

STAND-ALONE PROJECT - FINAL REPORT

Project number P18804

Project title Bindungs- und temperaturabhängige Elektronenanlagerung

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Project website¹ <http://www.uibk.ac.at/ionen-angewandte-physik/nanobio/fwf-p18804/>

Part 1 of the project report is intended for interested members of the public; **parts 2-4** are addressed to reviewers and must be submitted in the language of the original application.

Part 5 provides an opportunity to report to the FWF on interactions with the administration during the course of the project.

The complete report must be submitted in hardcopy and on electronic medium (CD or floppy disc) in Word for Windows format. Guidelines and forms for the final report can be downloaded from the FWF web site

(<http://www.fwf.ac.at/de/faq/einzelprojekte/evaluierung.html>)

¹ Projects that started after 01.01.2009 are required to have a website

1. Summary for public relations work

Die nichtelastische Wechselwirkung von langsamen Elektronen mit Molekülen führt oftmals zur Bildung negativ geladener Ionen. In vielen Anwendungsgebieten ist dieser Prozess von entscheidender Relevanz, wie zum Beispiel in der Strahlenphysik, Umweltphysik und technischen Plasmaphysik. Darüber hinaus spielen diese Prozesse auch eine wichtige Rolle in der Synthese und dem Abbau von Molekülen in interstellaren Wolken. 2005 konnten Experimente in Innsbruck erstmals zeigen, dass langsame Elektronen in der Lage sind durch geeignete Wahl ihrer kinetischen Energie, gezielt Bindungen in komplexen (Bio-)Molekülen zu brechen. Neben der kinetischen Energie der Elektronen spielt aber auch die innere Energie der Moleküle eine wichtige Rolle bei der Erzeugung negativ geladener Ionen und speziell auch bei der Bildung von anionischen Fragmenten.

Im vorliegenden Projekt wurden daher entsprechende umfangreiche Untersuchungen über die Elektronenanlagerung an Moleküle bei unterschiedlichen Temperaturen durchgeführt. Durch die Verwendung von Tröpfchen aus Helium und speziell entwickelten Öfen konnten Temperaturen von -272.8°C und 550°C erreicht werden. Bei den niedrigen Temperaturen befinden sich alle Moleküle in ihrem Schwingungsgrundzustand während für höhere Temperaturen schwingungsangeregte Moleküle eine wichtige Rolle spielen. Für halogenierte Kohlenwasserstoffe, die in der Umweltphysik von großer Bedeutung sind (Ozonabbau), wurde in den meisten Fällen eine Zunahme der Ionenausbeute bei hohen Molekültemperaturen und niedrigen Elektronenenergien beobachtet, während im Fall vom Sprengstoff Trinitrotoluol eine komplette Unterdrückung der Fragmentierung in Heliumtröpfchen beobachtet wurde. Die Untersuchungen wurden mit mehreren Apparaturen durchgeführt, die am Institut für Ionenphysik und Angewandte Physik in den letzten Jahren entwickelt wurden. Diese Apparaturen erlauben Untersuchungen mit hoher Energieauflösung, hoher Empfindlichkeit und großer Genauigkeit.

Es konnten im vorliegenden Projekt zahlreiche fundamentale Ergebnisse erhalten werden, die zu insgesamt 67 Publikationen, davon 44 Publikationen in den renommiertesten physikalischen (Phys.Rev.Letters, Phys. Chem. Chem. Phys.) und chemischen (Angewandte Chemie Int.Edition, J. Am. Chem. Soc., Chem. Eur. J., ChemPhysChem) Zeitschriften führten. Aufgrund der Relevanz und Bedeutung der Ergebnisse wurde der Projektleiter und Mitarbeiter insgesamt 30 mal eingeladen auf internationalen Tagungen über diese Resultate vorzutragen, außerdem gab es zahlreiche weitere Konferenzbeiträge.

Die Ergebnisse sind auch von praktischer Bedeutung und werden in der Radiotherapie, Fusionsforschung und den Materialwissenschaften benötigt.

Inelastic interaction of low-energy electrons with molecules often leads to the formation of negatively charged ions. This process is of fundamental relevance for several applied research areas, including radiation physics and chemistry, environmental physics and technical plasma physics. Furthermore, electron attachment plays an important role in the synthesis and destruction of molecules in dense interstellar clouds. In 2005 experiments in Innsbruck demonstrated for the first time that low-energy electrons can break selectively individual bonds in complex (bio-)molecules just by appropriate choice of their kinetic energy. Besides the kinetic energy of the electron also the internal energy of the molecule has a strong influence on the formation of negatively charged ions and, in particular, also on the subsequent fragmentation of these anions.

In the present project electron attachment to molecules at different temperatures was investigated in detail. Temperatures between 0.37K (inside helium nanodroplets) up to 820K (utilizing heated capillaries) were accessible. At the low end of this temperature range all molecules are in their vibrational ground state whereas at high temperatures vibrationally excited molecules play an important role. For most halogenated hydrocarbon molecules that are of relevance for the destruction of the ozone layer we observed a strong enhancement of the anion production at low electron energies for hot molecules. In the case of the explosive trinitrotoluene fragmentation upon electron attachment was completely quenched inside helium nanodroplets. Specially designed and costumes built instruments that were developed over the last years in our institute were utilized for the present investigations. These experimental setups allow investigations with high energy resolution, high sensitivity and good accuracy.

Several fundamental results could be obtained in the present project that were published in 67 papers, 44 of those in refereed papers, including the most relevant journals of physics (Phys. Rev. Letters, Phys. Chem. Chem. Phys.) and chemistry (Angew. Chem. Int. Ed., J. Am. Chem. Soc., Chem. Eur. J., ChemPhysChem). The principal investigator and his co-workers were invited to talk at 30 international conferences about the results obtained in this project, in addition numerous further conference contributions were presented.

Besides the academic interest the present results provide important input for applied topics such as radiotherapy and material technology.

2. Brief project report

2.1. Report on the scientific work

2.1.1 Information on the development of the research work

From the initially proposed list of halogenated hydrocarbon molecules only a fraction could be measured during the time of this project. Two scientific papers on these results have been published so far and another one will be submitted soon. The main reasons were experimental difficulties with the trochoidal electron monochromator instrument and the attached quadrupole mass filter. For more than one year no useful measurements could be obtained due to technical reasons mainly caused by the aggressiveness of the gases under study in the high resolution apparatus. However, interesting results on other molecules such as various explosives, on biomolecules and doped helium nanodroplets opened new perspectives that were followed along this project. The isothermal bath a He nanodroplet provides allows to quench all vibrational modes to the ground state at 0.37 K. These experiments nicely complement our measurements at elevated temperatures for the halogenated hydrocarbons where the effect of vibrational excitation on dissociative electron attachment is studied. Moreover, dissociative electron attachment to monomolecular explosives, like trinitrotoluene (P. Sulzer et al. *Int. J. Mass. Spectrom.* **272** (2008) 149), nitropenta (A. Edtbauer et al. *J. Chem. Phys.* **132** (2010) 134305) or royal demolition explosive (P. Sulzer et al. *J. Chem. Phys.* **131** (2009) 144304) provides a possibility to identify and analytical detect these substances. Delayed unimolecular fragmentation and electron attachment to He nanodroplets doped with these molecules provide important information on the molecular pathways of the ignition of an explosive.

2.1.2 most important results and brief description of their significance

Due the large number of successful investigations (resulting in 67 published papers) only the most pertinent results will be discussed here.

In extension to the earlier studies on site sensitivity of dissociative electron attachment low-energy electrons turn out to be a sensitive probe for isomeric versions of molecules. This could be demonstrated for mono- and di-nitrotoluene as well as di-nitrobenzene (P. Sulzer et al. *Anal. Chem.* **79** (2007) 6585, P. Sulzer et al. *Int. J. Mass. Spectrom.* **266** (2007) 138). In the case of nitroaromatic compounds that are used as volatile markers for non-volatile explosives dissociative electron attachment provides an interesting method to detect and identify high-energetic materials based on nitro-containing molecules. Utilizing a hemispherical electron monochromator having an energy spread of less than 100meV and a highly sensitive sector field mass spectrometer, a comprehensive study of the anion efficiency curves of product ions formed upon free electron attachment to several nitroaromatic compounds as well as the stability of the major anions was performed. Delayed unimolecular loss of NO was observed for the parent anions as well as some heavy fragment anions of nitroaromatic explosives. This reaction was triggered upon capture of a low-energy (close to zero eV) electron and the kinetic energy released in these decay reactions reached values of more than one eV.

Additionally electron attachment to trinitrotoluene (TNT) embedded in helium nanodroplets was investigated (A. Mauracher et al. *Phys. Chem. Chem. Phys.* **11** (2009) 8240). In contrast to free electron attachment to gas phase molecules of TNT where decomposition into a large number of fragment anions is observed already close to zero eV, exclusively non-decomposed complexes of the form $\text{He}_m\text{TNT}_n^-$ are identified upon electron attachment to doped helium nanodroplets. The complete freezing of dissociation intermediates in TNT embedded in the droplet is explained by the particular mechanisms of dissociative electron attachment in nitrobenzenes, which is characterized by complex rearrangement processes in the transient negative ion prior to decomposition. These mechanisms provide the condition for effective energy withdrawal from the metastable parent anion into the dissipative

environment, thereby completely suppressing its decomposition. In the case of the DNA base thymine and the methylated thymine anions, formed inside doped helium nanodroplets, were mass spectrometrically analyzed for the first time (S. Denifl et al. *Phys. Rev. Lett.* **97** (2006) 043201). Anions from several other molecules embedded in helium nanodroplets have been investigated in the mean time (see list of publications below). In contrast to free electron attachment to gas phase molecules often the non-fragmented parent anions are observed from the doped droplets. As in the case of TNT time consuming rearrangement processes prior to fragmentation are the reason for efficient energy dissipation into the surrounding helium matrix which leads to a complete quenching of these decay reactions. Loss of a neutral hydrogen atom requires only the cleavage of a single sigma bond and cannot be quenched by the helium. However, all lower mass fragment anions, including CNO^- which is the most abundant fragment upon electron attachment to gas phase thymine at electron energies above 3 eV, are not formed from doped helium nanodroplets. Instead the anion efficiency curve of the dehydrogenated closed-shell anion $[\text{T-H}]^-$ resembles the total anion efficiency curve for gas phase (S. Denifl et al. *ChemPhysChem* **9** (2008) 1387). Helium nanodroplets provide an unprecedented possibility to stabilize otherwise unstable reaction intermediates and to follow a molecular reaction process step by step. Furthermore, these results indicate that gas phase results may not be appropriate to explain corresponding processes in bulk or under salvation environment. In the case of radiation damage to organic tissue the effect of water surrounding the biomolecules should not be ignored and additional experiments with biomolecules embedded in water clusters are an important next step to understand radiation damage at the molecular level.

Another interesting possibility to be studied in helium nanodroplets are metastable structures of polar molecules. Long range electrostatic interaction between the dipoles of an additional molecule and a cluster of these molecules leads to a preferential orientation during the approach in the droplet. Miller and co-workers proofed spectroscopically the existence of dipolar chains of HCN and acetic acid. In the case of water such metastable neutral structures are the reason for the formation of $(\text{H}_2\text{O})_n^-$ anions with $n=3, 4$ and 5 (F. Zappa et al. *J. Am. Chem. Soc.* **130** (2008) 5573). By utilizing more than one pickup cell water clusters could be formed at the surface of cold fullerene molecules inside helium nanodroplets. Electron ionization leads to an intensity anomaly for four water molecules attached to both C_{60}^+ and $(\text{C}_{60})_2^+$ (S. Denifl et al. *Angew. Chem. Int. Ed.* **48** (2009) 8940). Doped helium nanodroplets provide a way to form ice covered dust particles that have a structure that might be similar to the cold interstellar medium. Long range dipole interaction and complete cooling of the cluster between two attaching molecules is essential for the molecular structure in both cases, the interstellar medium and the doped helium nanodroplets. Finally, a pronounced temperature dependence was observed for dissociative electron attachment to the three isomers of dichlorobenzene (M. Mahmoodi-Darian et al. *J. Phys. Chem. A* **113** (2009) 14923) and two isomers of chlorobromobenzene (M. Mahmoodi-Darian et al. *Int. J. Mass. Spectrom.* **293** (2010) 51). Differences in the out-of-plane vibrations are expected to be the reason for the isomeric differences observed.

