XXVII ICPEAC

27th International Conference on Photonic, Electronic and Atomic Collisions

Belfast, United Kingdom
27 July – 2 August, 2011

Conference Programme

Edited by:
Ian Williams, Gleb Gribakin
and Hugo van der Hart
XXVII ICPEAC Local Organising Committee

(Queen’s University Belfast unless denoted otherwise: DCU – Dublin City University, NUIM – National University of Ireland Maynooth, UCD – University College Dublin.)

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XXVII ICPEAC

Scientific Program

PL: Plenary Lecture (55 min + 5 min discussion)

PR: Progress Report (25 min + 5 min discussion)

SR: Special Report (13 min + 2 min discussion)

Tuesday, 26 July 2011

15:00 – 21:00  Registration in the Physics Department

18:00 – 21:00  Welcome Reception in the Ulster Museum
Wednesday, 27 July 2011

08:30 – 09:00  XXVII ICPEAC OPENING in the Whitla Hall

09:00 – 10:00  Plenary Session in the Whitla Hall  
(chair: Barry Dunning, Rice University, Houston, USA)  
Margaret Murnane (JILA, University of Colorado, Boulder, USA)  
PL: Ultrafast processes in atomic dynamics

10:00 – 10:30  Coffee break

10:30 – 12:30  Photons Session 1 in the Whitla Hall  
(chair: Johan Mauritssson, Lund University, Sweden)  
Rupamanjari Ghosh (Jawaharlal Nehru University, India)  
PR: Electromagnetically-induced transparency, slow light, and negative group velocities in room-temperature “He”

11:00 – 11:30  Noriyuki Kouchi (Tokyo Institute of Technology, Japan)  
PR: Dynamics of entangled H(2p) pair generated in the photodissociation of H2

11:30 – 12:00  Stefanie Gräfe (Vienna University of Technology, Austria)  
PR: Control of electronic wavepacket dynamics in atomic and molecular systems in strong multi-color fields

12:00 – 12:30  Raimund Feifel (Uppsala University, Sweden)  
PR: Multi-electron coincidence studies of double core-hole creation and double core hole decay processes in molecules

10:30 – 12:30  Leptons Session 1 in the David Keir Building  
(chair: Birgit Lohmann, University of the Sunshine Coast, Australia)  
Andrew Murray (University of Manchester, UK)  
PR: Electron impact excitation and ionization studies of laser prepared atomic targets

11:00 – 11:30  Chenzhong Dong (Northwest Normal University,)  
PR: Theoretical study on electron impact excitation and recombination of highly charged ions

11:30 – 12:00  Carsten Müller (MPI für Kernphysik, Heidelberg, Germany)  
PR: Electron recombination in dense photonic, electronic and atomic environments

12:00 – 12:30  Connor Ballance (Auburn University, USA)  
PR: An R-matrix approach for plasma modelling and the interpretation of astrophysical observation

12:30 – 14:00  Lunch

14:00 – 16:00  Photons Session 2 in the Whitla Hall  
(chair: Matjaz Zitnik, Institut Jozef Stefan, Slovenia)  
Catalin Miron (Synchrotron SOLEIL, l’Orme des Merisiers, France)  
PR: Decay dynamics and nuclear motion of core-excited species probed by high-resolution soft X-ray electron spectroscopy

14:30 – 15:00  Kaoru Yamanouchi (The University of Tokyo, Japan)  
PR: Ultrafast probing of molecules in intense laser fields by coincidence momentum imaging and gas electron diffraction

15:00 – 15:30  Manoj Harbola (Indian Institute of Technology, Kanpur, India)  
PR: Excited-state density functional theory

15:30 – 16:00  Henning Schmidt (Stockholm University, Sweden)  
PR: The lifetime of the He anion

14:00 – 16:00  Heavy Particles Session 1 in the David Keir Building  
(chair: Amine Cassimi, GANIL, France)  
Réka Bereczky (ATOMKI, Hungary)  
PR: Controlling the guiding properties of mesoscopic glass capillaries for slow highly charged ions

14:30 – 15:00  Steen Brondsted Nielsen (Aarhus University, Denmark)  
PR: Gas-phase spectroscopy of biomolecular ions: Porphyrins and metalloporphyrins

15:00 – 15:30  Walter Meissl (RIKEN, Japan)  
PR: Application of insulating nanocapillaries in living human cell irradiation

15:30 – 15:45  Jérôme Bernard (Université de Lyon, France)  
SR: Statistical and nonstatistical dissociation processes of tungsten hexacarbonyl W(CO)6 in collisions with protons, fluorine and chlorine ions

15:45 – 16:00  Chris Calvert (Queen’s University Belfast, UK)  
SR: LIAD-FS: A new technique for gas-phase studies of biomolecules

16:00 – 18:00  Poster Session in the Students Union

19:00 – 20:00  Public Lecture in the Whitla Hall: Professor Mike Baillie  
How precise tree-ring dating raises issues concerning the frequency of extraterrestrial impacts  
(chair: Ciaran Lewis, co-chair ICPEAC Local Organising Committee)
Thursday, 28 July 2011

09:00 – 10:00  Plenary Session in the Whitla Hall  
(chair: Joachim Burgdörfer, Vienna University of Technology, Austria)  
Yasunori Yamazaki (RIKEN, Wako, Japan)  
PL: Antiproton and positron collisions

10:00 – 10:30  Coffee break

10:30 – 12:30  Leptons Session 2 in the Whitla Hall  
(chair: Klaus Bartschat, Drake University, USA)  
10:30 – 11:00  Stephan Denifl (University of Innsbruck, Austria)  
PR: Fullerenes ions covered with helium and hydrogen

11:00 – 11:30  Isabella Baccarelli (CASPUR Supercomputing Consortium, Italy)  
PR: Quantum scattering of low-energy electrons by molecules of biological interest

11:30 – 12:00  Carl Winstead (California Institute of Technology, USA)  
PR: Low-energy electron interactions with biomolecules

12:00 – 12:15  Filipe Ferreira da Silva (Universidade Nova de Lisboa, Portugal)  
PR: Site and bond selective H formation in methylated pyrimidine bases driven by potassium molecule collisions

12:15 – 12:30  Jessica Brunton (Australian National University, Australia)  
PR: Anomalously large low-energy elastic cross sections for electron scattering form the CF₃ radical

10:30 – 12:30  Heavy Particles Session 2 in the David Keir Building  
(chair: Fernando Martin, Universidad Autonoma de Madrid, Spain)  
10:30 – 11:00  Anne Holm (Aarhus University, Denmark)  
PR: Ionization and fragmentation of cold clusters of PAH molecules: collisions with keV ions

11:00 – 11:30  Karine Béwoff (Université Paris Sud, France)  
PR: Fragmentation of multi-charged and highly excited clusters

11:30 – 12:00  Sébastien Zamith (Université Toulouse, France)  
PR: Attachment and fragmentation cross-sections of water clusters

12:00 – 12:15  Martino Trassinelli (Université Pierre et Marie Curie, France)  
SR: Determining clustering properties through the selectivity of collision dynamics

12:15 – 12:30  Kunihiro Okada (Sophia University, Tokyo, Japan)  
SR: Laser-induced reactions between a Ca²⁺ Coulomb crystal and polar molecules

12:30 – 14:00  Lunch

14:00 – 16:00  Photons Session 3 in the Whitla Hall  
(chair: Stephan Fritzschke, University of Heidelberg, Germany)  
14:00 – 14:15  Mathieu Gisselbrecht (Lund University, Sweden)  
SR: Exploring single-photon ionization on the attosecond time scale

