

MO 7: Ion Traps, Molecules, Clusters, Decay and Reactions

Time: Tuesday 11:00–13:00

Location: PH/HS2

Invited Talk

MO 7.1 Tue 11:00 PH/HS2

Direct search for the neutrino mass: the KATRIN experiment — ●CHRISTIAN WEINHEIMER for the KATRIN-Collaboration — Westfälische Wilhelms-Universität Münster

Since the discovery of neutrino oscillations we know that neutrinos have non-zero masses, but the absolute neutrino mass scale is still unknown. The knowledge of the neutrino masses is very important for astrophysics and cosmology as well as for nuclear and particle physics.

With the KARlsruhe TRitium Neutrino experiment KATRIN we directly search for the neutrino mass by investigating the endpoint region of the tritium beta decay spectrum at 18.6 keV with ultra-high precision and sensitivity. This method is complementary to the search for neutrinoless double beta-decay and analyses of cosmological data.

The KATRIN experiment, which is being set up at Karlsruhe Institute for Technology, will improve the sensitivity of direct neutrino mass experiments by one order of magnitude down to 200 meV/c². The apparatus consists of a windowless gaseous tritium source, a beta electron transport and tritium elimination system based on differential and cryogenic pumping, and a doublet of electron spectrometers of MAC-E-Filter type followed by an electron detector. Its high sensitivity requires KATRIN to be technically very demanding and to drive several technologies to the extreme.

Currently the KATRIN spectrometer and detector system (SDS) is being commissioned. In this talk the status of the KATRIN experiment and the recent SDS commissioning measurements will be presented.

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MO 7.2 Tue 11:30 PH/HS2

Auf dem Weg zum FT-ICR Nachweis mehrfach negativ geladener Clusterionen — STEFFI BANDELOW¹, FRANKLIN MARTINEZ², GERRIT MARX¹, LUTZ SCHWEIKHARD¹ und ●ALBERT VASS¹ — ¹Institut für Physik, Ernst-Moritz-Arndt Universität, 17487 Greifswald, Deutschland — ²Institut für Physik, Universität Rostock, 18055 Rostock, Deutschland

Durch die gleichzeitige Speicherung von Elektronen und Monoanionen in einer Penningfalle werden bis zu 10fach negativ geladene Metallcluster erzeugt, wobei der erreichbare Ladungszustand mit der Clustergröße steigt [1]. Die in den bisherigen Experimenten verwendete Flugzeit (ToF)-Methode ermöglicht zwar die Detektion sehr weniger Ionen, ist aber ein destruktiver Nachweis. Außerdem begrenzt das ToF-Massenaufklärungsvermögen die Identifikation der größeren Clusterpolyanionen.

In einem alternativen Ansatz soll ein Fouriertransformations-Ionenzyklotronresonanz-Nachweis (FT-ICR) implementiert werden. Hierbei werden die m/q -abhängigen Bewegungsfrequenzen der gespeicherten Ionen genutzt, deren Bildladungssignale auf den Elektroden der Penningfalle detektiert werden. Diese nichtdestruktive Methode besitzt eine größere Massenaufklärung, wenn auch bei geringerer Nachweisempfindlichkeit. Im Beitrag wird auf die Implementierung der FT-ICR-Detektion zum Nachweis mehrfach negativ geladener Cluster eingegangen und es werden erste Messergebnisse präsentiert.

[1] F. Martinez et al., Int. J. Mass Spectrom. 365-366 (2014) 266.

MO 7.3 Tue 11:45 PH/HS2

New setup to study the reactivity of metal clusters in the gas phase — ●DANIEL NEUWIRTH¹, JAN ECKHARD¹, KATHRIN LANGE¹, BRADLEY VISSER², MARTIN TSCHURL¹, and UELI HEIZ¹ — ¹Lehrstuhl für Physikalische Chemie & Catalysis Research Center, Chemistry Department, Technische Universität München, Lichtenbergstraße 4, 85748 Garching bei München, Germany — ²Paul-Scherrer Institute, 5232 Villigen PSI, Switzerland

Many properties of metal clusters differ significantly from the properties of the bulk material. For example the reactivity of such clusters depends often on charge and size. Within our group we want to investigate reactions of metal clusters with various molecules in the gas phase. Therefore clusters are produced with a laser-vaporization-cluster-source, size-selected with a quadrupole mass filter and stored within a ring electrode ion trap. The trap is filled with a buffer gas, consequently clusters and reaction products are constantly thermalized. The special geometry of the trap allows the controlled ejection of the reaction products into a reflectron mass spectrometer. As reaction time, temperature and concentration of the reactive gas can be varied,

the kinetics of the reaction can be determined. First results of this experimental setup will be presented.

MO 7.4 Tue 12:00 PH/HS2

Polyanionische Metallcluster — ●STEFFI BANDELOW¹, FRANKLIN MARTINEZ², GERRIT MARX¹, LUTZ SCHWEIKHARD¹ und ALBERT VASS¹ — ¹Institut für Physik, Ernst-Moritz-Arndt Universität, 17487 Greifswald, Deutschland — ²Institut für Physik, Universität Rostock, 18055 Rostock, Deutschland

Ionenfallen haben sich als vielfältiges Instrument zur Untersuchung gespeicherter atomarer Cluster etabliert. Sie ermöglichen die Beobachtung zeitlich ausgedehnter Wechselwirkungen gröÙenselektierter Cluster mit Elektronen, Laserstrahlung, Neutralgas oder anderen Ionen. Insbesondere eignen sie sich zur Erzeugung mehrfach negativ geladener Cluster durch Elektronenanlagerung an niedrigere Ladungszustände (z.B. Monoanionen). Die Techniken zur Polyanionenproduktion in Penningfallen und in digital betriebenen Paulfallen werden erläutert [1,2]. Für Gold- und Aluminiumcluster werden Messungen zur Auftretshäufigkeit höherer Ladungszustände als Funktion der Clustergröße und Cluster-Elektronen-Interaktionszeit diskutiert. Darüber hinaus werden Ansätze zur theoretischen Beschreibung der Stabilität polyanionischer Metallcluster bezüglich Elektronenemission vorgestellt.