2.1.3 information on the running of the project, use of the available funding and where appropriate any changes to the original project plan

Due to the technical problems encountered with one of the instruments and lack of qualified personnel that could have been hired at the beginning of the project a cost-neutral extension of the project duration by one year was requested and granted by the FWF. The distribution of the funding among personnel and consumables was close to initial plans. No significant deviations concerning the use of the available funding were made.

2.2. Personnel development – importance of the project for the scientific careers of those involved (including the project leader)

Six PhD students funded by this project finished successfully their PhD thesis in the last two years. In addition, two undergraduate students finished their diploma and were hired in the industry. Both PostDoc researchers involved in the project got interesting positions in academia and the university hospital. The following list briefly summarizes the current position of the former co-workers funded by this project:

Dr. Abid Aleem: permanent position at the Pakistan Institute of Nuclear Science and Technology

Dr. Elahe Alizadeh: PostDoc fellow at Sherbrooke University, Canada

Dr. Nikolaus Endstraßer: PostDoc fellow at the IPP Garching, Germany

Dr. Stefan Feil: Tenure track position at Claude Bernard University Lyon, France

Dr. Mikhail Gutkin: currently applying for a PostDoc fellow at NASA, USA

Dr. Christian Mair: physicist at the university clinics for nuclear medicine in Innsbruck

Dr. Masoomeh Mamoodi Darian: permanent position in Iran but currently still in Innsbruck finishing one paper

Dr. Andreas Mauracher: PostDoc fellow at Uppsala University, Sweden

Dr. Fabio Zappa: assistant professor at the University Juiz de Fora, Brazil

Mag. Michal Cingel: working at a company in Bratislava, Slovak Republic

Mag. Emanuel Reichsöllner: teacher in Innsbruck, Austria

Mag. Bernhard Rittenschober: technical engineer at a company in Innsbruck

The present project was essential for the development of special qualifications and skills for all co-workers listed above. In most cases undergraduate or PhD students successfully finished their theses and for the three PostDoc researchers this project was an important step to a tenure track position at a university (Stefan Feil and Fabio Zappa) or a university clinics (Christian Mair). For the principal investigator (strongly supported by Prof. Paul Scheier who took over responsibilities in the institute the last years when the principal investigator was asked to serve as vice rector for research at the university of Innsbruck) this project was probably the last FWF project in a long list of FWF projects carried out during a career leading to about 700 papers in refereed journals. Nevertheless, besides the continuation of existing international collaborations with Prof. Eugen Illenberger from Berlin, Prof. Diethard K. Bohme from Toronto and Prof. Paulo Limao-Vieira from Lisbon, two new collaborations were established with help of this project, i.e., Prof. Andrew Ellis from Leicester and Prof. Shan Xi Tian from Hefei, China that were already leading to joint publications.

2.3 effects of the project outside the scientific field

The need for detection of explosives has increased over the years and consequently the number of techniques to distinguish them from other substances due to the high risk of terroristic attacks. One of the key issues is the fast capability to distinguish explosives among a background of other nitrogen-containing compounds. The first results obtained for trinitrotoluene and several other nitroaromatic compounds were motivating a collaboration between the Institut für Ionenphysik and Angewandte Physik and the company Ionicon Analytik GmbH which finally was leading to a joint project supported by the FFG. A prototype of a sensitive device for the detection of volatile organic compounds in general and of explosives in particular was developed, based on anion formation and time-of-flight analysis of these ions.

The results on explosives as well as on doped helium nanodroplets attract the interest of the public at the long night of research for instance. Thus information was provided for the media and was leading to several contributions in the local and international press (see attachment below).

3. Information on project participants

not funded by the FWF			funded by the FWF (project)		
co-workers	number	Person-months	co-workers	number	Person - months
non-scientific co-workers	4	7	non-scientific co-workers	0	0
diploma students	2	15	diploma students	0	0
PhD students	2	30	PhD students	8	71
post-doctoral co-workers	2	16	post-doctoral co-workers	2	5.5
co-workers with "Habilitation" (professorial qualifications)	1	8	co-workers with "Habilitation" (professorial qualifications)	0	0
professors	6	9	professors	0	0

4. Attachments

(lists may be as long as required)

List 1

1.a. scientific publications²

with an indication of the status (published, in press, submitted, in preparation)

Open Access: http://www.fwf.ac.at/de/public_relations/oai/index.html

If the project could not follow the FWF Open Access Policy for some or for all publications (1.a.1 to 1.a.3) please list the reasons:

Publications may only be listed if they relate directly to the project. **Up to three of the most important publications** should be indicated (e.g. printed in bold letters). **Please note that publication costs may be requested (under the original project number) for up to three years following completion of a project.**

A common format for citations should be followed.

1.a.1. Peer-reviewed publications (journals, contribution to anthologies, working papers, proceedings etc.)

- 1) M. Braun, M. Ruf, H. Hotop, P. Cicman, P. Scheier, T. Märk, E. Illenberger, R. Tuckett, C. Mayhew, High resolution studies of low-energy electron attachment to SF₅Cl. Product anions and absolute cross sections. *Int. J. of Mass Spectrom.* **252** (2006) 234-241
- 2) P. Burrow, G. Gallup, A. Scheer, S. Denifl, S. Ptasinska, T. D. Märk, P. Scheier, Vibrational Feshbach resonances in uracil and thymine. *J. Chem. Phys.* **124** (2006) 124310, selected for the *Virtual Journal of Biological Physics Research* **11** (2006) issue 7
- 3) S. Denifl, S. Matejcek, J. Skalny, T. Märk, Electron impact ionization of CH₃D and CD₄ near threshold. Isotope and temperature effects. *Int. J. of Mass Spectrom.* **248** (2006) 29-35
- 4) S. Denifl, B. Sonnweber, J. Mack, L. Scott, P. Scheier, K. Becker, T. Märk, Appearance energies of singly, doubly, and triply charged coronene and corannulene ions produced by electron impact. *Int. J. of Mass Spectrom.* **249-250** (2006), 353-358
- 5) S. Denifl, M. Stano, A. Stamatovic, P. Scheier, T. Märk, Electron-impact ionization of helium clusters close to the threshold. Appearance energies. *J. Chem. Phys.* **124** (2006) 054320 (8 pages)
- 6) S. Denifl, F. Zappa, I. Mähr, J. Lecointre, M. Probst, T. Märk, P. Scheier, Mass Spectrometric Investigation of Anions Formed upon Free Electron Attachment to Nucleobase Molecules and Clusters Embedded in Superfluid Helium Droplets. *Phys. Rev. Lett.* **97** (2006) 043201 (4 pages)
- 7) J. Fedor, P. Cicman, B. Coupier, S. Feil, M. Winkler, K. Gluch, J. Husarik, D. Jaksch, B. Farizon, N. J. Mason, P. Scheier, T. D. Märk, Fragmentation of transient water anions following low-energy electron capture by H₂O / D₂O. *J. Phys. B: At. Mol. Opt. Phys.* **39** (2006) 3935-3944
- 8) S. Feil, A. Bacher, K. Gluch, S. Matt-Leubner, P. Scheier, T. Märk, Absolute partial cross sections and kinetic energy analysis for the electron impact ionization of propene. *Int. J. of Mass Spectrom.* **253** (2006) 122-129

² The publication list must mention for each work: all authors; full title; series/journal title; year; volume; and page numbers. Furthermore, if publications are freely available in the internet, please add the URL of the publication.

- 9) S. Feil, K. Gluch, A. Bacher, S. Matt-Leubner, D. K. Böhme, P. Scheier, T. D. Märk, Cross sections and ion kinetic energy analysis for the electron impact ionization of acetylene. *J. Chem. Phys.* **124** (2006) 214307
- 10) S. Feil, K. Gluch, S. Denifl, F. Zappa, O. Echt, P. Scheier, T. Märk, Metastable dissociation and kinetic energy release of helium clusters upon electron impact ionization. *Int. J. of Mass Spectrom.* **252** (2006) 166-172
- 11) S. Feil, K. Gluch, S. Matt-Leubner, O. Echt, C. Lifshitz, B. Cao, T. Wakahara, T. Akasaka, P. Scheier, T. Märk, The stability of singly and multiply charged La@C₈₀ and La@C₈₂ ions determined from kinetic energy release measurements. *Int. J. of Mass Spectrom.* **249-250** (2006) 396-402
- 12) S. Feil, M. Winkler, P. Sulzer, S. Ptasinska, S. Denifl, F. Zappa, B. Kräutler, T. Märk, P. Scheier, Single, double and triple ionization of tetraphenyl iron(III) porphyrin chloride. *Int. J. of Mass Spectrom.* **255-256** (2006) 232-238
- 13) D. Huber, M. Beikircher, S. Denifl, F. Zappa, S. Matejcik, A. Bacher, V. Grill, T. D. Märk, P. Scheier, High resolution dissociative electron attachment to gas phase adenine. *J. Chem. Phys.* **125** (2006) 084304; selected for the *Virtual Journal of Biological Physics Research* **12** (2006) issue 5
- 14) I. Ipolyi, P. Cicman, S. Denifl, V. Matejcik, P. Mach, J. Urban, P. Scheier, T. Märk, S. Matejcik, Electron impact ionization of alanine. Appearance energies of the ions. *Int. J. of Mass Spectrom.* **252** (2006) 228-233
- 15) S. Ptasinska, S. Denifl, S. Gohlke, P. Scheier, E. Illenberger, T. Märk, Decomposition of Thymidine by Low-Energy Electrons. Implications for the Molecular Mechanisms of Single-Strand Breaks in DNA. *Angew. Chem. Int. Ed.* **45** (2006) 1893-1896
- 16) S. Ptasinska, O. Echt, S. Denifl, M. Stano, P. Sulzer, F. Zappa, A. Stamatovic, P. Scheier, T. D. Märk, Electron Attachment to Higher Fullerenes and to Sc₃N@C₈₀. *J. Phys. Chem. A* **110** (2006) 8451-8456
- 17) P. Sulzer, S. Ptasinska, F. Zappa, B. Mielewska, A. R. Milosavljevic, P. Scheier, T. Märk, I. Bald, S. Gohlke, M. Huels, E. Illenberger, Dissociative electron attachment to furan, tetrahydrofuran, and fructose. *J. Chem. Phys.* **125** (2006) 044304; selected for the *Virtual Journal of Biological Physics Research* **12** (2006) issue 3
- 18) J. M. vanDoren, J. F. Friedman, T. Miller, A. A. Viggiano, S. Denifl, P. Scheier, T. Märk, J. Troe, Electron attachment to POCl₃. Measurement and theoretical analysis of rate constants and branching ratios as a function of gas pressure and temperature, electron temperature, and electron energy. *J. Chem. Phys.* **124** (2006) 124322
- 19) S. Denifl, A. Mauracher, P. Sulzer, A. Bacher, T.D. Märk, P. Scheier; Free electron attachment to the chloromethane CHCl₃. *Int. J. Mass. Spectrom.* **265** (2007) 139-145
- 20) S. Denifl, P. Sulzer, D. Huber, F. Zappa, M. Probst, T.D. Märk, P. Scheier, N. Injan, J. Limtrakul, R. Abouaf, H. Dunet; Influence of Functional Groups on the Site-Selective Dissociation of Adenine upon Low-Energy Electron Attachment. *Angew. Chem. Int. Ed.* **46** (2007) 5238-5241
- 21) S. Feil, P. Sulzer, A. Mauracher, M. Beikircher, N. Wendt, A. Aleem, S. Denifl, F. Zappa, S. Matt-Leubner, A. Bacher, S. Matejcik, M. Probst, P. Scheier, T.D. Märk; Electron Impact Ionization/Dissociation of Molecules. Production of Energetic Radical Ions and Anions. *J. Phys.: Conf. Ser.* **86** (2007) 012003
- 22) H.D. Flosadottir, S. Denifl, F. Zappa, N. Wendt, A. Mauracher, A. Bacher, H. Jonsson, T.D. Märk, P. Scheier, O. Ingolfsson; Combined Experimental and Theoretical Study on the Nature and the Metastable Decay Pathways of the Amino Acid Ion Fragment [M-H]⁻. *Angew. Chem. Int. Ed.* **46** (2007) 8057-8059
- 23) A. Mauracher, S. Denifl, A. Aleem, N. Wendt, F. Zappa, P. Cicman, M. Probst, T.D. Märk, P. Scheier, H.D. Flosadottir, O. Ingolfsson, E. Illenberger; Dissociative electron attachment to gas phase glycine. Exploring the decomposition pathways by mass separation of isobaric fragment anions. *Phys. Chem. Chem. Phys.* **9** (2007) 5680-5685