14:15 – 14:30  Renate Pazourek (Vienna Institute of Technology, Austria)  
SR: Probing scattering phase shifts by attosecond streaking

14:30 – 15:00  Richard Taib (Université Pierre et Marie Curie, France)  
PR: Attosecond imaging of molecular electronic wave-packet

15:00 – 15:30  Ursula Keller (ETH Zürich, Switzerland)  
PR: Attoclock reveals new insights into tunnel ionization

15:30 – 16:00  Nora Berrah (Western Michigan University, USA)  
PR: X-Ray FEL induced multiple ionization and double core-hole production

14:00 – 16:00  Leptons Session 3 in the David Keir Building  
(chair: Jimena Gorfinkiel, The Open University, UK)  
14:00 – 14:30  Ann Orel (University of California, Davis, USA)  
PR: Resonant enhanced electron impact dissociation of molecules

14:30 – 15:00  Oldrich Novotny (Columbia University, USA)  
PR: Astrochemistry with ion storage rings

15:00 – 15:30  Romarly da Costa (Universidade Federal do ABC, Brazil)  
PR: Low-energy elastic and electronically inelastic electron scattering from biomolecules: the role of polarization and multichannel coupling effects

15:30 – 16:00  Jonathan Tennyson (University College London, UK)  
PR: Electron and positron molecule collisions using the R-matrix with pseudostates method

16:00 – 18:00  Poster Session in the Students Union

18:30 – 20:30  Reception at the Belfast City Hall
Friday, 29 July 2011

09:00 – 11:30  Poster Session in the Students Union

11:30 – 12:30  Plenary Session in the Whita Hall
   (chair: Hartmut Hotop, Technische Universität Kaiserslautern, Germany)
   Michael Allan (University of Fribourg, Switzerland)
   PL: Electron-molecule collisions

12:30 – 14:00  Lunch

14:00 – 16:00  Photons Session 4 in the Whita Hall
   (chair: Johannes Feist, ITAMP, Harvard, USA)
   14:00 – 14:15  Jhon Pérez-Torres (Universidad Autónoma de Madrid, Spain)
   SR: Attosecond control in photoionization of D₂
   14:15 – 14:30  Boris Bergues (MPI für Quantenoptik, Garching, Germany)
   SR: Confining the double ionization dynamics of argon to half of a laser cycle
   14:30 – 15:00  Giuseppe Sansone (Politecnico Milano, Italy)
   PR: New perspectives in attosecond physics
   15:00 – 15:30  Kiyonobu Nagaya (Kyoto University, Japan)
   PR: Multiple photoionization of rare-gas clusters by EUV-FEL at Spring-8
   15:30 – 16:00  Yuhai Jiang (MPI für Kernphysik, Heidelberg, Germany)
   PR: XUV-pump XUV-probe experiments at FELs

14:00 – 16:00  Heavy Particles Session 3 in the David Keir Building
   (chair: Maria Silvia Gravieri, Universidad de Buenos Aires, Argentina)
   14:00 – 14:15  Jyoti Rajput (University of Delhi, India)
   SR: Energetic Rydberg neutrals from water dissociation
   14:15 – 14:30  Xichen Wang (MPI für Kernphysik, Heidelberg, Germany)
   SR: Kinematically complete studies on mutual projectile and target ionization
   14:30 – 14:45  Hajime Tanuma (Tokyo Metropolitan University, Japan)
   SR: Unexpected mobility of OH⁻ and OD⁻ molecular ions in cooled gas
   14:45 – 15:00  Claire Couratin (Université de Caen Basse-Normandie, France)
   SR: Measurement of the ³Li charge state distributions following the ⁴He⁺ beta decay
   15:00 – 15:30  Yuji Nakano (RIKEN Advanced Science Institute, Japan)
   PR: Controlling and probing of highly charged ions up to Li-like U⁶⁰⁺ by resonant coherent excitation
   15:30 – 16:00  Xavier Fléchard (Laboratoire de Physique Corpusculaire de CAEN, France)
   PR: Asymmetry in multiple-electron capture revealed by Radiative Charge Transfer in Ar dimers

16:00 – 16:30  Coffee break

16:30 – 18:00  Photons Session 5 in the Whita Hall
   (chair: Uwe Becker, FHI, Berlin, Germany)
   16:30 – 17:00  Eiji Takahashi (RIKEN, Japan)
   PR: Generation of microjoule isolated attosecond pulses by infrared two-color laser field synthesis
   17:00 – 17:30  Will Bryan (Swansea University, UK)
   PR: Electronic and nuclear dynamics revealed by ultrashort tuneable-XUV and strong-field laser pulses
   17:30 – 17:45  Hendrik Sann (Goethe-Universität, Frankfurt, Germany)
   SR: Electron diffraction self imaging of molecular fragmentation in two step double ionization of water
   17:45 – 18:00  David Kilcoyne (Lawrence Berkeley National Laboratory, USA)
   SR: Confinement resonances in photoionization of endohedral Xe@C₆₀⁺

16:30 – 18:00  Leptons Session 4 in the David Keir Building
   (chair: Jim Williams, University of Western Australia, Perth, Australia)
   16:30 – 17:00  Anne Lafosse (Institut des Sciences Moléculaires d’Orsay, France)
   PR: Electron induced chemistry in molecular solids
   17:00 – 17:30  Aleksandar Milosavljević (University of Belgrade, Serbia)
   PR: Transmission of low-energy electrons through Al₂O₃ nanopillaries
   17:30 – 17:45  Thomas Pflüger (MPI für Kernphysik, Heidelberg, Germany)
   SR: A kinematically complete (e,2e)-experiment on small rare gas clusters
   17:45 – 18:00  Kirill Gokhberg (Universität Heidelberg, Germany)
   SR: Environment assisted electron capture
Monday, 1 August 2011

08:30 – 10:00   Plenary Session in the Whitla Hall
                (chair: Yaming Zou, Fudan University, China)

08:30 – 09:30   Thomas Stöhlker (Universität Heidelberg, Germany)
                PL: Relativistic ion collisions

09:00 – 10:00   IUPAP Young Scientist Prize Lecture:
                Ian Spielman (NIST, Gaithersburg, USA)
                Modifying interatomic interactions using Raman coupling: a tale of slowly colliding Bose-Einstein condensates

10:00 – 10:30   Coffee break

10:30 – 12:30   Heavy Particles Session 4 in the Whitla Hall
                (chair: Don Madison, Missouri University of Science & Technology, USA)

10:30 – 11:00   Tom Kirchner (York University, Toronto, Canada)
                PR: Calculations for charge transfer and ionization in heavy-particle collisions from water molecules

11:00 – 11:30   Roberto Rivarola (UNR-CONICET, Rosario, Argentina)
                PR: Partial localization and symmetries in coherent electron emission from molecules

11:30 – 12:00   Anna Simon (Michigan State University, USA)
                PR: Radiative double electron capture (RDEC) in ion-atom collisions

12:00 – 12:30   Lothar Schmidt (Goethe-Universität, Frankfurt, Germany)
                PR: Imaging of $H_2^+$ vibrational wavefunctions via dissociative electron transfer

10:30 – 12:30   Photons Session 6 in the David Keir Building
                (chair: Kiyoshi Ueda, Tohoku University, Japan)

10:30 – 11:00   Christoph Lemell (Vienna University of Technology, Austria)
                PR: Time-resolved photoelectron emission from surfaces

11:00 – 11:30   Uwe Hergenhahn (MPI für Plasmaphysik, Garching, Germany)
                PR: Cluster autoionization via ultrafast energy transfer and charge transfer

