MO 8: Experimental Techniques

Time: Tuesday 11:00–13:00 Location: f142

MO 8.1 Tue 11:00 f142

Toward electron diffraction off controlled molecules — •Nele L. M. Müller[1], Sebastian Trippel[1], Karol Długołęcki[1], and Jochen Küpper[1,2,3] — [1]Center for Free-Electron Laser Science, DESY, Hamburg — [2]The Hamburg Center for Ultrafast Imaging, Hamburg — [3]Department of Physics, University of Hamburg

The aim of this work is to investigate the structure and intrinsic dynamics of small molecules in the gas-phase by electron diffraction. Controlling the molecules' state and spatial orientation will allow to enhance the information retrieved from diffraction data, such as bond length and angles [1]. This contribution details the setup consisting of an electron gun and a controlled-molecules apparatus [2,3,4]. It allows for laser- and electron-interaction with the state-selected and laser-aligned molecules. Apart from recording electron diffraction patterns, the new setup allows for imaging the spatial orientation of molecules through ion Velocity-Map Imaging. Characterizing experiments and electron diffraction data of isotropic gas-phase samples will be presented.

[1] Hensley, Yang, Centurion, *Phys. Rev. Lett.* **109**, 133202 (2012)
[2] Müller, Trippel, Długołęcki, Küpper, *J. Phys. B* **48**, 244001 (2015)
[3] Trippel, Mullins, Müller, Kienitz, Długołęcki, Küpper, *Mol. Phys.* **111**, 1738 (2013)
[4] Chang, Horke, Trippel, Küpper, *Int. Rev. Phys. Chem.* **34**, 557 (2015)

MO 8.2 Tue 11:15 f142

Optical cell transfection platform — •Hans Georg Breunig[1], Ana Batista[2], Aisada Uchugonova[1,2], and Karsten König[1,2] — [1]JenLab GmbH, Science Park 2, 66123 Saarbrücken, Germany and Schillerstr. 1, 07745 Jena, Germany — [2]Department of Biophotonics and Laser Technology, Saarland University, 66123 Saarbrücken, Germany

Cells can be transfected by transient laser-induced perforation of the cell membrane which allows foreign genetic material to enter the cell interior. This method (optoporation) has emerged as a powerful non-invasive and highly efficient cell-transfection technique. We present an experimental platform based on a modified multiphoton laser scanning microscope employing a femtosecond laser, beam shaping, and custom-made control software for computer-automated cell optoporation. The software evaluates the image contrast due to cell contours, automatically designates cell locations for laser illumination, centres those locations in the laser focus (Gaussian or Bessel beam profile), and executes the illumination. By software-controlled meandering of the sample stage, in principle all cells in a typical cell culture dish can be targeted without further user interaction. For an illumination duration of 100 ms, 7-8 positions on different cells can be targeted every second. Ultra-short fs pulses are in particular efficient for the optoporation due to underlying multiphoton absorption processes. The experimental capabilities of the setup are illustrated in experiments with Chinese hamster ovary cells. Furthermore, the influence of laser characteristics on the optoporation efficiency is discussed.

MO 8.3 Tue 11:30 f142

Piezo-electric detection of a pulsed supersonic beam — •Wolfgang Christen[1], Paul Saftien[1], and Karsten Lange[2] — [1]Humboldt-Universität zu Berlin, Institut für Chemie, Brook-Taylor-Str. 2, 12489 Berlin — [2]Sensor- und Lasertechnik, Schulstr. 15, 15366 Neuenhagen

Supersonic molecular beams obtained by the adiabatic expansion of a gas under high pressure into vacuum constitute a powerful and versatile technique in modern physics, with applications in analytical chemistry, cluster science, metrology, optical spectroscopy, quantum physics, and surface science. Accordingly, various techniques have been developed for beam detection, with each method providing characteristic features.

Here we report on the development of a piezo-electric based detection of pulsed supersonic beams in an ultrahigh vacuum environment. Key benefits of this technique are a fast detector response and the fact that no ionisation is required. Besides characteristic features of the detection we present first experimental results for supersonic beams of helium, argon, and carbon dioxide, in a wide range of source conditions (source pressures between 5 and 120 bar, source temperatures between −40 and 110 °C).

MO 8.4 Tue 11:45 f142

Enhancement of CARS signal via tailored probing in spectral focusing — •Lukas Brückner, Tiago Buckup, and Marcus Motzkus — Physikalisch-chemisches Institut, Universität Heidelberg, Germany

In the framework of coherent anti-Stokes Raman scattering (CARS), applying the same chirp to pump and Stokes frequencies allows for focusing most of the spectral amplitude into one specific Raman line. Here, a novel approach for spectral focusing using a broadband oscillator in combination with a pulse shaper controlling phase and amplitude is presented. The flexibility of the single-beam setup allows for variable and fast adjustment of the instantaneous bandwidth to the linewidths of different Raman levels throughout the spectrum. Furthermore, by identifying the frequencies acting as pump, Stokes and probe, the high degree of control can be exploited in order to specifically and independently tailor the spectral region acting only as probe to achieve the highest signal intensity. While maintaining optimal excitation of the vibrational coherence, a significant increase in comparison with usual spectral focusing schemes is readily obtained without even nearly maxing out the applicable power of the probe before photo-damage can be observed. The signal improvement and contrast is demonstrated by imaging the lipid distribution of human skin tissue.