- 24) I. Mähr, F. Zappa, S. Denifl, D. Kubala, O. Echt, T.D. Märk, P. Scheier; Multiply Charged Neon Clusters. Failure of the Liquid Drop Model?. *Phys. Rev. Lett.* **98** (2007) 023401
- 25) P. Sulzer, A. Mauracher, S. Denifl, M. Probst, T.D. Märk, P. Scheier, E. Illenberger; Probing di-nitrobenzene by low energy electrons. Identification of isomers via resonances in dissociative electron attachment. *Int. J. Mass. Spectrom.* **266** (2007) 138-148
- 26) P. Sulzer, A. Mauracher, S. Denifl, F. Zappa, S. Ptasinska, M. Beikircher, A. Bacher, N. Wendt, A. Aleem, F. Rondino, S. Matejcek, M. Probst, T.D. Märk, P. Scheier; Identification of Isomers of Nitrotoluene via Free Electron Attachment. *Anal. Chem.* **79** (2007) 6585-6591
- 27) P. Sulzer, A. Mauracher, S. Denifl, F. Zappa, S. Ptasinska, F. Rondino, P. Scheier, T.D. Märk; Dissociative electron attachment to nitroaromatic compounds – resonances as fingerprints for isomers. *J. Phys.: Conf. Ser.* **88** (2007) 012075
- 28) F. Zappa, S. Denifl, I. Mähr, J. Lecointre, F. Rondino, O. Echt, T.D. Märk, P. Scheier; Electron impact ionization of thymine clusters embedded in superfluid helium droplets. *Eur. Phys. J. D* **43** (2007) 117-120
- 29) J. Fedor, M. Cingel, J. D. Skalny, P. Scheier, T. D. Märk, M. Cizek, P. Kolorenc, J. Horacek; Dissociative electron attachment to HBr. A temperature effect. *Phys. Rev. A* **75** (2007) 022703
- 30) A. Aleem, A. Mauracher, P. Sulzer, S. Denifl, F. Zappa, A. Bacher, N. Wendt, T. D. Märk, P. Scheier, Relative partial cross sections for anions formed upon electron attachment to nitrotoluene. *Int. J. Mass. Spectrom.* **271** (2008) 36-44
- 31) E. Alizadeh, F. Ferreira da Silva, F. Zappa, A. Mauracher, M. Probst, S. Denifl, A. Bacher, T. D. Märk, P. Limao-Vieira, P. Scheier, Dissociative electron attachment to nitromethane. *Int. J. Mass. Spectrom.* **271** (2008) 15-21
- 32) S. Denifl, P. Sulzer, A. Mauracher, M. Probst, T. D. Märk, P. Scheier, Site selective cleavage of purine derivatives by capture of low energy electrons. *Physica Scripta* **78** (2008) 058101
- 33) S. Denifl, P. Sulzer, F. Zappa, S. Moser, B. Kräutler, O. Echt, D. K. Bohme, T. D. Märk, P. Scheier, Isotope effects in dissociative electron attachment to the DNA base thymine. *Int. J. Mass. Spectrom.* **277** (2008) 296-299
- 34) S. Denifl, F. Zappa, A. Mauracher, F. Ferreira da Silva, A. Bacher, O. Echt, T. D. Märk, D. K. Böhme, P. Scheier, Dissociative Electron Attachment to DNA Bases Near Absolute Zero Temperature. Freezing Dissociation Intermediates. *ChemPhysChem* **9** (2008) 1387-1389
- 35) S. Denifl, F. Zappa, I. Mähr, A. Mauracher, M. Probst, T. D. Märk, P. Scheier, Inelastic Electron Interaction with Chloroform Clusters embedded in Helium Droplets. *J. Am. Chem. Soc.* **130** (2008) 5065-5071
- 36) S. Feil, T. D. Märk, A. Mauracher, P. Scheier, C. A. Mayhew, Investigations of electron attachment to the perfluorocarbon molecules $c\text{-C}_4\text{F}_8$, $2\text{-C}_4\text{F}_8$, $1,3\text{-C}_4\text{F}_6$, and $c\text{-C}_5\text{F}_8$. *Int. J. Mass. Spectrom.* **277** (2008) 41-5
- 37) K. Graupner, T. A. Field, A. Mauracher, P. Scheier, A. Bacher, S. Denifl, F. Zappa, T. D. Märk, Fragmentation of metastable SF_6^{+*} ions with microsecond lifetimes in competition with autodetachment. *J. Chem. Phys.* **128** (2008) 104304
- 38) S. Jaksch, A. Mauracher, A. Bacher, S. Denifl, F. Ferreira da Silva, H. Schöbel, O. Echt, T. D. Märk, M. Probst, D. K. Bohme, P. Scheier, Formation of even-numbered hydrogen cluster cations in ultracold helium droplets. *J. Chem. Phys.* **129** (2008) 224306
- 39) J. Kopyra, I. Szamrej, K. Graupner, L. M. Graham, T. A. Field, P. Sulzer, S. Denifl, T. D. Märk, P. Scheier, I. I. Fabrikant, M. Braun, M. -W. Ruf, H. Hotop, Low-energy electron attachment to chloroform (CHCl_3) molecules. A joint experimental and theoretical study. *Int. J. Mass. Spectrom.* **277** (2008) 130-141
- 40) A. Mauracher, P. Sulzer, E. Alizadeh, S. Denifl, F. Ferreira da Silva, M. Probst, T. D. Märk, P. Limao-Vieira, P. Scheier, Electron attachment studies to musk ketone and

- high mass resolution anionic isobaric fragment detection. *Int. J. Mass. Spectrom.* **277** (2008) 123-129
- 41) M. Probst, N. Injan, S. Denifl, F. Zappa, I. Mähr, M. Beikircher, S. Ptasinska, J. Limtrakul, T. D. Märk, A. Mauracher, P. Scheier, Calculation of Processes Relevant to Reactions Between Nucleic Acids and Free Electrons. *Chem. Eng. Commun.* **195** (2008) 1371-1381
 - 42) S. Ptasinska, E. Alizadeh, P. Sulzer, R. Abouaf, N. J. Mason, T. D. Märk, P. Scheier, Negative ion formation by low energy electron attachment to gas-phase 5-nitouracil. *Int. J. Mass. Spectrom.* **277** (2008) 291-295
 - 43) P. Sulzer, E. Alizadeh, A. Mauracher, T. D. Märk, P. Scheier, Detailed dissociative electron attachment studies on the amino acid proline. *Int. J. Mass. Spectrom.* **277** (2008) 274-278
 - 44) P. Sulzer, F. Rondino, S. Ptasinska, E. Illenberger, T. D. Märk, P. Scheier, Probing trinitrotoluene (TNT) by low-energy electrons. Strong fragmentation following attachment of electrons near 0 eV. *Int. J. Mass. Spectrom.* **272** (2008) 149-153
 - 45) F. Zappa, M. Beikircher, A. Mauracher, S. Denifl, M. Probst, N. Injan, J. Limtrakul, A. Bacher, O. Echt, T. D. Märk, P. Scheier, T. A. Field, K. Graupner, Metastable Dissociation of Anions Formed by Electron Attachment. *ChemPhysChem* **9** (2008) 607-611
 - 46) F. Zappa, S. Denifl, I. Mähr, A. Bacher, O. Echt, T. D. Märk, P. Scheier, Ultracold Water Cluster Anions. *J. Am. Chem. Soc.* **130** (2008) 5573-5578
 - 47) S. Denifl, I. Mähr, F. Ferreira da Silva, F. Zappa, T. D. Märk, P. Scheier, Electron impact ionization studies with the amino acid valine in the gas phase and (hydrated) in helium droplets. *Eur. Phys. J. D* **51** (2009) 73-79
 - 48) A. Edtbauer, K. Russell, L. Feketeova, J. Taubitz, C. Mitterdorfer, S. Denifl, T. D. Märk, P. Scheier, U. Wille, Formation of pyrimidine dimer radical anions in the gas phase. *Chem. Commun.* (2009) 7291-7293
 - 49) N. Endstrasser, B. Rasul, W. Schustereder, K. Krieger, A. Kendl, P. Scheier, T. D. Märk, Reflection properties of small hydrocarbons impinging on tungsten and carbon surfaces. *Nucl. Instr. Meth. B* **267** (2009) 700-703
 - 50) N. Endstrasser, F. Zappa, A. Mauracher, A. Bacher, S. Feil, D. K. Böhme, P. Scheier, M. Probst, T. D. Märk, Absolute partial cross sections and kinetic energy analysis for the electron impact ionization of ethylene. *Int. J. Mass. Spectrom.* **280** (2009) 65-71
 - 51) F. Ferreira da Silva, P. Bartl, S. Denifl, O. Echt, T. D. Märk, P. Scheier, Argon clusters embedded in helium nanodroplets. *Phys. Chem. Chem. Phys.* **11** (2009) 9791-9797
 - 52) F. Ferreira da Silva, P. Waldburger, S. Jaksch, A. Mauracher, S. Denifl, O. Echt, T. D. Märk, P. Scheier, On the Size of Ions Solvated in Helium Clusters. *Chem.-Eur. J.* **15** (2009) 7101-7108
 - 53) S. Jaksch, F. Ferreira da Silva, S. Denifl, O. Echt, T. D. Märk, P. Scheier, Experimental Evidence for the Existence of an Electronically Excited State of the Proposed Dihydrogen Radical Cation He-H-H-He⁺. *Chem.-Eur. J.* **15** (2009) 4190-4194
 - 54) S. Jaksch, I. Mähr, S. Denifl, A. Bacher, O. Echt, T. D. Märk, P. Scheier, Electron attachment to doped helium droplets. C₆₀⁻, (C₆₀)₂⁻, and C₆₀D₂O⁻ anions. *Eur. Phys. J. D* **52** (2009) 91-94
 - 55) F. Klauser, R. Stijepovic, N. Endstrasser, S. Jaksch, N. Memmel, P. Scheier, Oxidation study of silicon nanoparticle thin films on HOPG. *Surf. Sci.* **603** (2009) 2999-3004
 - 56) M. Mahmoodi-Darian, A. Mauracher, A. Aleem, S. Denifl, B. Rittenschober, A. Bacher, M. Probst, T. D. Märk, P. Scheier, Temperature Effects on the Dissociative Electron Attachment to Dichlorobenzene Isomers. *J. Phys. Chem. A* **113** (2009) 14923-14929
 - 57) A. Mauracher, H. Schöbel, F. Ferreira da Silva, A. Edtbauer, C. Mitterdorfer, S. Denifl, T. D. Märk, E. Illenberger, P. Scheier, Electron attachment to trinitrotoluene