11:30 – 12:00   Nicolas Sisourat (Université Pierre et Marie Curie, France)
                PR: Giant interatomic Coulombic decay

12:00 – 12:15   Michael Lysaght (Queen’s University Belfast, UK)
                SR: The RMT method for describing many-electron atoms in intense short laser pulses

12:15 – 12:30   Elena Gryzlova (Moscow State University, Russia)
                SR: Angular distributions and correlations in sequential three-photon triple atomic ionization

12:30 – 14:00   Lunch

14:00 – 16:00   Leptons Session 5 in the Whitla Hall
                (chair: Gaetana Laricchia, University College London, UK)

14:00 – 14:30   Cliff Surko (University of California, San Diego, USA)
                PR: Positron binding to molecules

14:30 – 15:00   Dmitry Fursa (Curtin University, Perth, Australia)
                PR: Positron scattering from noble gases

15:00 – 15:30   Yasuyuki Nagashima (Tokyo University of Science, Japan)
                PR: Spectroscopy of positronium negative ions

15:30 – 15:45   Sergio Sanchez (Universidade Federal do Paranã, Brazil)
                SR: Multimode vibrational couplings in resonant positron annihilation

15:45 – 16:00   Simon Brawley (University College London, UK)
                SR: The production of positronium and its resonant scattering

14:00 – 16:00   Heavy Particles Session 5 in the David Keir Building
                (chair: Xinwen Ma, Institute of Modern Physics, Chinese Academy of Sciences, China)

14:00 – 14:30   Ara Chutjian (Jet Propulsion Laboratory, California Institute of Technology, USA)
                PR: Collision physics in the atomic and molecular universe

14:30 – 15:00   Sebastian Otranto (Universidad Nacional del Sur, Bahia Blanca, Argentina)
                PR: Charge exchange processes involving highly-charged ions and targets of astrophysical and fusion plasma interest

15:00 – 15:30   Claudia Montanari (Institute of Astronomy and Space Physics, Buenos Aires, Argentina)
                PR: Multiple ionization of atoms including post-collisional contributions

15:30 – 15:45   Kenneth Miller (Columbia University, USA)
                SR: Measurement of the associative detachment reaction $H_2^+ \rightarrow H_2 + e^-$ using a merged-beams method

15:45 – 16:00   Radek Plašil (Charles University, Prague, Czech Republic)
                SR: Radiative association of $H^+$ and $H_2^+$ – experimental study

16:00 – 18:00   Poster Session in the Students Union

19:00 – 22:00   Conference Banquet at the Ramada Hotel (buses depart 18.15)
Tuesday, 2 August 2011

08:30 – 11:00  Poster Session in the Students Union

11:00 – 12:00  Plenary Session in the Whitla Hall

  (chair: Phil Burke, Queen’s University Belfast, UK)

  Chris Greene (University of Colorado, Boulder, USA)

PL: Few-body highly-correlated dynamics

12:00 – 12:30  ICPEAC Business Meeting in the Whitla Hall

12:30 – 14:00  Lunch

14:00 – 16:00  Photons Session 7 in the Whitla Hall

  (chair: Hema Ramachandran, Raman Research Institute, Bangalore, India)

14:00 – 14:30  Michael Drewsen (University of Aarhus, Denmark)

  PR: Single molecular ion investigations

14:30 – 15:00  Alban Kellerbauer (MPI für Kernphysik, Heidelberg, Germany)

  PR: Negative osmium ions: Spectroscopy and fundamental applications

15:00 – 15:30  Antoine Browaeys (Université Paris-Sud, France)

  PR: Entanglement of two individual atoms using Rydberg blockade

15:30 – 16:00  Randall Hulet (Rice University, Houston, USA)

  PR: Three and four-body Efimov states in an ultracold atomic gas

14:00 – 16:00  Leptons Session 6 in the David Keir Building

  (chair: Nigel Badnell, University of Strathclyde, UK)

14:00 – 14:30  Stefan Schippers (Justus-Liebig-University Giessen, Germany)

  PR: Storage-ring ionization and recombination experiments with multiply charged ions relevant to astrophysical and fusion plasmas

14:30 – 15:00  Cristina Lopes (Universidade Federal de Juiz de Fora, Brazil)

  PR: Low-energy electron scattering from fuels

15:00 – 15:30  Christopher Fontes (Los Alamos National Laboratory, USA)

  PR: Atomic data and the modeling of supernova light curves

15:30 – 15:45  Dietrich Bernhardt (Justus-Liebig-Universität Giessen, Germany)

  SR: Dielectronic recombination of metastable berylliumlike xenon ions

15:45 – 16:00  Oleg Zatsarinny (Drake University, USA)

  SR: Electron scattering from krypton: High-resolution electron scattering experiments and B-spline R-matrix calculations

16:00 – 16:30  Coffee break

16:30 – 18:00  Photons Session 8 in the Whitla Hall

  (chair: Uwe Hergenhahn, MPI für Plasmaphysik, Germany)

16:30 – 17:00  Moritz Kurka (MPI für Kernphysik, Heidelberg, Germany)

  PR: Multiphoton ionization and pump-probe experiments at FLASH

17:00 – 17:30  Akiyoshi Hishikawa (Nagoya University, Japan)

  PR: Shot-by-shot photoelectron spectroscopy of non-linear processes of atoms in intense EUV FEL fields

17:30 – 18:00  Michael Meyer (WH European XFEL GmbH, Hamburg, Germany)

  PR: Two-colour FEL experiments in the gas phase

16:30 – 18:00  Heavy Particles Session 6 in the David Keir Building

  (chair: Bernard Pons, University of Bordeaux, France)

16:30 – 17:00  Kaifeng Zhao (Fudan University, China)

  PR: Dwell time measurement of wall collisions of spin polarized Rb atoms on antirelaxation coatings

17:00 – 17:30  Nikolaus Stolterfoht (Helmholtz-Zentrum Berlin, Germany)

  PR: Dynamics of ion guiding through nanocapillaries in insulating polymers

17:30 – 18:00  Helmut Winter (Humboldt-Universität, Berlin, Germany)

  PR: Fast atom diffraction at surfaces

END OF CONFERENCE
Speaker Abstracts
Wednesday, 27 July 2011

PL: Ultrafast processes in atomic dynamics

Margaret Murnane

JILA, University of Colorado, Boulder, USA

High-order harmonic generation (HHG) results from the extreme distortion of an electron wave function of an atom or molecule in the presence of a strong femtosecond laser field. Using a simple analogy, an atom or molecule driven by a strong laser field behaves like an antenna - the radiated field will depend on the shape and dynamics of the antenna.

In this work, we demonstrate bright coherent HHG X-rays at photon energies up to 1.6 keV (<7.8 Å) for the first time, promising to realize a coherent ultrafast implementation of the Roentgen X-ray tube on a tabletop (see Fig. 1). By using a longer driving laser wavelength, the atom is tunnel-ionization by the laser field, while the strongly-driven electron has significantly higher recollision energy. When combined with optimal conditions under which the laser and generated harmonics can travel through the medium at the same phase velocity, full phase matching up to the 5031st harmonic order is possible using driving laser wavelengths of 3.9μm. [1-6]

We also generate the broadest coherent supercontinuum to date of ~1 keV, from any light source, large or small scale. This ultrabroad bandwidth can support unprecedented single-digit attosecond pulse durations – 2.5 as – scalable to zeptosecond time scales (1 zs = 10^{-21} s). It was already shown that the phase matching gating process selects a single HHG burst from the train of HHG pulses. Thus, it is likely that isolated, few-attosecond pulses can be generated in the keV region. Extrapolating the phase matching to shorter X-ray wavelengths and broader supercontinua, this mechanism should lead to sub-attosecond (zeptosecond) pulses.