[1] F. Martinez et al., Int. J. Mass Spectrom. 365-366 (2014) 266.

[2] S. Bandelow et al., Int. J. Mass Spectrom. 353 (2013) 49.

MO 7.5 Tue 12:15 PH/HS2

Cryo kinetics of size selected cobalt clusters — ●JENNIFER MOHRBACH, SEBASTIAN DILLINGER, and GEREON NIEDNER-SCHATTEBURG — Fachbereich Chemie und Forschungszentrum OPTIMAS, Technische Universität Kaiserslautern, 67663 Kaiserslautern, Germany

A customized Fourier Transform Ion Cyclotron Resonance (FT-ICR) mass spectrometer served to investigate the kinetics of nitrogen adsorption on size selected cobalt cluster cations (Co_n^+ , $9 < n < 29$) at well-defined cryo temperatures. Our setup combines a hexapole ion trap for kinetic studies with a FT-ICR cell for Infrared Multiple Photon Dissociation (IRMPD) studies and mass analysis. Both ion traps are cryogenically cooled to temperatures below 30 K. We have conducted kinetic studies to determine the rates and numbers of the N_2 adsorption to the respective cobalt clusters. Furthermore we have performed IR(M)PD spectroscopy in the N-N stretching frequency range of the adsorbed nitrogen to gain insight into its binding motifs on the cluster and the structure of the cobalt clusters themselves.

MO 7.6 Tue 12:30 PH/HS2

Size-dependent gas phase reactivity of tantalum cluster cations with small alcohols — ●JAN ECKHARD¹, DANIEL NEUWIRTH¹, KATHRIN LANGE¹, BRADLEY VISSER², MARTIN TSCHURL¹, and UELI HEIZ¹ — ¹Lehrstuhl für Physikalische Chemie & Catalysis Research Center, Chemistry Department, Technische Universität München, Lichtenbergstraße 4, 85748 Garching bei München, Germany — ²Paul-Scherrer Institute, 5232 Villigen PSI, Switzerland

As the properties of metal clusters may change vastly as a function of cluster size, their study is a model approach to find and tune catalysts for use in specific reactions. The detailed investigation of metal clusters is facilitated in the gas phase. As a result, we found a strong size dependence for the reactivity of tantalum cluster cations with small alcohol molecules. The clusters were produced in the gas phase by laser vaporization; various alcohols (methanol, ethanol, n-propanol and 2-propanol) were consecutively added to the cluster beam in a pulsed jet and allowed to react to an extent of conversion of approximately 50 %. The charged reaction products were subsequently measured using time-of-flight mass spectrometry. Two distinct reaction pathways were observed, involving complete dehydrogenation or OH abstraction from the alcohol molecule. The relative total reaction yield was found to not vary significantly within the cluster size regime studied. The branching ratios for the reaction demonstrated a cluster-size dependence, with a minimum of OH abstraction occurring for a cluster size of 7 atoms.

MO 7.7 Tue 12:45 PH/HS2

Slow molecular beams of biochromophores via laser induced acoustic desorption — ●UGUR SEZER¹, LISA WÖRNER¹, CHRISTOPH

GÖTZ², ALIPASHA VAZIRI², and MARKUS ARNDT¹ — ¹University of Vienna, Faculty of Physics, VCQ and QuNaBioS, Boltzmannngasse 5, 1090 Vienna, Austria — ²University of Vienna, Max F. Perutz Laboratories; Research Institute of Molecular Pathology; QuNaBioS, Doktor-Bohr-Gasse 7, 1030 Vienna, Austria.

A beam of intact, neutral, and slow molecules is an essential criterion for experiments in physical chemistry and quantum optics, such as deflectometry and matter-wave interferometry[1]. Different molecular beam methods have been developed over recent years, among them thermal beams of functionalized molecules[2], free laser desorption[3] or supersonic expansion of laser desorbed molecules[4].

In this work we show that beams of intact, neutral, biologically rel-

evant chromophores, such as chlorophyll a and hemin can be launched in high vacuum with mean velocities as low as 45 m/s with minimal fragmentation. The molecules are volatilized via laser-induced acoustic desorption[5], photoionized with lasers light at 157 nm or 266 nm, and detected in time-of-flight mass spectrometry. We present mass spectra, desorption and photoionization efficiencies as well as velocity distributions and discuss possible applications.

[1] K. Hornberger et al. *Rev. Mod. Phys.* 2012, 84. [2] S. Eibenberger et al. *Phys. Chem. Chem. Phys.* 2013, 15. [3] P. Schmid et al. *J. Am. Soc. Mass. Spectrom.* 2013, 24. [4] M.-H. Ha-Thi et al. *Phys. Chem. Chem. Phys.* 2010, 12. [5] A.V. Zinovev et al. *Anal. Chem.* 2007, 79.