- (TNT) embedded in He droplets. Complete freezing of dissociation intermediates in an extended range of electron energies. *Phys. Chem. Chem. Phys.* **11** (2009) 8240-8243
- 58) H. Schöbel, M. Dampc, F. Ferreira da Silva, A. Mauracher, F. Zappa, S. Denifl, T. D. Märk, P. Scheier, Electron impact ionization of CCl₄ and SF₆ embedded in superfluid helium droplets. *Int. J. Mass. Spectrom.* **280** (2009) 26-31
- 59) P. Sulzer, A. Mauracher, F. Ferreira da Silva, S. Denifl, T. D. Märk, M. Probst, P. Limao-Vieira, P. Scheier, Probing royal demolition explosive (1,3,5-trinitro-1,3,5-triazocyclohexane) by low-energy electrons. Strong dissociative electron attachment near 0 eV. *J. Chem. Phys.* **131** (2009) 144304
- 60) E. Alizadeh, K. Graupner, A. Mauracher, S. Haughey, A. Edtbauer, M. Probst, T. D. Märk, T. A. Field, P. Scheier, Electron attachment to 2-nitro-m-xylene. *Int. J. Mass. Spectrom.* **289** (2010) 128-137
- 61) S. Denifl, F. Zappa, I. Mähr, A. Mauracher, M. Probst, J. Urban, P. Mach, A. Bacher, D. K. Bohme, O. Echt, T. D. Märk, P. Scheier, Ionization of doped helium nanodroplets. Complexes of C₆₀ with water clusters. *J. Chem. Phys.* **132** (2010) 234307
- 62) A. Edtbauer, S. Denifl, V. Vizcaino, L. An der Lan, K. Russell, J. Taubitz, U. Wille, L. Feketeova, R. A. O'Hair, T. D. Märk, E. Illenberger, P. Scheier, Very Low Energy Electrons Transform the Cyclobutane-Pyrimidine Dimer into a Highly Reactive Intermediate. *ChemPhysChem* **11** (2010) 561-564
- 63) A. Edtbauer, P. Sulzer, A. Mauracher, C. Mitterdorfer, F. Ferreira da Silva, S. Denifl, T. D. Märk, M. Probst, Y. Nunes, P. Limao-Vieira, P. Scheier, Dissociative electron attachment to pentaerythritol tetranitrate. Significant fragmentation near 0 eV. *J. Chem. Phys.* **132** (2010) 134305
- 64) F. Ferreira da Silva, P. Bartl, S. Denifl, T. D. Märk, A. M. Ellis, P. Scheier, Formation of the Magic L-Serine Octamer in Helium Nanodroplets. *ChemPhysChem* **11** (2010) 90-92
- 65) F. Ferreira da Silva, S. Denifl, T. D. Märk, A. M. Ellis, P. Scheier, Electron attachment to amino acid clusters in helium nanodroplets. Glycine, alanine, and serine. *J. Chem. Phys.* **132** (2010) 214306
- 66) F. Ferreira da Silva, S. Denifl, T. D. Märk, N. L. Doltsinis, A. M. Ellis and P. Scheier, Electron Attachment to Formamide Clusters in Helium Nanodroplets. *J. Phys. Chem. A* **114** (2010) 1633–1638
- 67) M. Mahmoodi-Darian, S. X. Tian, S. Denifl, S. Matejcik, T. D. Märk, P. Scheier, Temperature dependence of dissociative electron attachment to 1-bromo-2-chlorobenzene and 1-bromo-3-chlorobenzene. *Int. J. Mass. Spectrom.* **293** (2010) 51-55

List 2 project-related participation in international scientific conferences

(with an indication of the conference date) – 4 subunits:

2.1. Conference participations - invited lectures

- 1) P. Scheier, *Bond and Site Selective Fragmentation upon Dissociative Electron Attachment*. Much ado about Ions, Black Creek Pioneer Village, Toronto, Canada (October 13th 2006)
- 2) P. Scheier, *Formation and stability of anions upon free electron attachment to biomolecules in the gas phase and embedded in superfluid helium droplets*. EIPAM Meeting 06, Valletta, Malta (September 17th 2006)
- 3) P. Scheier, *Site Selective Bond Cleavage Upon Dissociative Electron Attachment - A Tool to Control Chemical Reactions*. 37th Meeting of the American Physical Society Division of Atomic, Molecular and Optical Physics (DAMOP) 2006, Knoxville, TN, USA (May 16th – 20th 2006)
- 4) P. Scheier, *Bond and site selective fragmentation upon dissociative electron attachment*. 231st American Chemical Society National Meeting, Atlanta, GA, USA (March 26th – 30th 2006)
- 5) T.D. Märk, *Electron driven processes in molecules of biological relevance: bond, site, energy and state selectivity*. ESF-FWF Conference "Biomolecules - From Gas Phase Properties to Reactions relevant in Living Cells", Obergurgl (June 26th 2006)
- 6) T.D. Märk, *Reactive Ion Surface Collisions*. , 16th International Workshop on Inelastic Ion-Surface Collisions (IISC-16), Hernstein (September 18th 2006)
- 7) Märk, T.D.: *Low energy electron interaction with biomolecules and biomolecular clusters*. Modelling Radiation Damage, Lyon, 03.12.2007 - 06.12.2007.
- 8) Denifl, S.: *Elektronenanlagerung an Molekülen in ultrakalten Heliumtröpfchen*. Clustertreffen 2007, Berlin-Spandau, 23.09.2007 - 28.09.2007.
- 9) Märk, T.D.: *Electron Interaction With Biomolecules And Clusters Embedded In Helium Droplets*. COSTUK Meeting, Oxford, 10.09.2007 - 12.09.2007.
- 10) Zappa, F.: *Electron Impact Ionization and Attachment to Molecules Embedded in Helium Droplets*. 15th International Symposium on Electron Molecule Collisions and Swarms (EMS 2007), Reading, 01.08.2007 - 04.08.2007.
- 11) Märk, T.D.: *Electron Scattering on Clusters and Biomolecules Embedded in Helium Droplets*. 2nd International Symposium "Atomic Cluster Collisions: structure and dynamics from the nuclear to the biological scale" (ISACC 2007), Darmstadt, 19.07.2007 - 23.07.2007.
- 12) Scheier, P.: *Electron-driven damage to biomolecular systems*. 2nd International Workshop on Electrostatic Storage Devices (ESD 2007), Stockholm, 17.06.2007 - 21.06.2007.
- 13) Zappa, F.: *Electron-molecule interactions inside helium droplets*. Conference on Electron Induced Processes At the Molecular Level (EIPAM 07), Hveragerdi, 25.05.2007 - 29.05.2007.
- 14) Scheier, P.: *Electron reactions with free clusters and nanoparticles attached to a surface*. Conference on Electron Induced Processes At the Molecular Level (EIPAM 07), Hveragerdi, 25.05.2007 - 29.05.2007.
- 15) Scheier, P.: *Dissociative electron attachment to biomolecules: from gas phase to complex nanodroplets*. 25th Miller Conference on Radiation Chemistry, Buxton, 14.04.2007 - 19.04.2007.
- 16) Scheier, P.: *Inelastic interaction of free electrons with pristine and doped rare gas clusters*. Frühjahrstagung der Deutschen Physikalischen Gesellschaft (DPG) 2007, Düsseldorf, 19.03.2007 - 23.03.2007.
- 17) Märk, T.D.: *Electrons and Biomolecules*. Symposium on Size Selected Clusters (S3C) 2007, Brand, 12.03.2007 - 16.03.2007.
- 18) Märk, T.D.: *Electron Impact Ionization/Dissociation of Molecules: Production of Energetic Radical Ions and Anions*. 5th EU-Japan Joint Symposium on Plasma Processing, Belgrad, 07.03.2007 - 09.03.2007.

- 19) Märk, T.D.: *Elementary plasma reactions revisited: Electron ionization and ion surface reactions relevant for fusion plasmas*. 16th Symposium on Application of Plasma Processes (SAPP XVI), Podbanske, 20.01.2007 - 25.01.2007.
- 20) Mauracher, A.: *Electron Attachment Energy Spectroscopy MS*. 4th EMSG Ardgour Symposium, Ardgour House, 22.10.2007 - 26.10.2007.
- 21) Scheier, P.: *Free electron attachment to molecules in the gas phase and embedded in superfluid He droplets*. Gordon Research Conference on Radiation Chemistry - Radiation Driven Processes In Physics, Chemistry And Biology, Waterville Valley, NH, 06.07.2008 - 11.07.2008
- 22) Alizadeh, E.: *Dissociative electron attachment to biomolecules and explosives*. LEEMI-EIPAM'08, Roscoff, 07.05.2008 - 11.05.2008
- 23) Denifl, S.: *Inelastic electron interaction with doped helium droplets*. 3rd International Symposium Atomic Cluster Collisions: structure and dynamics from the nuclear to the MesoBioNano scales (ISACC 2008), St. Petersburg, 03.06.2008 - 07.06.2008
- 24) Denifl, S.: *Inelastic interaction of electrons with molecules inside cold helium droplets: detection of novel molecular aggregates*. LEEMI-EIPAM'08, Roscoff, 07.05.2008 - 11.05.2008
- 25) Mahmoodi-Darian, M.: *Temperature effects in dissociative electron attachment: from 0.37 K to 700 K*. LEEMI-EIPAM'08, Roscoff, 07.05.2008 - 11.05.2008
- 26) Märk, T.D.: *Low-Energy Electron Interaction with Molecules in the Gas Phase and in More Complex Media*. Gas Phase Ion Chemistry: State of the Art and Perspectives, Kloster Eberbach, 14.12.2008 - 16.12.2008
- 27) Märk, T.D.: *Low energy electron interaction with biomolecules: from gas to condensed phase - from room temperature to near absolute zero*. Latsis-Symposium "Intramolecular Dynamics, Symmetry and Spectroscopy", Zürich, 06.09.2008 - 10.09.2008
- 28) Märk, T.D.: *Low Energy Electron Interaction with Biomolecules in Different Environments: from the Gas Phase to Droplets*. Isolated Biomolecules and Biomolecular Interactions (IBBI08), Valladolid, 13.04.2008 - 18.04.2008
- 29) Scheier, P.: *Low-energy electron interactions with biomolecules: from gas phase to hydrated complexes*. Chemical Control with Electrons and Photons, Obergurgl, 22.11.2008 - 27.11.2008
- 30) Scheier, P.: *Electron attachment to and identification of explosives*. 6th International Conference on Atomic and Molecular Data and Their Applications (ICAMDATA 2008), Peking, 28.10.2008 - 31.10.2008
- 31) Scheier, P.: *Electron driven reactions at ultra-low temperatures*. Control of Molecular Processes Induced by electrons and photons: experiments and interpretation, Rom, 02.10.2008 - 04.10.2008
- 32) Scheier, P.: *Electron Driven Reactions in Doped He Droplets*. XIV International Symposium on Small Particles and Inorganic Clusters, Valladolid, 15.09.2008 - 19.09.2008
- 33) Scheier, P.: *Inelastic interactions of electrons with biomolecules: from gas phase to complexes and clusters*. 8th International Conference on Pulse Investigations in Chemistry, Biology and Physics (PULS'2008), Krakau, 06.09.2008 - 12.09.2008
- 34) Scheier, P.: *Inelastic interactions of electrons with molecules and clusters embedded in superfluid helium droplets*. Electron Controlled Chemical Lithography (ECCL) - 2008 Meeting, Lisbon, 12.03.2008 - 16.03.2008
- 35) Scheier, P.: *Positive and negative ion formation upon free electron interaction with doped helium droplets*. 16th Symposium on Atomic and Surface Physics (SASP 2008), Les Diablerets, 20.01.2008 - 25.01.2008
- 36) Denifl, S.: *Chemistry driven by low-energy electrons at ultra-low temperatures*. 17th Symposium on Application of Plasma Processes (SAPP XVII), Liptovsky Jan, 17.01.2009 - 22.01.2009
- 37) Ferreira da Silva, F.: *Low electron energy driven reactions at ultra cold temperatures*. 37th Annual Meeting of the European Radiation Research Society, Prag, 26.08.2009 - 29.08.2009