Finally, tomographic reconstruction of molecular orbitals from the HHG signal from molecules is predicted to be more straightforward for higher-energy recolliding electrons. In recent exciting work, we observed record HHG emission to >0.4keV from an unaligned N₂ molecular sample.

Looking to the future, ultrafast X-rays are ideal probes of the nanoworld, enabling elemental and chemically-specific imaging of thick samples at the level of electrons. The unprecedented femtosecond-to-attosecond pulse duration and full spatial coherence of HHG beams makes it possible to capture the coupled motions of electrons, spins and atoms in molecules and materials in real time.

**PR: Electromagnetically-induced transparency, slow light, and negative group velocities in room-temperature $^4$He**

Rupamanjari Ghosh

School of Physical Sciences, Jawaharlal Nehru University, New Delhi 110067, India

In this talk, I will review some of our recent work [1-6] involving electromagnetically-induced transparency (EIT) in room-temperature metastable $^4$He in a discharge cell. We have carved out a L-system using polarization-selective transitions. EIT has been observed with resonance widths as low as 10 kHz. Using pulses of bandwidth well within the EIT window, controllable delays of a few ms has been measured in a cell of length 2.5 cm. A theoretical model has been developed taking into account all the relevant decoherence processes including collisions. We have observed transitions from slow to fast to negative group-velocity light when the one-photon detuning is varied. We have also been able to select a tripod system using a weak magnetic field. Interesting interplay between EIT resonances has been recorded and interpreted.

The work has been carried out by the authors listed in the cited publications, with the experiments performed at the CNRS-Laboratoire Aimé Cotton, Université Paris Sud 11, Orsay, France, under an Indo-French Networking Project, and also supported by the Indo-French Centre for the Promotion of Advanced Research.


**PR: Dynamics of entangled H(2p) pair generated in the photodissociation of H$_2$**

Noriyuki Kouchi

Department of Chemistry, Tokyo Institute of Technology, Japan

It was predicted by our group that the entangled pair of H(2p) atoms is generated in the photodissociation of H$_2$ and the angular correlation of two Lyman–α photons emitted by them shows the strong anisotropy due to the entanglement [1]. We recently measured the angular distribution of two Lyman–α photons in the photodissociation of H$_2$ and found that the experimental results approach the theoretical prediction with decreasing the hydrogen gas pressure from 0.40 Pa to 0.02 Pa, which indicates the generation of the entangled H(2p) pair as predicted [2, 3]. The pressure effect on the angular distribution turned out to be attributed to the reaction of the entangled H(2p) pair with an H$_2$ molecule. It is roughly two orders of magnitude faster than the reaction of a single H(2p) atom with an H$_2$ molecule [2]. We further demonstrated that at 0.02 Pa the decay time constant in the coincidence time spectrum of two Lyman–α photons is approximately half the lifetime of a single H(2p) atom, i.e. 1.60 ns, while at 0.40 Pa it is in agreement with 1.60 ns [3]. Interestingly entangled H(2p) atoms look as if they decay faster than a single H(2p) atom.

In this talk, some recent activities regarding control of electronic dynamics by mid-intense few-color laser pulses are presented. The first part concentrates on purely theoretical results where the localization dynamics of an electron in a diatomic molecule is steered using trains of half-cycle pulses. Solving the coupled nuclear-electronic Schrödinger equation of bound and dissociative model systems, the control landscape and the mechanism is explored [1,2]. The second part of the talk focuses on very recent mixed theoretical and experimental research on control of electronic ionization dynamics in rare gas atoms. Experiments (performed by M. Kitzler et al., VUT Vienna) have measured the coincidence momentum distribution of those atoms subjected to the combined high intensity of two equally strong color fields, varying the relative phase between the two colors. Theory shows that scanning the relative phase serves as a probe of the Coulomb potential of the ionized atom. Depending on the relative phase, the Coulomb influence can be mapped into asymmetries of the momentum distribution of the electrons [3].


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Energies of the hollow molecules CH$_4^{2+}$ and NH$_3^{2+}$ with double vacancies in the 1s shells have been measured using an efficient coincidence technique combined with synchrotron radiation [1]. The energies of these states have been determined accurately by high-level electronic structure calculations and can be well understood on the basis of a simple theoretical model. Their major decay pathway, successive Auger emissions, leads first to a new form of triply charged ion with a core hole and two valence vacancies; experimental evidence for such a state is presented with its theoretical interpretation. Pre-edge 2-hole-1-particle (2h-1p) states at energies below the double core hole states are located in the same experiments and their decay pathways are also identified. To demonstrate the structure sensitivity of double inner-shell hole spectroscopy, we have measured energies of H$_2$S$^{2+}$, SO$_2^{2+}$, and CS$_2^{2+}$ with the two vacancies in the sulfur 2p shell [2]. We will discuss how to extract intrinsic chemical information, which is masked by the orbital relaxation effect in conventional core-level photoelectron spectroscopy.

Work done in collaboration with J.H.D. Eland, P. Linusson, K. Ueda, M. Tashiro, M. Ehrara, and O. Takahashi. Work funded by the Swedish Research Council (VR), the Göran Gustafsson Foundation (UU/KTH) and the Knut and Alice Wallenberg Foundation, Sweden.

PR: Electron impact excitation and ionization studies of laser prepared atomic targets

Andrew James Murray

School of Physics & Astronomy, University of Manchester, Manchester M13 9PL, UK

In this presentation experiments will be described that study electron impact excitation and ionization of laser prepared atomic targets. These have been carried out at low incident energies (~5eV to 70eV), and include studies of ionization of laser aligned Mg atoms using the (e,2e) technique [1], excitation of Ca and other targets in super-elastic studies [2,3], and the preparation of a cold ensemble of K atoms in an AC-driven Magneto Optical Trap [4]. By using high resolution continuous wave (CW) lasers in combination with electron impact processes, the advantages of both can be fully exploited to ascertain additional information about the interactions. Experimental results will be presented, and new techniques being developed in Manchester will be discussed. These techniques include the use of deep UV CW laser systems, adoption of new methods for the production of cold atoms that allow interactions with low energy electrons to be carried out, and the investigation of electron scattering from atoms excited by laser radiation in an optical enhancement cavity.


PR: Theoretical study on electron impact excitation and recombination of highly charged ions

Chen-Zhong Dong

Key Laboratory of Atomic and Molecular Physics and Functional Materials of Gansu Province, College of Physics and Electronic Engineering, Northwest Normal University, Lanzhou 730070, China

Electron impact excitation and recombination are the most essential atomic processes. A systematical study on these processes will be helpful for both the understanding of atomic and/or ionic excited structures and the modelling of various plasma properties. Recently, based on the GRASP92/2K and RATIP packages which were developed under the multi-configuration Dirac-Fock (MCDF) method, some new programs, such as REDR05 for dielectronic recombination (DR), RERR06 for radiative recombination (RR) and REIE06 for electron impact excitation (EIE), have been developed by us. By using these new programs, some detailed studies have been carried out for EIE, polarization of the emitted photons following EIE, radiative electron capture (REC), RR, DR and the interference between RR and DR for highly charged ions. In this presentation, some selected examples will be presented and discussed in details.
Electron recombination in dense photonic, electronic and atomic environments

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Free electrons can recombine with atomic ions by either radiative, dielectronic or three-body recombination. In this contribution we discuss variants of these fundamental processes which can occur in dense photonic, electronic and atomic environments. First, we generalize dielectronic recombination to the case where two atomic centers participate in the process [1]. In this situation, the incident electron is captured at one center with simultaneous excitation of a neighboring ion, atom or molecule which subsequently decays via photo-emission. The process relies on resonant two-center electron-electron correlations and can be remarkably strong. Afterward, we discuss modifications of radiative recombination in the presence of a strong laser field. Various relativistic effects, arising from a high energy of the incoming electron and its strong coupling to the intense laser field, are found to clearly manifest themselves in the energy and angular spectra of the emitted photons [2]. Finally, we consider three-body “recombination” (i.e. annihilation) of an electron and a positron via single-photon emission in the presence of an additional spectator electron [3]. The process is shown to be competitive with the usual annihilation into two photons at very high electronic densities. Here, the time-reversed process is trident photo-production of electron-positron pairs [4].


