

**Seminar Series of the
CENTRE FOR RESEARCH IN MOLECULAR MODELING**

May 20, 2014, 2:00 PM – SP-S185.11

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Electron induced chemistry in water clusters

Electrons solvated with water molecules in the gas phase not only exhibit interesting dynamics [1], but also a rich and multifaceted chemistry with small molecules. These fundamental chemical reactions can be studied by Fourier transform ion cyclotron resonance (FT-ICR) mass spectrometry [2].

Examples of one electron reductions include the first step of the Birch reduction, observed for di- and trifluorobenzene [3], competing with electron induced cleavage of the C-F bond. Electron induced bond cleavage is also observed with methyl mercaptane CH_3SH and dimethyldisulfide CH_3SSCH_3 [4]. The products, however, differ from the reactions with bulk hydrated electrons, presumably due to the reduced cage effect in gas phase clusters.

Many molecules, e.g. O_2 and CO_2 , simply form hydrated radical anions. In these cases it is particularly interesting to analyze the thermochemistry of the reaction with nanocalorimetry [5]. These data in turn yield access to the hydration enthalpy of the radical anion in bulk solution. Hydrated electrons are not only destructive. They may also induce oligomerization reactions, e.g. with acrylic acid, or the formation of five membered rings in the case of methyl acrylate [6]. The complex reaction sequence of the latter reaction only became evident through the high mass resolution of the FT-ICR technique.

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[3] R.F. Höckendorf, O.P. Balaj, M.K. Beyer, Phys. Chem. Chem. Phys. 13 (2011) 8924.

[4] R.F. Höckendorf, Q. Hao, Z. Sun, B.S. Fox-Beyer, Y. Cao, O.P. Balaj, V.E. Bondybey, C.-K. Siu, M.K. Beyer, J. Phys. Chem. A 116 (2012) 3824.

[5] R.F. Höckendorf, C. van der Linde, O.P. Balaj, M.K. Beyer, Phys. Chem. Chem. Phys. 12 (2010) 3772.

[6] K.P. Jäger, R.F. Höckendorf, M.K. Beyer, Int. J. Mass Spectrom. 330/332 (2012) 246.



Martin Beyer studied physics at Technical University of Munich, where he did his diploma thesis and PhD work with Vladimir Bondybey, graduating 1999. After post-doctoral research at UC Berkeley, working with Richard Saykally and Julie Leary, he returned to TU Munich for his habilitation, which he finished in 2004. In 2005, he moved to TU Berlin, to work in the organic chemistry department as an associate of Helmut Schwarz. In 2007, he was appointed professor for physical chemistry at Kiel University. In 2008, he received an offer for a professor position at the Centre for Research in Mass Spectrometry at York University, Toronto, but decided to stay in Kiel. Since October 2013, Martin Beyer is professor at the Institute for Ion Physics and Applied Physics at the University of Innsbruck. His research group works on gas phase reactions of solvated ions and clusters, and single-molecule force spectroscopy of mechanochemical reactions. Martin Beyer received a Feodor Lynen fellowship from the Alexander von

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