[1] L. Brückner, T. Buckup and M. Motzkus, Opt. Lett. 22, 5204-5207 (2015)

MO 8.5 Tue 12:00 f142

Investigation of the chemical enhancement contribution to SERS using a Kretschmann arrangement — •Faezeh Mohaghegh, Alireza Mazaheri Tehrani, and Arnulf Materny — Physics and Earth Sciences, Jacobs University Bremen, Campus Ring 1, 28759 Bremen

The fundamental enhancement mechanisms of SERS are the so-called electromagnetic enhancement (EM) caused by surface plasmon polaritons (SPPs) and a chemical enhancement (CE) resulting from the change of the molecule' electronic structure when adsorbed on the metal surface.

In our work, we use a Kretschmann arrangement (KC), which allows for the study of the SERS effect using reproducible flat metal surfaces as SERS substrates. Dye molecules are used as adsorbates. The experiment has been optimized to achieve reproducible conditions. Within the experiment a decaying behavior of the Raman line intensities has been observed and analyzed. SERS spectra were obtained excluding the contribution of this deactivation process for different angles of incidence of the exciting laser beam. The Raman deactivation rate was found to be different for different vibrational modes where high-energy vibrations showed slower decay than the group of low-energy modes. The variation of the surface plasmon excitation in the thin silver film coated onto the prism surface of the KC resulted in drastically different relative enhancements of the different Raman modes pointing to a dominating contribution of the chemical enhancement mechanism in the single-layer SERS experiment.

MO 8.6 Tue 12:15 f142

A new laser desorption source for controlled molecule imaging — •Nicole Teschmit[1], Daniel Horke[1], Karol Długołęcki[1], Daniel Gusa[1], and Jochen Küpper[1,2,3] — [1]Center for Free-Electron Laser Science, DESY, Hamburg — [2]The Hamburg Center for Ultrafast Imaging, Hamburg — [3]Department of Physics, University of Hamburg

Control methodologies for neutral molecules allow for, e.g., the separation of different conformers, the alignment and orientation of molecules in space, and the separation of different quantum states or clusters, by using static and/or dynamic electric fields [1]. Such controlled molecules are ideal targets to gain structural and dynamic information with Coulomb explosion and diffractive imaging measurements [2].

Here, we present a new laser-desorption setup for the production of very cold molecules that will allow for the above mentioned control experiments. Large biological molecules will be vaporized and, subsequently, cooled by entrainment in supersonic noble gas beams. We present characterisation measurements of the created molecular beam and a quantitative comparison to other vaporisation methods such as

laser induced acoustic desorption and thermal vaporisation.

[1] Y.-P. Chang et al, Int. Rev. Phys. Chem. 34, 557 (2015)
[2] J. Küpper et al, Phys. Rev. Lett. 112, 083002 (2014)

MO 8.7 Tue 12:30 f142

The Structure of Water under Extreme Conditions — •Hendrik Vondracek, Lukas Knake, and Martina Havenith — Ruhr-Universität Bochum, LS Physikalische Chemie II, Bochum, Deutschland.

Studies of water under extreme conditions (high and low temperatures, extreme pressures) are of particular scientific interest. Understanding the properties of water under extreme conditions is not only a fundamental prerequisite for a better understanding of geological and biological processes and the exploitation of various technical applications, but is also widely believed to be fundamental for a deeper understanding of the structure of water under ambient conditions.[1] Under high pressures and temperatures to the supercritical regime, the structure of water and the hydrogen bond network show peculiar features, e.g. clustering.[2]

THz spectroscopy is an ideal tool to study the structural properties of water as it allows for a direct study of the intermolecular hydrogen-bond network. The principle of this spectroscopic technique and specific experimental challenges will be explained. Furthermore, first results of spectroscopic measurements of water under high pressure conditions will be presented.

[1] A. Nilsson, L.G.M. Pettersson - Perspective on the structure of liquid water - Chem. Phys., 389,1-34 (2011). [2] Q. Sun, Q. Wang and D. Ding - Hydrogen Bonded Networks in Supercritical Water - J. Phys. Chem. B, 118, 11253-11258 (2014).

MO 8.8 Tue 12:45 f142

High resolution IR-spectroscopy based on Synchrotron radiation — •Pia Kutzer[1], Olivier Pirali[2], and Thomas Giesen[1] — [1]Universität Kassel, Institut für Physik, Heinrich-Plett Str. 40, D-34132 — [2]Société civile Synchrotron SOLEIL, L'Orme des Merisiers, Saint-Aubin - BP 48, F-91192 Gif Sur Yvette Cedex

The AILES beam line at SOLEIL Synchrotron facility is dedicated to a spectral range between 8 and 1500 cm^{-1} with a maximum resolution of 0.0008 cm^{-1}. Together with a multi-pass White cell this allows high resolution Fourier transform spectroscopy with a long absorption pathlength up to 150 m with a very sufficient sensitivity.

This spectrometer is very useful for studies on stable molecules like eg. Dimethyl-Ether (DME) as well as for instable radicals. Especially its use for investigation of astrophysical molecules is of relevance in the interpretation of astrophysical spectra.

Here we present our results on astrophysically relevant DME isotopologues as well as on Tert-buthyl-Phosphor-di-Bromide (PBr-tBu) a chiral molecule which has been studied for the first time by means of spectroscopy.

We recorded first infrared broadband spectra of PBr-tBu in the region of 100 cm^{-1} to 650 cm^{-1} at AILES beamline and also high resolution broadband spectra of singly and doubly ^{13}C substituted DME in the region of 70 cm^{-1} to 500 cm^{-1}.

Here we show our results on the vibrational bands of PBr-tBu and also on the C-O-C bending mode of DME isotopologues.