An R-matrix approach for plasma modelling and the interpretation of astrophysical observation

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Over the last decade an Auburn-Rollins-Strathclyde consortium has developed several suites of parallel R-matrix codes [1] that can meet the fundamental data needs required for the interpretation of astrophysical observation and/or plasma experiments. Traditionally our collisional work on light fusion-related atoms has been focused towards spectroscopy and impurity transport for magnetically confined fusion devices. Our approach has been to provide a comprehensive data set for the excitation/ionisation for every ion stage of a particular element. As we progress towards a burning fusion plasma, there is a demand for the collisional processes involving tungsten, which has required a revitalisation of the relativistic R-matrix approach. The implementation of these codes on massively parallel supercomputers has facilitated the progression to models involving thousands of levels in the close-coupling expansion required by the open d and f sub-shell systems of mid Z tungsten. This work also complements the electron-impact excitation of Fe-Peak elements required by astrophysics, in particular the near neutral species, which offer similar atomic structure challenges. Although electron-impact excitation work is our primary focus in terms of fusion application, the single photon photoionisation codes are also being developed in tandem, and benefit greatly from this ongoing work. I will describe our code developments in relation to the application needs that drive these innovations.

Decay dynamics and nuclear motion of core-excited species probed by high-resolution soft X-ray electron spectroscopy

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When performed in ultra-high resolution conditions, X-ray spectroscopies provide an accurate probe of ultrafast (fs) decay dynamics, in particular for isolated, inner-shell excited species [1]. Unprecedented scientific opportunities are being offered by the bright and highly monochromatic X-ray beams coupled to state-of-the-art instrumentation available at the newest facilities for dilute matter spectroscopy, such as the PLEIADES beamline at the SOLEIL (France), operated as a user facility since March 2010.

Following the first experimental evidence of Vibrational Scattering Anisotropy (VSA) in the resonant Auger decay of core-excited C$_2$H$_2$ [2], we have recently observed VSA for the decay of the O$_1s$→$\sigma^*$ excited state in molecular oxygen and we predict this type of breakdown of the Born-Oppenheimer approximation to be a general phenomenon, which is possible to observe for a variety of situations as soon as experimental resolution is high enough. In molecular nitrogen, Doppler-limited resonant Auger spectroscopy ($\approx$50 meV total linewidth) has allowed us to experimentally reconstruct the potential energy curve for selected electronic state of N$_2$, in good agreement with ab initio calculated potential. The possibility to generate circularly polarized light (CPL) has been used to study the Auger electron emission anisotropy from dissociating core-excited SF$_6$ molecules, where an Auger-Doppler effect has been first observed with CPL [3].


Ultrafast probing of molecules in intense laser fields by coincidence momentum imaging and gas electron diffraction

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When molecules are exposed to an intense laser field, a variety of characteristic dynamical processes are induced. Among them, ultrafast hydrogen migration processes are noteworthy. By the coincidence momentum imaging method on the decomposition processes of hydrocarbon molecules in an intense laser field, we find that the hydrogen migration proceeds extremely rapidly within 10~20 fs [1], and that not only one proton but also two protons migrate [2]. We show that the spatial distributions of the migrating protons are spread so widely within a molecule, reflecting the wave nature of protons. We introduce also a new experimental technique called light-assisted electron scattering (LAES) [3] developed for probing extremely rapid nuclear dynamics within a molecule as a series of snapshots of gas electron diffraction patterns with temporal resolution comparable with a pulse duration of ultrashort laser pulses (1~100 fs).

PR: Excited-state density functional theory

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Density-functional theory (DFT) provides a way of obtaining the ground-state density and the corresponding energy by employing energy functionals of density. Its methodology is therefore different from theories that look for solutions of the Schrodinger equation. While direct solution of the Schrodinger equation involves approximating the wavefunction and making it more accurate, DFT employs approximate energy functionals starting from the local-density approximation (LDA) and then building upon it to get more accurate functionals. Over the last decade, it has been established [1-3] that excited-state energy $E[\rho;\rho_0]$ of a many-electron system with external potential $v(\vec{r})$ can also be written as a bifunctional

$$E[\rho;\rho_0]=F[\rho;\rho_0]+\int d\vec{r} v(\vec{r})\rho(\vec{r})$$

of the excited- and the ground-state densities $\rho(\vec{r})$ and $\rho_0(\vec{r})$, respectively. Functional $F[\rho;\rho_0]$ gives the kinetic and the electron-electron interaction energies of electrons. This opens up possibility of obtaining excited-state energies by developing energy functionals for them. In this talk we present our method [4-6] of constructing excited-state LDA functionals by splitting the $k$-space for homogeneous electron gas. We show that these functionals give accurate excitation energies.


PR: The lifetime of the He anion

Henning T. Schmidt

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Negative helium ions exist only in the metastable $1s2s2p$ $^4P$ state, which autodetaches by relativistic effects since Coulomb autodetachment is spin-forbidden. The $J=1/2$ and $J=3/2$ fine structure levels decay on the $10$ $\mu$s time scale via relativistically induced coulomb autodetachment through couplings to the corresponding $^2P$ levels. The $J=5/2$ level, however, can only decay through the slower direct spin-spin and spin-other-orbit couplings yielding the long lifetime ($359.0\pm0.7\mu$s) found in the present experiment [1]. This slow decay and the very weak binding of the excess electron make measurements of this lifetime sensitive to photodetachment by black-body radiation from the surroundings. In earlier experiments [2,3], this effect was corrected for in the analysis, while the present work [1] was performed in the cryogenic ion-beam trap setup of the DESIREE facility at $10$ K. Here the photodetachment rate due to black-body radiation is negligible, and this elimination of the need for corrections gives this result with much higher precision than previous measurements or calculations [4].

PR: Controlling the guiding properties of mesoscopic glass capillaries for slow highly charged ions

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The basic concept of the guiding effect is that charged particles can be transmitted through insulating nano-sized capillaries under incident angles much larger than the geometrical limitation. Ions are guided through the capillary by an electric field caused by remaining charge patches at the inner wall. Recently, we demonstrated that the guiding mechanism is valid up to macroscopic length-scale in the case of a straight glass capillary [1, 2]. We present transmission measurements of highly charged ions through a single, high aspect ratio glass capillary made of borosilicate glass with a recently self-built, temperature regulated sample holder, which utilizes surrounding copper parts in order to assure a uniform temperature along the capillary. The measurements were carried out using beams of 4.5 keV Ar\(^{9+}\) ions produced by the Vienna 14.5 GHz electron cyclotron resonance Ar\(^{9+}\) ion source. By changing the temperature of the glass capillary we are able to manipulate the electrical conductivity by several orders of magnitude and therefore study the effect of conductivity on the build-up and removal of charge patches inside the capillary. We find a large influence of the glass temperature (i.e. conductivity) onto the transmission of ions which can be compensated by adjusting the incident ion flux. The work was performed in collaboration with G. Kowarik, F. Ladinig, D. Schrempf, C. Lemell, K. Tokesi, J. Burgdorfer, F. Aumayr.