- 38) Märk, T.D.: Electron impact mass spectrometry of biomolecules: from gas to condensed phase - from room temperature to near absolute zero. 42. Jahrestagung der Deutschen Gesellschaft für Massenspektrometrie, Konstanz, 08.03.2009 - 11.03.2009
- 39) Märk, T. D.: Low energy electron attachment and ionization of complex molecules. Radiation damage in biomolecular systems (RADAM 2009), Frankfurt, 01.07.2009 - 05.07.2009
- 40) Märk, T.D.: Electron interaction with clusters in He nanodroplets. Clustertreffen 2009, Herzogenhorn, 04.10.2009 - 09.10.2009
- 41) Märk, T.D.: Electron Scattering Processes and Cross Sections for Biological Molecules. Advanced Lectures on Protection of Humans and Their Environment Against Ionising Radiation, Bad Honnef, 09.02.2009 - 18.02.2009
- 42) Märk, T.D.: Ion Scattering Processes and Cross Sections for Biological Molecules. Advanced Lectures on Protection of Humans and Their Environment Against Ionising Radiation, Bad Honnef, 09.02.2009 - 18.02.2009
- 43) Scheier, P.: Site selective reactions driven by low energy electrons: from gas phase to solvated molecules. Gordon Research Conference on Gaseous Ions: Structures, Energetics & Reactions, Galveston, TX, 01.03.2009 - 06.03.2009
- 44) Scheier, P.: Cluster in He droplets. Symposium on Size Selected Clusters (S3C) 2009, Brand, 08.03.2009 - 13.03.2009
- 45) Scheier, P.: Free electron collisions with doped He droplets - cation and anion formation. Quantum Fluid Clusters, Dresden, 25.05.2009 - 27.05.2009
- 46) Scheier, P.: Ultracold cluster ions formed in doped helium droplets. 4th International Symposium "Atomic Cluster Collisions: structure and dynamics from the nuclear to the biological scale" (ISACC 2009), Ann Arbor, 14.07.2009 - 18.07.2009
- 47) Scheier, P.: Biomolecules and Clusters in Collisions. 26th International Conference on Photonic, Electronic and Atomic Collisions (XXVI ICPEAC), Kalamazoo, 22.07.2009 - 28.07.2009
- 48) Scheier, P.: Low energy electron interactions with biomolecules from gas phase to solvated molecules. 55th Annual Meeting Radiation Research Society, Savannah, Georgia, 04.10.2009 - 07.10.2009
- 49) Scheier, P.: Electron driven reactions in doped helium nanodroplets. ECAMP2010, Salamanca, Spain, 04.07.2010-09.07.2010
- 50) Denifl, S.: Biomolecules and Clusters in He droplets: synthesis and characterization. RADAM 2010, Madrid, Spain, 30.06.2010-04.07.2010

2.2. Conference participations - lectures

- 1) Denifl, S. et al. (15.03.2006) Inelastic electron interaction (ionization/attachment) of biomolecules embedded in superfluid He droplets, Frühjahrstagung der Deutschen Physikalischen Gesellschaft (DPG), Frankfurt/Main
- 2) Denifl, S. et al. (30.09.2006) Inelastic electron interaction with nucleobases: From the isolated molecules to base pairs, 3rd Annual Meeting of the Center of Molecular Biosciences (CMBI), Vill
- 3) Huber, D. et al. (20.09.2006) Development of a spray source for vaporization of low volatile biomolecules, 56. Jahrestagung der Österreichischen Physikalischen Gesellschaft (ÖPG), Graz
- 4) Jaksch, S. et al. (19.09.2006) STM Untersuchungen von Silizium-Nanoteilchen-Filmen, 56. Jahrestagung der Österreichischen Physikalischen Gesellschaft (ÖPG), Graz
- 5) Lokuliyana, K. et al. (19.09.2006) Ionized-cluster source based on high-pressure corona discharge, 56. Jahrestagung der Österreichischen Physikalischen Gesellschaft (ÖPG), Graz
- 6) Mähr, I. et al. (21.09.2006) Multiply charged neon cluster ions: critical size and Coulomb explosion, 56. Jahrestagung der Österreichischen Physikalischen Gesellschaft (ÖPG), Graz

- 7) Rasul, B. et al. (19.09.2006) Ion surface collisions on surfaces relevant for fusion devices, 56. Jahrestagung der Österreichischen Physikalischen Gesellschaft (ÖPG), Graz
- 8) Rasul, B. et al. (21.09.2006) Mass Spectrometry, Surface Ion Collisions, Fusion Experiments, 56. Jahrestagung der Österreichischen Physikalischen Gesellschaft (ÖPG), Graz
- 9) Sulzer, P. et al. (08.03.2006) Dissociative electron attachment to gas phase explosives, 39. Jahrestagung der Deutschen Gesellschaft für Massenspektrometrie (DGMS), Mainz
- 10) Scheier, P.: STM investigations of films of nanoparticles formed upon plasma sputtering. Chemical control by scanning tunnelling microscopy, Berlin, 07.12.2007.
- 11) Scheier, P.: Electron driven reactions at ultra-low temperatures - Molecular synthesis in interstellar clouds. 4th Annual Meeting of the Center of Molecular Biosciences (CMBI), Igls, 28.09.2007 - 29.09.2007.
- 12) Aleem, A.: Identification of Isomers of Nitroaromatic Compounds via Free Electron Attachment. 57. Jahrestagung der Österreichischen Physikalischen Gesellschaft (ÖPG), Krems, 24.09.2007 - 29.09.2007.
- 13) Mahmoodi, M.: Temperature Effects for Dissociative Electron Attachment to DBr. 57. Jahrestagung der Österreichischen Physikalischen Gesellschaft (ÖPG), Krems, 24.09.2007 - 29.09.2007.
- 14) Sulzer, P.: Dissociative electron attachment to explosives. 25th International Conference on Photonic, Electronic and Atomic Collisions (XXV ICPEAC), Freiburg, 25.07.2007 - 31.07.2007.
- 15) Denifl, S.: Electron attachment to gas phase biomolecules in superfluid helium. Annual Conference on Radiation Damage in Biomolecular Systems (RADAM'07), Dublin, 19.06.2007 - 22.06.2007.
- 16) Denifl, S.: Inelastic electron interactions with biomolecules: from gas phase to complex systems. Annual Conference on Radiation Damage in Biomolecular Systems (RADAM'07), Dublin, 19.06.2007 - 22.06.2007.
- 17) Scheier, P.: Inelastic interactions of electrons with biomolecules: from gas phase to complex systems. Symposium on Radiation Effects of Biomedical Interest, Madrid, 22.02.2007 - 25.02.2007.
- 18) Edtbauer, A.: Electron driven chemistry of biomolecules in interstellar clouds probed in a laboratory experiment. 5th Annual Meeting of the Center of Molecular Biosciences (CMBI), Igls, 26.09.2008 - 27.09.2008
- 19) Edtbauer, A.: Biomolecules inside superfluid helium droplets at 0.37 K. 58. Jahrestagung der Österreichischen Physikalischen Gesellschaft (ÖPG), Leoben, 22.09.2008 - 26.09.2008
- 20) Reichsöllner, E.: Elektronenanlagerung an dotierte Heliumtröpfchen mit hoher Energieauflösung durch Verwendung eines hemisphärischen Elektronenmonochromators. 58. Jahrestagung der Österreichischen Physikalischen Gesellschaft (ÖPG), Leoben, 22.09.2008 - 26.09.2008
- 21) Ferreira da Silva, F.: DEA of clusters of amino acid in He droplets and triggering of peptide formation due to low energy electrons. Radiation Damage in Biomolecular Systems (RADAM2008), Debrecen, 13.06.2008 - 15.06.2008
- 22) Alizadeh, E.: Experimental Study of Biomolecules in the Gas-Phase. ITS LEIF Winter School - 2nd Specialised Course, Obergurgl, 17.02.2008 - 22.02.2008
- 23) Ferreira da Silva, F.: The role of electron interaction with biomolecules embedded in superfluid helium droplets. 3rd Annual ITS LEIF Meeting & Summer School, Da Balaia, 19.05.2008 - 24.05.2008
- 24) Mauracher, A.: Theoretical and experimental investigations of molecules in the gasphase. ITS LEIF Winter School - 2nd Specialised Course, Obergurgl, 17.02.2008 - 22.02.2008
- 25) Scheier, P.: Clusters and Biomolecules. 3rd Annual ITS LEIF Meeting & Summer School, Da Balaia, 19.05.2008 - 24.05.2008

- 26) Ferreira da Silva, F.: Mass spectrometry of biomolecules: from gas phase to superfluid helium droplets. 18th International Mass Spectrometry Conference, Bremen, 30.08.2009 - 04.09.2009
- 27) Ferreira da Silva, F.: Magic L-serine clusters in cold helium nanodroplets. Electron Controlled Chemical Lithography (ECCL) - 2009 Meeting, Istanbul, 04.06.2009 - 09.06.2009
- 28) Mauracher, A.: Comparative study of delayed fragmentation resulting from electron attachment to nitro-aromatic compounds. Electron Controlled Chemical Lithography (ECCL) - 2009 Meeting, Istanbul, 04.06.2009 - 09.06.2009
- 29)

2.3. Conference participations - posters

- 1) Beikircher, M. et al. (25.06.2006) Stability of nucleobase anions, ESF-FWF Conference "Biomolecules - From Gas Phase Properties to Reactions relevant in Living Cells", Obergurgl
- 2) Beikircher, M. et al. (14.03.2006) Stability of uracil and thymine cations, Frühjahrstagung der Deutschen Physikalischen Gesellschaft (DPG), Frankfurt/Main
- 3) Beikircher, M. et al. (05.02.2006) Stability of uracil and thymine cations, 15th Symposium on Atomic, Cluster and Surface Physics and Related Topics (SASP 2006), Obergurgl
- 4) Cingel, M. et al. (05.02.2006) Temperature effects on dissociative electron attachment to HBr and DBr, 15th Symposium on Atomic, Cluster and Surface Physics and Related Topics (SASP 2006), Obergurgl
- 5) Denifl, S. et al. (13.09.2006) Free electron attachment to nucleobases: reactions induced by hydride ions, European Conference on Dynamics of Molecular Systems (MOLEC XVI), Trento
- 6) Denifl, S. et al. (30.09.2006) Free electron attachment to nucleobases: reactions induced by hydride ions, 3rd Annual Meeting of the Center of Molecular Biosciences (CMBI), Vill
- 7) Denifl, S. et al. (05.02.2006) Inelastic electron interaction (ionization/attachment) of biomolecules embedded in superfluid He droplets, 15th Symposium on Atomic, Cluster and Surface Physics and Related Topics (SASP 2006), Obergurgl
- 8) Denifl, S. et al. (07.03.2006) Inelastic electron interaction (ionization/attachment) of biomolecules embedded in superfluid He droplets, 39. Jahrestagung der Deutschen Gesellschaft für Massenspektrometrie (DGMS), Mainz
- 9) Endstrasser, N. et al. (21.09.2006) Ion Surface Collisions on Surfaces Relevant for Fusion Devices, 16th International Workshop on Inelastic Ion-Surface Collisions (IISC-16), Hernstein
- 10) Fedor, J. et al. (26.07.2006) Kinetic energy distributions in metastable decay reactions of rare gas dimer ions, XIII International Symposium on Small Particles and Inorganic Clusters (ISSPIC XIII), Göteborg
- 11) Fedor, J. et al. (05.02.2006) Kinetic energy distributions in metastable decay of rare gas dimer ions, 15th Symposium on Atomic, Cluster and Surface Physics and Related Topics (SASP 2006), Obergurgl
- 12) Feil, S. et al. (24.07.2006) Metastable dissociation and kinetic energy release of helium clusters upon electron impact ionization, XIII International Symposium on Small Particles and Inorganic Clusters (ISSPIC XIII), Göteborg
- 13) Feketeova, L. et al. (05.02.2006) Ion-Surface collisions of ethane cations C₂H₄⁺ and C₂D₄⁺ on stainless steel and diamond surfaces, 15th Symposium on Atomic, Cluster and Surface Physics and Related Topics (SASP 2006), Obergurgl
- 14) Feketeova, L. et al. (01.11.2006) Reactive Interactions of Singly and Doubly Charged Molecular Ions with Surfaces, Biology and Medicine with Low Energy Synchrotron Radiation & ISA Users meeting 2006, Aarhus

