SYIB 2: Fast Ion Beams in Nuclear, Atomic and Molecular Physics Research II

Time: Tuesday 14:00–16:00 Location: V55.22

Invited Talk SYIB 2.1 Tue 14:00 V55.22

Ion induced fragmentation of large (bio)molecules — •Thomas Schlathölter — KVI Atomic and Molecular Physics, University of Groningen , Zernikelaan 25, 9747AA Groningen, The Netherlands

The advantage of fast ions for cancer therapy lies in their unique dose-distribution in human tissue. At a well-defined depth ions are slowed down to MeV energies and cell killing is most effective due to maximum linear energy transfer and radiobiological effectiveness. Such volume sensitivity renders ion-therapy a superior tool for a number of localized tumors, in some cases decreasing the yearly risk of radiation induced development of lethal secondary tumors by up to one order of magnitude! To date, many molecular mechanisms underlying biological radiation action remain unclear and particularly the exceptional cell killing efficiency of heavy ions and protons is largely unexplored on the molecular level. In this talk I will show that ion collisions with gas phase DNA, proteins and their building blocks are an excellent approach to study molecular mechanisms underlying ion-therapy. Controlled attachment of water molecules even allows to study solvation effects on ion induced fragmentation in the gas-phase.

Invited Talk SYIB 2.2 Tue 14:30 V55.22

Using femtosecond lasers for determining the structure and dynamics of complex molecules — •Jason Greenwood — Centre for Plasma Physics, Queen's University Belfast, Belfast, UK

Ultrashort laser pulses are powerful tools with which to probe matter since their spectral, phase and polarisation parameters can to a degree be controlled. This has led to the field of attoscience where we now are on the cusp of observing electronic motion in matter. Biomolecules are one area where ultrafast phenomena are increasingly being recognised as central to biological processes such as photosynthesis, vision, and DNA damage and repair. To probe the fundamental of such dynamics and compare with theoretical models, it is necessary to study these molecules in the gas phase and to be able to mass analyse these systems which may have very high masses. In this talk I will describe an instrument which uses a laser induced acoustic desorption process to volatilise some simple biomolecular building blocks, ionise and fragment them with a femtosecond laser, and mass analyse the resulting ions. Our instrument can use either conventional time of flight or for very heavy masses a novel, very high resolution electrostatic ion trap mass spectrometer. The potential for using femtosecond lasers as ion sources for sensitive gas analysis and in determining the structural and dynamic properties of biomolecules will be discussed.

Invited Talk SYIB 2.3 Tue 15:00 V55.22

Fast beam momentum spectroscopy on XUV excited molecular ions — •Henrik Pedersen — Department of Physics and Astronomy, Aarhus University, Denmark

Dynamics of highly excited molecular ions reached by XUV-photoabsorption has been a main field of research at the Free-electron LASer in Hamburg FLASH. XUV photoinduced processes in molecular ions are relevant both for understanding molecular dynamics in simple model systems, for characterizing processes in ionized gas-phase media, e.g. in astrophysical plasmas and outer planetary atmospheres, as well as for describing ionic states in liquid media. In the presentation, we will exemplify the new possibilities for studies of molecular ions using FELs by recent results from the TIFF (Trapped Ion Fragmentation with an FEL) experiment at FLASH. For the simplest water cluster cations, $H^+(H_2O)_{n=1-4}$, the dominating photoionization and -dissociation channels have been clarified among numerous possibilities and revealed interesting trends in the product branching ratios for dissociative photoionization with cluster size. Finally, we will give some perspectives for further developments when FELs and synchrotron radiation facilities are combined with methods based on accelerated, stored, and cooled ion beams.

Invited Talk SYIB 2.4 Tue 15:30 V55.22

Electron Emission from Hot Stored Molecular and Cluster Anions — •Michael Lange[1], Klaus Blaum[1], Christian Breitenfeldt[1,2], Michael Froese[1], Sebastian Menk[1], Andreas Wolf[1], Swarup Das[3], and Manas Mukherjee[3] — [1]Max-Planck-Institut für Kernphysik, Heidelberg — [2]Physikalisches Institut, Ernst-Moritz-Arndt-Universität Greifswald — [3]Raman Center for Atomic Molecular & Optical Science, Kolkata

Electron emission from excited molecular or cluster anions has been extensively studied in both ion storage rings and traps, which because of the long observation times are ideal tools for such investigations. For a variety of molecular and cluster anions a power law decay was found over a long time interval, followed by a reduction in rate often attributed to radiative quenching. However, evidence for this interpretation has remained circumstantial.

Our cryogenic electrostatic ion beam trap affords a very low residual gas density and, hence, a significant reduction of residual gas-related background in the measured decay rates. This has enabled us to observe the expected deviation from the power law in the decay of SF_6^- for the first time. Using a statistical rate model we found that this feature can be well reproduced by assuming a sizeable rotational excitation of the anions, which so far has not been fully considered in experiments. Further evidence was found in an experiment on aluminum clusters with $3 \ldots 7$ atoms where after the initial power-law decay and steep decline in rate a second, weaker power-law phase was found that is not readily explained from decay models including radiative relaxation.