PR: Gas-phase spectroscopy of biomolecular ions: Porphyrins and metalloporphyrins

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The electronic structure of a biochromophore (i.e., light absorber) is strongly perturbed by its environment, e.g., water or amino acid residues within protein pockets. To reveal the intrinsic electronic properties, it is therefore necessary to study isolated molecules in vacuo. Many biochromophores are ionic in their natural environment, which renders experiments complicated as it is not possible to produce enough absorbing species for traditional light transmission spectroscopy. In Aarhus we have developed state-of-the-art apparatus to record gas-phase absorption spectra of macromolecular ions. The technique is based on the combination of an electrospray ion source, a multipole ion trap for pre-storage, an electrostatic ion storage ring, and pulsed tuneable lasers and relies on measurements of the delayed dissociation of photoexcited ions (action spectroscopy). In this talk I will present some recent results for porphyrin and metalloporphyrin ions. One important target system is heme that is a porphyrin with an iron atom located in the centre bound to four ring nitrogens. It colours blood red and is located in hydrophobic pockets of heme proteins with minimal access to water. Such proteins are ubiquitous in nature and are responsible for key biological processes such as dioxygen transport and storage, and sensing of small molecules like CO. We gradually build up the microenvironment of the heme to elucidate the impact of single molecules on heme?s electronic structure. Such information is important in bioanalytical spectroscopy and to monitor conformational changes and dynamics. Finally, our spectra provide a natural testing ground for future quantum chemical theories.
PR: Application of insulating nanocapillaries in living human cell irradiation

Walter Meissl

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Tapered insulating glass capillaries have demonstrated their ability to guide beams of slow highly charged ions as well as MeV light ions [1] and can thus form a micro-beam even down to below 1 µm diameter without the need for other sophisticated ion beam optics. When a thin exit window of the order of 1 µm is attached to their end, beams of ions fast enough to penetrate the window can be extracted into a liquid medium and accurately pinpointed to a target. We use this method to irradiate living human cells in cell culture dishes as well as other biological targets both in vivo and in vitro. The extracted ions in our experiments have a primary kinetic energy chosen such that they are fully stopped within a few µm after they pass the exit window of the capillary, enabling full three-dimensional confinement of the interaction region [2]. This presents a fresh alternative to existing micro-irradiation facilities that focus the beam exclusively in two dimensions and fully penetrate any target cell or tissue. This novel method can be used to perform irradiation dose response studies on targets much smaller than the well-studied nucleus as well as a series of other novel experiments. This project was supported by the Japanese Society for the Promotion of Science (Grant-in-Aid No. 17654079 and No. 20510119) and the international Human Frontier Science Program.


SR: Statistical and non statistical dissociation processes of Tungsten Hexacarbonyl W(CO)6 in collisions with protons, fluorine and chlorine ions.

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The excitation and dissociation processes of the molecule W(CO)6 in collisions with low kinetic energy (3 keV) protons, monocharged fluorine and chlorine ions has been studied using double charge transfer spectroscopy. Based on the experimental data, the emission of the first CO is tentatively attributed to a non-statistical direct dissociation process whereas the emission of the second or more CO ligands is attributed to the statistical dissociation processes.

SR: LIAD-FS: A new technique for gas-phase studies of biomolecules

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An experimental technique for femtosecond (fs) pulse studies of gas-phase biomolecules is reported. Using Laser-Induced Acoustic Desorption (LIAD) to produce a plume of neutral molecules, a time-delayed femtosecond interaction is employed for ion activation/fragmentation. Subsequent extraction and analysis of products, in either a time-of-flight device or an ion trap mass spectrometer, provides insight into the fs interaction process.
Thursday, 28 July 2011

PL: Antimatter matters: Progress in cold antihydrogen research
Yasunori Yamazaki
RIKEN Advanced Science Institute, Japan

The CPT (C: Charge conjugation, P: Parity transformation, T: Time reversal) conservation is believed to be the most fundamental law of physics, which however is the target we want to seriously attack comparing the spectroscopic properties of hydrogen and antihydrogen. Antihydrogen, the opposite number of hydrogen, is the simplest antimatter. At the same time, antihydrogen is stable in vacuum, which in principle guarantees high precision spectroscopy like in the case of hydrogen. Recently, experimentalists working on cold antihydrogen have achieved two new progresses [1, 2]. One is the trapping of antihydrogen atoms in a magnetic bottle consisting of an octupole magnet and a pair of mirror coils [1]. Although the potential depth of the bottle for antihydrogen is only 0.5 K or so, several antihydrogen atoms were eventually trapped for more than 1000 s [3]. The other progress is the first successful synthesis of antihydrogen atoms in a so-called cusp trap [2], the magnetic field of which is provided by anti-Helmholtz coils. Because the cusp magnetic field is axially symmetric, antihydrogen atoms synthesized in the cusp trap can be extracted as an intensified and spin-polarized beam [4], and be efficiently transported to a field-free region, where real high resolution spectroscopy is assured. With these achievements, the field of cold antimatter research is now ready to start real physics experiments such as laser spectroscopy of 1S-2S transition and microwave spectroscopy of ground state hyperfine transitions.

PR: Fullerene ions covered with helium and hydrogen

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Recently a rich chemistry of fullerenes in interstellar gas was suggested on the basis of the astronomical detection of fullerenes in a planetary nebula [1]. In the present contribution we studied the formation of fullerene ions in cold superfluid helium droplets, which remain strongly covered with helium also after the ionization process inside the droplets. These complexes are sufficiently stable to allow the detection by high resolution time-of-flight mass spectrometry on ms timescales. The recorded mass spectra showed pronounced intensity drops which may indicate the presence of solvation shells. For example, in the case of C_{60} and C_{70} the mass spectra show strong intensity drops at C_{60}He_{32}^+ and C_{70}He_{37}^+, respectively. In this case each of the carbon rings of the fullerene may be covered by one He atom. Molecular dynamics simulations have been performed in order to determine the He adsorption sites on the fullerenes. They confirm this intuitive interpretation.

We also co-doped fullerenes with hydrogen in helium droplets and studied the formation of fullerene-hydrogen complexes. The cluster ion yields consist of two series, C_{m}(H_2)_{n}^+ and C_{m}(H_2)_{n-1}H_3^+ (m = 60, 70), which show the same intensity drops as mentioned for helium covered fullerenes. For fullerene dimers the intensity drops are shifted to larger n (n = 58 for C_{120} and n = 66-68 for C_{140}) because some carbon rings may be blocked by the steric dimer configuration.


PR: Quantum scattering of low energy electrons by molecules of biological interest

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A quantum mechanical analysis [1] of the scattering of low energy electrons by molecules of biological interest is presented for a variety of systems, ranging from the single DNA components up to nucleotides. The delay matrix formalism [2] is used in order to characterize the transient negative ions which might act as precursor of molecular dissociation, and to show to which extent we can correlate the results obtained on isolated molecules, i.e., the DNA components, with realistic macromolecules made up of those components, such as the nucleotides. The behavior of different systems with radiosensitizing properties is also presented and discussed.