- 15) Huber, D. et al. (20.09.2006) Development of a spray source for vaporization of low volatile biomolecules, 56. Jahrestagung der Österreichischen Physikalischen Gesellschaft (ÖPG), Graz
- 16) Injan, N. et al. (25.05.2006) Energetics of the base pairs TT, AA and AT, XIIth International Congress of Quantum Chemistry (ICQC), Kyoto
- 17) Jaksch, S. et al. (19.10.2006) Nanolithography on Silicon-Nanocluster-Films, INNANO – Advances in nano-biotechnology, Innsbruck
- 18) Jaksch, S. et al. (20.09.2006) STM Untersuchungen von Silizium-Nanoteilchen-Filmen, 56. Jahrestagung der Österreichischen Physikalischen Gesellschaft (ÖPG), Graz
- 19) Jaksch, S. et al. (11.07.2006) Nanolithography on Silicon-Nanocluster-Films, 1st Annual ITS LEIF Meeting, Sonderborg
- 20) Kethsiri, L. et al. (30.09.2006) Development of a spray source for the vaporization of neutral low volatile molecules, 3rd Annual Meeting of the Center of Molecular Biosciences (CMBI), Vill
- 21) Lokuliyange, K. et al. (20.09.2006) Ionized-cluster source based on high-pressure corona discharge, 56. Jahrestagung der Österreichischen Physikalischen Gesellschaft (ÖPG), Graz
- 22) Mähr, I. et al. (25.06.2006) Free electron attachment to biomolecules embedded in superfluid helium and neon droplets, ESF-FWF Conference "Biomolecules - From Gas Phase Properties to Reactions relevant in Living Cells", Obergurgl
- 23) Mähr, I. et al. (26.07.2006) Multiply charged neon cluster ions: critical size and Coulomb explosion, XIII International Symposium on Small Particles and Inorganic Clusters (ISSPIC XIII), Göteborg
- 24) Mähr, I. et al. (20.09.2006) Multiply charged neon cluster ions: critical size and Coulomb explosion, 56. Jahrestagung der Österreichischen Physikalischen Gesellschaft (ÖPG), Graz
- 25) Märk, T.D. et al. (31.08.2006) Dissociative Electron Attachment to Gas Phase Explosives, 17th International Mass Spectrometry Conference (17th IMSC), Prag
- 26) Mauracher, A. et al. (30.09.2006) Stability of negatively charged biomolecules and explosives, 3rd Annual Meeting of the Center of Molecular Biosciences (CMBI), Vill
- 27) Ptasinska, S. et al. (14.03.2006) Site selectivity in dissociative free-electron attachment to gas phase nucleobases, Frühjahrstagung der Deutschen Physikalischen Gesellschaft (DPG), Frankfurt/Main
- 28) Ptasinska, S. et al. (24.07.2006) Electron Attachment to Higher Fullerenes and to Sc₃N@C₈₀, XIII International Symposium on Small Particles and Inorganic Clusters (ISSPIC XIII), Göteborg
- 29) Ptasinska, S. et al. (07.03.2006) Bond and site selective fragmentation upon dissociative electron attachment, 39. Jahrestagung der Deutschen Gesellschaft für Massenspektrometrie (DGMS), Mainz
- 30) Sulzer, P. et al. (29.09.2006) Low Energy electron interactions with labelled gas phase nucleobases, 3rd Annual Meeting of the Center of Molecular Biosciences (CMBI), Vill
- 31) Sulzer, P. et al. (25.06.2006) Low energy interactions with labelled gas phase nucleobases, ESF-FWF Conference "Biomolecules - From Gas Phase Properties to Reactions relevant in Living Cells", Obergurgl
- 32) Sulzer, P. et al. (05.02.2006) Explosives detection by low energy electrons, 15th Symposium on Atomic, Cluster and Surface Physics and Related Topics (SASP 2006), Obergurgl
- 33) Sulzer, P. et al. (16.03.2006) Dissociative electron attachment to gas phase explosives, Frühjahrstagung der Deutschen Physikalischen Gesellschaft (DPG), Frankfurt/Main
- 34) Zappa, F. et al. (24.07.2006) Electron impact ionization of thymine clusters embedded in superfluid helium droplets, XIII International Symposium on Small Particles and Inorganic Clusters (ISSPIC XIII), Göteborg

- 35) Zappa, F. et al. (07.06.2006) Hidden resonances in Dissociative Electron Attachment to Thymine?, Radiation Damage in Biomolecular Systems (RADAM'06), Groningen
- 36) Zappa, F. et al. (20.09.2006) Ion surface collisions on surfaces relevant for fusion devices, 56. Jahrestagung der Österreichischen Physikalischen Gesellschaft (ÖPG), Graz
- 37) Mauracher, A.; Denifl, S.; Zappa, F.; Wendt, N.; Bacher, A.; Illenberger, E.; Probst, M.; Märk, T.D.; Scheier, P.: Dissociative electron attachment to amino acids - theory and experiment. 4th Annual Meeting of the Center of Molecular Biosciences (CMBI), Igls, 28.09.2007 - 29.09.2007.
- 38) Alizadeh, E.; Mauracher, A.; Denifl, S.; Zappa, F.; Flosadottir, H.D.; Ingolfsson, O.; Märk, T.D.; Scheier, P.: Metastable Decay Pathways of Amino Acid Anions. 4th Annual Meeting of the Center of Molecular Biosciences (CMBI), Igls, 28.09.2007 - 29.09.2007.
- 39) Sulzer, P.; Denifl, S.; Huber, D.; Zappa, F.; Probst, M.; Märk, T.D.; Scheier, P.: Probing of derivatives of adenine with low energy electrons. 4th Annual Meeting of the Center of Molecular Biosciences (CMBI), Igls, 28.09.2007 - 29.09.2007.
- 40) Alizadeh, E.; Mauracher, A.; Flosadottir, H.; Denifl, S.; Zappa, F.; Märk, T.D.; Scheier, P.: Dissociative electron attachment to amino acids. 57. Jahrestagung der Österreichischen Physikalischen Gesellschaft (ÖPG), Krems, 24.09.2007 - 29.09.2007.
- 41) Aleem, A.; Sulzer, P.; Mauracher, A.; Denifl, S.; Zappa, F.; Bacher, A.; Probst, M.; Illenberger, E.; Märk, T.D.; Scheier, P.: Identification of Isomers of Nitroaromatic Compounds via Free Electron Attachment. 57. Jahrestagung der Österreichischen Physikalischen Gesellschaft (ÖPG), Krems, 24.09.2007 - 29.09.2007.
- 42) Mahmoodi, M.; Cingel, M.; Feil, S.; Denifl, S.; Scheier, P.; Märk, T.D.: Temperature Effects for Dissociative Electron Attachment to DBr. 57. Jahrestagung der Österreichischen Physikalischen Gesellschaft (ÖPG), Krems, 24.09.2007 - 29.09.2007.
- 43) Probst, M.; Injan, N.; Denifl, S.; Zappa, F.; Limtrakul, J.; Märk, T.D.; Scheier, P.; Urban, J.; Mach, P.: Dissociative Electron Attachment to Biomolecules. Canadian Symposium on Theoretical Chemistry - 2007, St. John's, 04.08.2007 - 09.08.2007.
- 44) Sulzer, P.; Rondino, F.; Kilgour, D.; Grill, V.; Ptasinska, S.; Brookes, M.D.; Scheier, P.; Märk, T.D.: Dissociative electron attachment to explosives. 25th International Conference on Photonic, Electronic and Atomic Collisions (XXV ICPEAC), Freiburg, 25.07.2007 - 31.07.2007.
- 45) Field, T.A.; Graupner, K.; Mauracher, A.; Scheier, P.; Bacher, A.; Denifl, S.; Zappa, F.; Märk, T.D.: Dissociative electron attachment to unstable molecules and slow fragmentation of metastable molecular anions. 25th International Conference on Photonic, Electronic and Atomic Collisions (XXV ICPEAC), Freiburg, 25.07.2007 - 31.07.2007.
- 46) Mauracher, A.; Wendt, N.; Sulzer, P.; Denifl, S.; Zappa, F.; Bacher, A.; Märk, T.D.; Scheier, P.; Probst, M.: Glycine - Theoretical and experimental studies. Annual Conference on Radiation Damage in Biomolecular Systems (RADAM'07), Dublin, 19.06.2007 - 22.06.2007.
- 47) Sulzer, P.; Denifl, S.; Mauracher, A.; Zappa, F.; Wendt, N.; Aleem, A.; Rondino, F.; Jaksch, S.; Bacher, A.; Grill, V.; Ptasinska, S.; Matejcek, S.; Scheier, P.; Märk, T.D.: Dissociative Electron Attachment to Nitrotoluene Isomers. 9th European Conference on Atoms Molecules and Photons (ECAMP IX), Heraklion, 06.05.2007 - 11.05.2007.
- 48) Mauracher, A.; Beikircher, M.; Denifl, S.; Zappa, F.; Bacher, A.; Echt, O.; Märk, T.D.; Scheier, P.: Metastable Decays of Negative Ions Formed Upon Electron Attachment to Small Biomolecules and Explosives. 9th European Conference on Atoms Molecules and Photons (ECAMP IX), Heraklion, 06.05.2007 - 11.05.2007.
- 49) Mähr, I.; Zappa, F.; Denifl, S.; Kubala, D.; Echt, O.; Märk, T.D.; Scheier, P.: Multiply Charged Neon Cluster Ions: Critical Size and Coulomb Explosion. 9th European Conference on Atoms Molecules and Photons (ECAMP IX), Heraklion, 06.05.2007 - 11.05.2007.

- 50) Denifl, S.: Solvated biomolecules embedded in helium droplets: Ionisation and electron attachment. 2nd Annual ITS LEIF Meeting & Summer School, Heraklion, 30.04.2007 - 06.05.2007.
- 51) Denifl, S.; Zappa, F.; Mähr, I.; Märk, T.D.; Scheier, P.: Inelastic electron interaction (ionization/attachment) with biomolecules embedded in superfluid helium droplets. Symposium on Size Selected Clusters (S3C) 2007, Brand, 12.03.2007 - 16.03.2007.
- 52) Mähr, I.; Zappa, F.; Denifl, S.; Kubala, D.; Echt, O.; Märk, T.D.; Scheier, P.: Multiply charged neon cluster ions: critical size and Coulomb explosion. Symposium on Size Selected Clusters (S3C) 2007, Brand, 12.03.2007 - 16.03.2007.
- 53) Probst, M.; Injan, N.; Denifl, S.; Zappa, F.; Limtrakul, J.; Märk, T.D.; Scheier, P.; Urban, J.; Mach, P.: Quantum Chemistry of Dissociative Electron Attachment to Adenine. 47th Sanibel Symposium, St. Simons Island, GA, 22.02.2007 - 27.02.2007.
- 54) Mähr, I.; Sulzer, P.; Rondino, F.; Grill, V.; Ptasinska, S.; Kilgour, D.; Brookes, M.D.; Scheier, P.; Märk, T.D.: Dissociative electron attachment to gas phase explosives. Symposium on Radiation Effects of Biomedical Interest, Madrid, 22.02.2007 - 25.02.2007.
- 55) Injan, N.; Probst, M.; Denifl, S.; Zappa, F.; Mähr, I.; Beikircher, M.; Ptasinska, S.; Limtrakul, J.; Märk, T.D.; Scheier, P.: Energetics and Geometrics of Nucleic Acid Base Pairs in the Gas Phase and in Liquid Helium. 47th Sanibel Symposium, St. Simons Island, GA, 22.02.2007 - 27.02.2007.
- 56) Mähr, I.; Denifl, S.; Zappa, F.; Märk, T.D.; Scheier, P.: Free electron attachment to nucleobases and amino acids embedded in superfluid helium droplets. Symposium on Radiation Effects of Biomedical Interest, Madrid, 22.02.2007 - 25.02.2007.
- 57) Mähr, I.; Mauracher, A.; Beikircher, M.; Denifl, S.; Zappa, F.; Bacher, A.; Grill, V.; Probst, M.; Märk, T.D.; Scheier, P.: Stability of negatively charged biomolecules and explosives. Symposium on Radiation Effects of Biomedical Interest, Madrid, 22.02.2007 - 25.02.2007.
- 58) Injan, N.; Probst, M.; Denifl, S.; Zappa, F.; Limtrakul, J.; Märk, T.; Scheier, P.; Urban, J.; Mach, P.: Quantum Chemistry of Dissociative Electron Attachment to Adenine. 16th Symposium on Application of Plasma Processes (SAPP XVI), Podbanske, 20.01.2007 - 25.01.2007.
- 59) Alizadeh, E.; Mauracher, A.; Denifl, S.; Edtbauer, A.; Märk, T.D.; Scheier, P.: Dissociative Electron Attachment to Biomolecules. 5th Annual Meeting of the Center of Molecular Biosciences (CMBI), Igls, 26.09.2008 - 27.09.2008
- 60) Denifl, S.; Mauracher, A.; Zappa, F.; Bacher, A.; Probst, M.; Scheier, P.; Märk, T.D.; Flosadottir, H.D.; Ingolfsson, O.; Illenberger, E.: Negative ion formation and fragmentation upon free electron attachment to simple amino acids. Isolated Biomolecules and Biomolecular Interactions (IBBI08), Valladolid, 13.04.2008 - 18.04.2008
- 61) Denifl, S.; Sulzer, P.; Zappa, F.; Probst, M.; Märk, T.D.; Scheier, P.; Injan, N.; Limtrakul, J.; Abouaf, R.; Dunet, H.: Site dependent dissociation of adenine: influence of functional groups upon dissociative electron attachment. 16th Symposium on Atomic and Surface Physics (SASP 2008), Les Diablerets, 20.01.2008 - 25.01.2008
- 62) Edtbauer, A.; Ferreira da Silva, F.; Denifl, S.; Mauracher, A.; Aleem, A.; Märk, T.D.; Scheier, P.: Electron driven chemistry of biomolecules in interstellar clouds probed in a laboratory experiment. 5th Annual Meeting of the Center of Molecular Biosciences (CMBI), Igls, 26.09.2008 - 27.09.2008
- 63) Edtbauer, A.; Ferreira da Silva, F.; Schöbel, H.; Mauracher, A.; Probst, M.; Denifl, S.; Märk, T.D.; Scheier, P.: Biomolecules in superfluid helium droplets at 0.37 K. 58. Jahrestagung der Österreichischen Physikalischen Gesellschaft (ÖPG), Leoben, 22.09.2008 - 26.09.2008
- 64) Edtbauer, A.; Ferreira da Silva, F.; Schöbel, H.; Mauracher, A.; Probst, M.; Denifl, S.; Märk, T.D.; Scheier, P.: Biomolecules inside superfluid helium droplets at 0.37 K. Radiation Damage in Biomolecular Systems (RADAM2008), Debrecen, 13.06.2008 - 15.06.2008

