterdrücken. Erste Tests mit einem Prototypen (CTF) haben gezeigt, dass die geplanten Anforderungen an Kammertemperaturen und Vakuum zu erreichen sind, so dass mit dem Aufbau des CSR begonnen werden konnte.