The discovery that sub-ionization, sub-excitation electrons induce strand breaks in DNA [1] has stimulated experimental and computational efforts to understand the mechanisms involved. While calculations using bound-state methods have made many contributions, the interaction of an unsolvated electron with a biomolecule is fundamentally a scattering problem, and it is desirable to apply scattering methodology to it in order to extract information such as resonance widths and the magnitudes of cross sections. At the same time, the large size and low symmetry of the molecules of interest make any accurate calculations, and especially scattering calculations, difficult. In this talk we describe studies using the Schwinger multichannel method [2] in which we have explored some of the low-energy electron-molecule collision dynamics relevant to DNA and RNA. Through an examination of model systems, including nucleobases, nucleotides, and models of the furanose and phosphate moieties, we have added to the understanding of some key mechanistic issues: Where does the electron initially attach? What are the natures of the metastable anions involved? At the same time, though, our work has highlighted gaps in our understanding of the electron-DNA interaction that suggest new directions for future study.

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SR: Site and bond selective H formation in methylated pyrimidine bases driven by potassium molecule collisions

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In this study we present for the first time site (N-H / N-H) and bond (N-H / C-H) selectivity of H formation in 1-methylthymine, 3-methyluracil and deuterated thymine (C positions) triggered by potassium molecule collisions. By comparing the H loss of these molecules with H loss in thymine and uracil and setting the energy one can predict site and bond selectivity in these set of molecules.

SR: Anomalously large low-energy elastic cross sections for electron scattering from the CF3 radical


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We present measured absolute cross sections for elastic electron scattering from the CF3 radical over the incident energy range of 7-50 eV and scattering angles between 20° and 135°. The results are compared to theoretical predictions from SMC, IAM-SCAR, and R-matrix calculations.
I will present results on collisions between keV ions and cold clusters of Poly Aromatic Hydrocarbon (PAH) molecules such as anthracene (C\textsubscript{14}H\textsubscript{10}), pyrene (C\textsubscript{16}H\textsubscript{10}), flouranthene (C\textsubscript{16}H\textsubscript{10}), and coronene (C\textsubscript{24}H\textsubscript{12}). For all clusters investigated it is found that charge and excitation energy are distributed on the individual PAH molecules before clusters fragmentation and that the most probable fragment always is a singly charged isolated PAH molecule. Clusters of large PAH molecules such as coronene may be singly ionized without fragmentation in collisions with He\textsuperscript{2+} already at a cluster size above five molecules. For the smaller PAH molecule, anthracene, small and intermediately sized clusters (<13 molecules), are found to fragment promptly even if it is only singly ionized whereas larger anthracene clusters may remain intact on microsecond timescales. Surprisingly, collisions between anthracene clusters and ions in low charge states lead to much hotter singly charged monomers than collisions with highly charged ions. At a first glance this appears counterintuitive as highly charged ions are known to remove electrons from larger distances than ions in lower charge states and thus would be expected to deposit less energy. However, a large amount of these monomers come from highly charged clusters. Therefore, they come from somewhat closer collisions meaning that electrons may not only be removed from the outermost shells of the individual PAHs but also from non-valence shells yielding excitation energies of several eV and that the Coulomb-driven fragmentation of multiply charged clusters may induce internal excitation energies in the individual molecules.

**PR: Fragmentation of multi-charged and highly excited clusters**

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We will address the question of the partitioning of energy in fragmenting multi-charged and highly excited carbon clusters. Whereas many studies have been devoted to size appearance of multi-charged clusters and/or determination of the main fragmentation channels, this topic has never been really looked at. One of the open question is to determine how is the internal energy dissipated and how is this one evolving with the charge of the cluster.

Multi-charged carbon cluster C\textsubscript{n}\textsuperscript{q+} (n=5-10, q=2-4) have been produced in high velocity collisions and their fragmentation totally recorded. The analysis of the data has been performed within a statistical context, using a semi-empirical determination of the clusters internal energy. A continuous evolution with q/n of the partitioning of energy between production of fragments and kinetic energy of the fragments is observed. We will discuss the origin of this scaling law.
PR: Attachment and fragmentation cross-sections of water clusters

Sébastien Zamith

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The experimental study of attachment and fragmentation of water clusters in collision with water molecules unveils the role of cluster’s internal vibrational dynamics. Attachment and fragmentation cross-sections of mass selected water clusters have been measured at different collision energies, and are in both cases lower than geometric cross-section.

Attachment cross-sections reach asymptotically geometric cross sections at large sizes, whereas they are lower for small sizes. It has been rationalized by comparing the period of the vibration excited during the collision to the collision time [1]. When the collision duration gets shorter than the vibrational period, the clusters cannot absorb the collision energy and the impinging molecule just bounces off the cluster’s surface, thus decreasing the attachment probability.

Concerning the fragmentation, we have analyzed the role of statistical evaporation and the effect of clusters’ initial temperature. Thermal evaporation is shown to play a major role, but the energy exchanged in the collision at high energy is lower than expected: for at least 30% of the collisions that occur within the hard sphere cross section, the clusters absorbs only a small fraction of the collision energy and do not undergo fragmentation. This “transparency” effect may be due to the interaction time being short compared to the cluster’s internal intermolecular vibrational modes, thus preventing from efficient energy transfer.


SR: Determining clustering properties through the selectivity of collision dynamics


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By exploiting the specific properties of cluster dynamics under the three types of ICPEAC “projectiles”, i.e. electrons, intense femtosecond photon pulses and slow highly charged ions, we access to the temporal structure of the cluster bunch which give rise to a direct experimental measurement of the clustering rate.

SR: Laser-induced reactions between a Ca\(^+\) Coulomb crystal and polar molecules


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We have investigated laser-induced reactions between laser-cooled crystallized Ca\(^+\) ions and polar molecule NH\(_3\) at room temperature. Reaction rates of Ca\(^+\)(3d \(^2\)D\(_{3/2}\), 4p \(^2\)P\(_{1/2}\)) + NH\(_3\) → products have been determined from time variation of the size of fluorescence images of Ca\(^+\) Coulomb crystals. From the pressure dependence of the reaction rates we determined a lower limit of the reaction rate coefficients.
One of the fundamental processes in nature is the photoelectric effect in which an electron is ripped away from its atom via the interaction with a photon. This process was long believed to be instantaneous but with the development of attosecond pulses (1 as = $10^{-18}$ s) we can finally get an insight into its dynamic. Here we measure a delay in ionization time between two differently bound electrons. The outgoing electrons are created via ionization with a train of attosecond pulses and we probe their relative delay with a synchronized infrared laser. We demonstrate how this probe field influences the measured delays and show that this contribution can be estimated with a universal formula, which allows us to extract field free atomic data.

Attosecond streaking is one of the most fundamental processes in attosecond science allowing for a mapping of temporal (i.e. phase) information to the energy domain. We show that on the single particle level attosecond streaking time shifts contain spectral phase information associated with the Eisenbud-Wigner-Smith time delay, as long as the influence of the streaking infrared field is properly accounted for.