- 65) Edtbauer, A.; Hamann, T.; Alizadeh, E.; Ferreira da Silva, F.; Mauracher, A.; Denifl, S.; Märk, T.D.; Scheier, P.: Dissociative Electron Attachment to Biomolecules. Chemical Control with Electrons and Photons, Obergurgl, 22.11.2008 - 27.11.2008
- 66) Ferreira da Silva, F.; Antunes, R.; Pavlovic, D.; Eden, S.; Mason, N.J.; Marinkovic, B.P.; Garcia, G.; Limao-Vieria, P.: Electronic excitation of halothane studied by VUV photoabsorption. Chemical Control with Electrons and Photons, Obergurgl, 22.11.2008 - 27.11.2008
- 67) Ferreira da Silva, F.; Denifl, S.; Zappa, F.; Mauracher, A.; Märk, T.D.; Scheier, P.: Radiation damage to solvated biomolecules. Chemical Control with Electrons and Photons, Obergurgl, 22.11.2008 - 27.11.2008
- 68) Ferreira da Silva, F.; Edtbauer, A.; Schöbel, H.; Mauracher, A.; Probst, M.; Denifl, S.; Märk, T.D.; Scheier, P.: Biomolecules inside the superfluid helium droplets at 0.37K. Gordon Research Conference on Radiation Chemistry - Radiation Driven Processes In Physics, Chemistry And Biology, Waterville Valley, NH, 06.07.2008 - 11.07.2008
- 69) Jaksch, S.; Mauracher, A.; Bacher, A.; Denifl, S.; Ferreira da Silva, F.; Schöbel, H.; Märk, T.D.; Probst, M.; Bohme, D.K.; Echt, O.; Scheier, P.: Hydrogen cluster ions in helium droplets. Chemical Control with Electrons and Photons, Obergurgl, 22.11.2008 - 27.11.2008
- 70) Kopyra, J.; Szamrej, I.; Graupner, K.; Graham, L.M.; Field, T.A.; Sulzer, P.; Denifl, S.; Märk, T.D.; Scheier, P.; Fabrikant, I.I.; Braun, M.; Ruf, M.-W.; Hotop, H.: Low-energy electron attachment to chloroform (CHCl₃) molecules: a joint experimental and theoretical study. LEEMI-EIPAM'08, Roscoff, 07.05.2008 - 11.05.2008
- 71) Mauracher, A.; Alizadeh, E.; Denifl, S.; Märk, T.D.; Scheier, P.; Probst, M.: High level ab initio studies concerning proline. 5th Annual Meeting of the Center of Molecular Biosciences (CMBI), Igls, 26.09.2008 - 27.09.2008
- 72) Mauracher, A.; Edtbauer, A.; Alizadeh, E.; Denifl, S.; Märk, T.D.; Scheier, P.; Probst, M.: Negative ion formation and fragmentation upon free electron attachment to amino acids. Chemical Control with Electrons and Photons, Obergurgl, 22.11.2008 - 27.11.2008
- 73) Mauracher, A.; Probst, M.; Denifl, S.; Injan, N.; Limtrakul, J.; Märk, T.D.; Scheier, P.: Anions of Aromatic Nitrate and the NO-Abstraction Reaction: Calculated Energetics. 16th Symposium on Atomic and Surface Physics (SASP 2008), Les Diablerets, 20.01.2008 - 25.01.2008
- 74) Mauracher, A.; Sulzer, P.; Denifl, S.; Zappa, F.; Probst, M.; Märk, T.D.; Scheier, P.: Identification of Explosives. 16th Symposium on Atomic and Surface Physics (SASP 2008), Les Diablerets, 20.01.2008 - 25.01.2008
- 75) Probst, M.; Scheier, P.; Märk, T.: Predicting the Sites of Electron Attachment to Biomolecules. 5th European Charge Density Meeting, Gravedona, 06.06.2008 - 11.06.2008
- 76) Ptasinska, S.; Alizadeh, E.; Sulzer, P.; Abouaf, R.; Mason, N.J.; Märk, T.D.; Scheier, P.: Formation of negative ions by low energy (<20 eV) electron impact to gas phase 5-nitrouracil. LEEMI-EIPAM'08, Roscoff, 07.05.2008 - 11.05.2008
- 77) Reichsöllner, E.; Denifl, S.; Mähr, I.; Ferreira da Silva, F.; Zappa, F.; Märk, T.D.; Scheier, P.: Radiation damage of solvated biomolecules. 5th Annual Meeting of the Center of Molecular Biosciences (CMBI), Igls, 26.09.2008 - 27.09.2008
- 78) Reichsöllner, E.; Denifl, S.; Mauracher, A.; Zappa, F.; Probst, M.; Flosadottir, H.D.; Ingolfsson, O.; Jonsson, H.; Märk, T.D.; Scheier, P.: Negative ion formation and fragmentation upon free electron attachment to amino acids. Electron Controlled Chemical Lithography (ECCL) - 2008 Meeting, Lisbon, 12.03.2008 - 16.03.2008
- 79) Schöbel, H.; Ferreira da Silva, F.; Dampc, M.; Denifl, S.; Märk, T.D.; Scheier, P.: Positive and negative ion formation upon free electron interactions with Helium nanodroplets doped with CO₂ and CCl₄. 3rd Annual ITS LEIF Meeting & Summer School, Da Balaia, 19.05.2008 - 24.05.2008
- 80) Aleem, A.; Mahmoodi Darian, M.; Rittenschober, B.; Matejcik, S.; Kocisek, J.; Denifl, S.; Märk, T.D.; Scheier, P.: Effect of the Temperature on Dissociative Electron


- Attachment to Halohydrocarbons. 17th Symposium on Application of Plasma Processes (SAPP XVII), Liptovsky Jan, 17.01.2009 - 22.01.2009
- 81) An der Lan, L.; Schöbel, H.; Ferreira da Silva, F.; Schuhfried, E.; Reichsöllner, E.; Denifl, S.; Märk, T.D.; Scheier, P.: Electron Attachment Experiments to Carbon Dioxide Clusters in Gas Phase and Helium Droplets. 4th International Symposium "Atomic Cluster Collisions: structure and dynamics from the nuclear to the biological scale" (ISACC 2009), Ann Arbor, 14.07.2009 - 18.07.2009
 - 82) Annen, I.; Mauracher, A.; Denifl, S.; Alizadeh, E.; Scheier, P.; Märk, T.D.; Probst, M.; Graupner, K.; Haughey, S.; Field, T.A.: Delayed fragmentations of nitro aromatic explosives resulting from electron attachment. Electron Controlled Chemical Lithography (ECCL) - 2009 Meeting, Istanbul, 04.06.2009 - 09.06.2009
 - 83) Bartl, P.; Edtbauer, A.; Ferreira da Silva, F.; Alizadeh, E.; Mauracher, A.; Denifl, S.; Scheier, P.; Märk, T.D.: Dissociative electron attachment to amino acids in the gas phase. 8. Iglar MS-Tage, Obergurgl, 22.02.2009 - 25.02.2009
 - 84) Bartl, P.; Ferreira da Silva, F.; Denifl, S.; Scheier, P.; Echt, O.; Märk, T.D.: Production and Mass Spectrometric Analysis of Argon Clusters within Helium Clusters. Symposium on Size Selected Clusters (S3C) 2009, Brand, 08.03.2009 - 13.03.2009
 - 85) Edtbauer, A.; Alizadeh, E.; Mauracher, A.; Denifl, S.; Sulzer, P.; Märk, T.D.; Scheier, P.: Dissociative electron attachment to amino acids. Gordon Research Conference on Gaseous Ions: Structures, Energetics & Reactions, Galveston, TX, 01.03.2009 - 06.03.2009
 - 86) Edtbauer, A.; Denifl, S.; Ferreira da Silva, F.; Aleem, A.; Mauracher, A.; Zappa, F.; Probst, M.; Bacher, A.; Echt, O.; Märk, T.D.; Scheier, P.: Water and ammonia clusters in helium nanodroplets doped with C60. Symposium on Size Selected Clusters (S3C) 2009, Brand, 08.03.2009 - 13.03.2009
 - 87) Edtbauer, A.; et al.: Low-energy electron damage to di-pyrimidines and clusters of pyrimidines and implications for radiation damage. Selective bond cleavage by electron induced dissociation, Berlin, 01.05.2009
 - 88) Edtbauer, A.; Mitterdorfer, C.; Russell, K.; Feketeova, L.; An der Lan, L.; Schuhfried, E.; Mauracher, A.; Denifl, S.; O'Hair, R.; Märk, T. D.; Scheier, P.: Low-energy electron damage to Di-Pyrimidines. LIFE SCIENCE Meeting, Igls, 18.09.2009 - 19.09.2009
 - 89) Ferreira da Silva, F.; Denifl, S.; Märk, T.D.; Scheier, P.: Chemistry of L-serie clusters in cold helium nanodroplets. LIFE SCIENCE Meeting, Igls, 18.09.2009 - 19.09.2009
 - 90) Ferreira da Silva, F.; Denifl, S.; Zappa, F.; Mauracher, A.; Märk, T.D.; Scheier, P.: MS of biomolecules embedded in helium droplets. 8. Iglar MS-Tage, Obergurgl, 22.02.2009 - 25.02.2009
 - 91) Haughey, S.; Graupner, K.; Mauracher, A.; Märk, T.D.; Scheier, P.; Field, T.A.: Dissociative Electron Attachment to 2-Nitro-m-xylene. Electron Controlled Chemical Lithography (ECCL) - 2009 Meeting, Istanbul, 04.06.2009 - 09.06.2009
 - 92) Mahmoodi-Darian, M.; Rittenschober, B.; Märk, T.D.; Scheier, P.: Temperature Dependence of Electron Attachment to 2-chlorotoluene, 3-chlorotoluene and 4-chlorotoluene. 4th Annual ITS LEIF Meeting, Playa de Aro, Girona, 15.05.2009 - 22.05.2009
 - 93) Mitterdorfer, C.; Edtbauer, A.; Alizadeh, E.; Mauracher, A.; Denifl, S.; Märk, T. D.; Scheier, P.: Metastable decays of biomolecules. LIFE SCIENCE Meeting, Igls, 18.09.2009 - 19.09.2009
 - 94) Mitterdorfer, C.; Edtbauer, A.; An der Lan, L.; Schuhfried, E.; Mauracher, A.; Denifl, S.; Märk, T.D.; Scheier, P.: Low-energy electron damage to Di-Pyrimidines. 4th Annual ITS LEIF Meeting, Playa de Aro, Girona, 15.05.2009 - 22.05.2009
 - 95) Ptasinska, S.; Mauracher, A.; Denifl, S.; Hunniford, C. A.; Mason, N. J.; Scheier, P.; McCullough, R.W.: Desorption of small fragments from oligonucleotides induced by low energy carbon ions. Radiation damage in biomolecular systems (RADAM 2009), Frankfurt, 01.07.2009 - 05.07.2009
 - 96) Schöbel, H.; Mauracher, A.; Mitterdorfer, C.; Denifl, S.; Märk, T.D.; Illenberger, E.; Scheier, P.: Electron Attachment to Trinitrotoluene embedded in Helium Droplets. 4th International Symposium "Atomic Cluster Collisions: structure and dynamics from

the nuclear to the biological scale" (ISACC 2009), Ann Arbor, 14.07.2009 - 18.07.2009

- 97) Schuhfried, E.; An der Lan, L.; Reichsöllner, E.; Denifl, S.; Ferreira da Silva, F.; Schöbel, H.; Märk, T. D.; Scheier, P.; Bartl, P.: Electron Attachment to Carbon Dioxide Clusters Embedded in Helium Nano-Droplets. 18th International Mass Spectrometry Conference, Bremen, 30.08.2009 - 04.09.2009
- 98) Schuhfried, E.; Reichsöllner, E.; Denifl, S.; Ferreira da Silva, F.; Schöbel, H.; Märk, T.D.; Scheier, P.: Electron attachment to carbon dioxide clusters embedded in helium-nanodroplets. Symposium on Size Selected Clusters (S3C) 2009, Brand, 08.03.2009 - 13.03.2009

List 3 Development of collaborations

Indication of the most important collaborations (maximum 5), that took place (initiated or continued) in collaboration please give the name of the collaboration partner (name, title, institution) and a few words about the scientific content. Please also assign one of the following categories to each collaboration:

N			Nature N (national); E (European); I (other international cooperation)
	E		Extent E1 low (e.g. no joint publications but mention in acknowledgements or similar); E2 medium (collaboration e.g. with occasional joint publications, exchange of materials or similar but no longer-term exchange of personnel); E3 high (extensive collaboration with mutual hosting of group members for research stays, regular joint publications etc.)
		D	Discipline D within the discipline T transdisciplinary



N	E	D	Collaboration partner / content of the collaboration
E	E3	D	1) Name: Eugen Illenberger Title: Prof. Dr. Institution: FU-Berlin Content: DEA to biomolecules, explosives and clusters
I	E2	D	2) Name: Diethard K. Bohme Title: Prof. Dr. Institution: York University Toronto Content: Freezing of reaction intermediates in He nanodroplets
E	E3	D	3) Name: Paulo Limao-Vieira Title: Prof. Dr. Institution: University of Lisbon Content: Electron attachment to explosives
E	E3	D	4) Name: Andrew M. Ellis Title: Prof. Dr. Institution: Leicester University Content: Ion formation in doped He nanodroplets
I	E2	D	5) Name: Shan Xi Tian Title: Prof. Dr. Institution: University of Science and Technology of China, Hefei Content: Temperature dependence of DEA to halo-carbons

Note: general scientific contacts and occasional meetings should not be considered as collaborations in the above sense.

List 4 “Habitations” (professorial qualifications) / PhD theses / diploma theses
with an indication of the status (in progress / completed)

Note: it will not be possible to assign a “Habilitation” to a single project; what is required here is a mention of those “Habitations” for which the project was important. A similar caveat applies to PhD and diploma theses: the FWF does not support thesis work but rather funds the scientific work that forms the basis for theses.

It should be mentioned that several Habitations are presently close to submission where the present project was important.

4.1. Professorial Qualifications

- 1) Paul Scheier, §99 professor in Innsbruck (2008-2010)
- 2) Fabio Zappa, Assistant professor at Juiz de Fora, Brazil, 2009

4.2. PhD Theses

- 1) Abid Aleem, 2010
- 2) Elahe Alizadeh, 2009
- 3) Nikolaus Endstraßeßer, 2009
- 4) Mikhail Gutkin, 2008
- 5) Masoomah Mamoodi-Darian, 2010
- 6) Andreas Mauracher, 2009
- 7) Christian Leidlmair, in progress

4.3. Diploma Theses

- 1) Emanuel Reichsöllner, 2009
- 2) Bernhard Rittenschober, 2009

List 5 Effects of the project outside the scientific field (where appropriate)

Sections of the list:

5.1. Media reports

- 1) Der Standard: Sternenstaub und andere Geheimnisse des Lebens (2. Februar 2010)
- 2) Wiener Zeitung: Nanowelt noch längst nicht erforscht (28. Januar 2010)
- 3) Innovations-Report.de: Kollisionsreiche Konferenz (25. Januar 2010)
- 4) Der Standard: Forschung aus der ersten Liga (13. Januar 2010)
- 5) Wiener Zeitung: Der Känguru-Trick in der Sonne (10. Dezember 2009)
- 6) ORF Tirol: Känguru hilft beim Kampf gegen Hautkrebs (2. Dezember 2009)
- 7) Reuters: Kangaroos may hold key to preventing skin cancer - study (1. Dezember 2009)
- 8) The Age: Kangaroo clue to skin cancer cure (1. Dezember 2009)
- 9) CBS4: Kangaroos Key to Skin Cancer Research (30. November 2009)
- 10) ORF Science: Den Urbausteinen des Lebens auf der Spur (29. Oktober 2009)
- 11) Wiener Zeitung: Zur Entstehung des Lebens (29. Oktober 2009)
- 12) Pro-Physik: Sprengstoff explodiert in Zeitlupe (13. August 2009)
- 13) ORF Science: TNT-Explosion in Zeitlupe (13. August 2009)
- 14) Pro-Physik: Ionen im „fliegenden Labor“ (26. Juni 2009)
- 15) ÖJ: Ionen im „fliegenden Labor“ (25. Juni 2009)
- 16) APA ZukunftWissen: Ionen im "fliegenden Labor" (25. Juni 2009)
- 17) Vorarlberger Nachrichten: Im ultrakalten, fliegenden Labor... (30. Mai 2009)
- 18) Die Presse: Explosive Experimente in Innsbruck (18. April 2009)
- 19) APA ZukunftWissen: Innsbrucker Physiker von deutscher Fachgesellschaft ausgezeichnet (13. März 2009)
- 20) ipoint: Hohe Ehre für Tilmann Märk (13. März 2009)
- 21) Innovations-Report.de: Der winzigste Fußball der Welt (26. Juni 2008)
- 22) Ö1-Dimensionen: (20. Juni 2008)
- 23) ipoint: Tilmann Märk in die Deutsche Akademie Leopoldina gewählt (3. Juni 2008)
- 24) ipoint: Fachzeitschrift zeichnet Ionenphysiker der Universität Innsbruck aus (29. April 2008)
- 25) Echo: Nanobombe (Erschienen in ECHO Science Nr. 2; Beilage zu ECHO - Tirols erste Nachrichtenillustrierte 10/2007)
- 26) ipoint: Neon: Ein Edelgas mit Rätseln (24. Januar 2007)
- 27) Pro-Physik: Edelgas mit Rätseln (22. Januar 2007)
- 28) ÖJ: Neon: Ein Edelgas mit Rätseln (19. Januar 2007)
- 29) ORF-Wissenschaftsmagazin Newton: Tanzende DNA (5. November 2006)
- 30) Wiener Zeitung: Wenn die Erbsubstanz "taktlos" ist (28. September 2006)
- 31) Der Standard: Krebs, eine Resonanzkatastrophe (27. September 2006)
- 32) Pro-Physik-de: Taktlose Erbsubstanz (26. September 2006)
- 33) ipoint: Kopf der Woche: Dr. Paul Scheier (4. September 2006)
- 34) Echo: Weltpremiere (Erschienen in ECHO - Tirols erste Nachrichtenillustrierte 09/2006)
- 35) Wiener Zeitung: Entstehen Biomoleküle im All? (19. August 2006)
- 36) Die Presse: Wie DNA-Basen brechen (19. August 2006)
- 37) ORF ON Science: Erbsubstanz konnte im Weltall entstehen (18. August 2006)
- 38) profil: Von der Fiction zur Fusion (aus: Nachrichtenmagazin profil, Ausgabe 19/06)
- 39) Mitteilungsblatt der Österreichischen Physikalischen Gesellschaft: Tilmann Märk Ehrendoktor der Comenius-Universität (Mai 2006)

5.2. Particular honours, prizes etc.

Märk, T.D. (2006) Honorary doctor at the Comenius-University Bratislava, Slovak Republic

Märk, T.D. (2008) Member of the German „Akademie der Naturforscher Leopoldina“

Märk, T.D. (2009) Wolfgang Paul Lecture Award

Mauracher, A. (2009) "Award of Excellence" des BMWF für besonders herausragende Dissertationen

Scheier, P. (2009) Forschungspreis der Stiftung Südtiroler Sparkasse

Sulzer, P. (2008) Award of Excellence des Bundesministeriums für Wissenschaft und Forschung

Sulzer, P.W. (2008) Wissenschaftspreis 2008 der Wirtschaftskammer Tirol

List 6. Applications for follow-up projects

with an indication of the status (submitted / approved) and the funding organization.

6.1 Applications for follow-up projects (FWF projects)

(with an indication of the project type, e.g. stand-alone project, NFN, SFB, WK, fellowship, contribution to a stand-alone publication)

- 1) FWF Positive ion formation in doped rare gas droplets, submitted
- 2) DACH Coherent control of doped helium droplets (I 641-N20) submitted

6.2 Applications for follow-up projects (Other national projects)

(e. g. FFG, CD Laboratory, a K-plus Centre, funding from the Austrian National Bank, the Federal Government, the provincial government or similar)

- 1) FFG-Bridge: Online Sprengstoffdetektion über Zerfallsprozesse von Anionen (Expond) approved

5. Zusammenarbeit mit dem FWF

Sie werden gebeten folgende Aspekte der Zusammenarbeit mit dem FWF zu bewerten. **Anmerkungen (Ausführungen)** unter Verweis auf den entsprechenden Referenzpunkt bitte auf Beiblatt.

Skala
-2 sehr unzufriedenstellend,
-1 unzufriedenstellend;
0 angemessen;
+1 zufriedenstellend;
+2 sehr zufriedenstellend.
X nicht beansprucht

Regelwerk

(Richtlinien für Programm, Antrag, Verwendung, Bericht)

Wertung

Antragsrichtlinien	Umfang	+2
	Übersichtlichkeit	+2
	Verständlichkeit	+2

Verfahren (Einreichung, Begutachtung, Entscheidung)

	Beratung	+2
	Dauer des Verfahrens	+2
	Transparenz	+2

Projektbegleitung

Beratung	Verfügbarkeit	+2
	Ausführlichkeit	+2
	Verständlichkeit	+2

Durchführung Finanzverkehr (Überweisungen, Gerätebeschaffungen, Personalwesen)		+2
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Berichtswesen/ Prüfung/ Verwertung

	Aufwand	X
	Transparenz	X
	Unterstützung bei Öffentlichkeitsarbeit/ Verwertung	X

Anmerkungen zur Zusammenarbeit mit dem FWF:

The cooperation works very well, obviously the FWF should fight for more funding money as compared to other national funding associations.