We present how complete measurement of high harmonic generation can lead to the tomographic reconstruction of molecular orbitals and the observation of dynamics of electronic wavepacket. The interaction of atomic or molecular gases with intense ($I = 10^{14}$ W/cm$^2$) femtosecond lasers revealed, since the mid 80’s, much unexpected highly non-linear phenomena. One of the most spectacular response of the gas is the emission of coherent light bursts of sub-femtosecond duration, composed of harmonics of the laser frequency over a wide spectrum. In the last ten years, it became possible not only to characterize but also to control such ultrashort light pulses. This opened the way to attosecond time resolved spectroscopy, that is to the time scale of electron motion within atoms and molecules. Besides, in 2004, Itatani et al [1] proposed a way to image molecular orbitals by a tomographic analysis of harmonic radiations generated on aligned molecules. In the conference, we will present and analyze the results obtained for nitrogen, with a complete set of experimental data consisting of harmonic amplitudes and phases. We will discuss the validity and limitations of the model on which the method is based and demonstrate that, under certain conditions, it allows to image the molecule’s HOMO ($3\sigma_g$) as well as the closest lower orbital (HOMO-1, $\pi_u$). In addition, combining the spatial and temporal aspects, we will show that the wave-packet of the electronic hole left in the molecule after ionization can be reconstructed with a temporal resolution of ±300 attoseconds [2]. Finally, we will show how to control the light emission on an attosecond scale by orienting the molecule [3].

PR: AttoClock reveals new insights into tunnel ionization

Ursula Keller

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The attoclock [1, 2] is a novel attosecond streaking technique and allows for unprecedented time resolution in the attosecond regime. We present new attoclock measurements for both helium and argon over a much larger intensity regime (moving from multi-photon ionization to tunnel ionization regime according to the Keldysh parameter). These new measurements reveal a significant modification to the standard semi-classical model for strong laser field ionization, but confirm our previous finding of instantaneous tunnel ionization within the measurement accuracy for two different atoms. The new model not only changes the physical picture of the attosecond ionization dynamics but also clearly demonstrates that multi-electron processes need to be taken into account for atoms at the first time. Streaking experiments, which have been typically used to resolve attosecond dynamics are affected because if additional force terms were not considered in the streaking dynamics, then this would result in misleading conclusions with possibly wrong time delays. The present work shows for the first time a clear multi-electron effect in tunneling ionization of single atoms. The multielectron effects reported here have to be considered to be able to push our understanding of how matter behaves on the attosecond time-scale.


PR: X-ray FEL induced multiple ionization and double core-hole production

Nora Berrah

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The response of molecular systems to the ultra-intense, femtosecond x-ray radiation from the Linac Coherent Light Source (LCLS) free electron laser at various wavelengths and pulse intensities has been investigated. We observed intense x-ray induced ionization and dissociation dynamics leading to various charge states up to fully-stripped fragment ions. By measuring partial ion yields from nitrogen molecules as a function of laser pulse duration (~4 fs - 280 fs), a molecular mechanism of frustrated absorption that suppresses the formation of high charge states at short pulse durations is revealed [1]. We have also measured double core holes with both vacancies on a single site [2] and recently we measured double core holes with a single vacancy on two different sites in molecules. The measurements were carried out using photoelectron and Auger spectroscopy in addition to ion spectrometry. We will present our measurements interpreted with ab initio calculations.


PR: Resonant enhanced electron impact dissociation of molecules
Ann Orel
Department of Applied Science, University of California, Davis, USA

In the collision of electrons with molecules and molecular ions, excitation and dissociation are dominated by resonant processes, where the electron becomes temporarily trapped, changing the forces felt by the nuclei. We have carried out calculations on the resonant process leading to dissociative attachment and dissociative recombination. We separate the problem into two steps. First, the resonance parameters are obtained from accurate electron scattering calculations using the Complex Kohn variational method. Then these parameters are used as input to the dynamics calculations. We will illustrate the method with a number of examples including the study of dissociative attachment in HCN, HCCCN, and CF₂ and dissociative recombination in CF⁺ and HCO⁺/HCO⁺.

PR: Astrochemistry with ion storage rings
Oldrich Novotný
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Dissociative recombination (DR) of molecular ions plays a key role in controlling the charge density and composition of the cold interstellar medium (ISM). Experimental data on DR and reliable predictions based on a good knowledge on the underlying quantum mechanisms are required to understand the chemical network in the ISM and related processes such as star formation from molecular clouds. Needed data include not only total reaction cross sections, but also the chemical composition and excitation states of the neutral products. Utilizing the TSR storage ring in Heidelberg, Germany, we are carrying out DR measurements on polyatomic molecular ions using a merged electron-ion beam technique together with a recently introduced energy- and position-sensitive imaging detector to record the fragments. Absolute rate coefficients are obtained from the DR fragment count rates. The measurement of the kinetic energies of the fragments allows for their mass identification and thus to identify the fragmentation channel for each DR event. The fragment distances on the imaging detector provide information on the reaction kinematics as well as on the initial and final excitations. Such combined information is essential for studies on DR of polyatomic ions with multi-channel, multi-fragment breakup. We report recent DR results on D₂O⁺, DCND⁺, D₂Cl⁺ and other systems. Extension of the technique to cryogenic electrostatic storage ring is in progress. This work is supported in part by the Max Planck Society and by the NSF Astronomy and Astrophysics Grant Program.
PR: Low energy elastic and electronically inelastic electron scattering from biomolecules: the role of polarization and multichannel coupling effects

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Recent studies have shown that reactions induced by low-energy electrons may act very efficiently and with a high degree of selectivity in the breaking of chemical bonds in polyatomic systems [1,2,3]. In addition, fine control of selectivity can be obtained based just on a suitable choice for the energy of the incident electron. The possibility of manipulating and controlling chemical reactions on the nanoscale points to new opportunities that can be explored both in the field of basic research and in developing new technologies to be applied to different areas of scientific knowledge. In this talk we discuss the role played by electronic excitation of gas phase molecules on electron-driven chemical processes. Special attention is focused in the analysis of the influence of polarization and multichannel coupling effects on the magnitude of elastic and electronically inelastic cross-sections. The discussion is based on results obtained for simple organic molecules and for some five-membered heterocyclic compounds. The characterization of shape and Feshbach resonances is also considered since the formation of such temporary anionic states represents an efficient mechanism leading to selective breakage of chemical bonds. The relevance of these issues is evaluated in the context of possible applications for the modeling of discharge environments and implications in the understanding of mutagenic rupture of DNA chains.


PR: Electron and positron molecule collisions using the R-matrix with pseudostates method

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The R-matrix method is widely used to study electron -- molecule collisions [1]. The R-matrix with pseudostates (RMPS) method, was originally implemented to treat electron -- molecule collisions at intermediate energy. It has been shown to be very effective at representing polarisation effects in both electron and positron molecule collisions. For example, recent RMPS calculations have successfully treated resonances in electron-impact detachment in carbon dimer anions [2] and annihilation effects in positron collisions [3]. However the RMPS method is computationally demanding and requires the development of new algorithms for its successful application to problems of interest.

PL: Measuring and modeling absolute data for electron-induced processes

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The talk will give a somewhat personal retrospect of selected developments in the field of electron-collision processes since the pioneering 70’s. They are often the result of mutual support of experiment and theory, and are often motivated and influenced by application needs, like plasma and atmospheric modeling, biologically relevant molecules, or electron-beam nanofabrication. Instrumental improvements were essential for much of the progress. Dramatic experimental and theoretical progress was achieved in electronic excitation of rare gas atoms where excellent quantitative agreement was reached down to threshold. The applications increasingly emphasize processes leading to chemical change, and the talk will discuss dissociative electron attachment (DEA). Here absolute data is becoming more widely available and theory makes progress on two fronts: One is tackling intricate nonlocal and non-adiabatic effects important at low energies and for polar molecules. These theories reproduce quantitatively the DEA cross sections for diatomic molecules like HBr, and are very helpful when polyatomic molecules can be treated as pseudo-diatomics. The other front is true multidimensional treatment of DEA, particularly in cases which can not be reduced to pseudo-diatomics, like acetylene – albeit in the local complex potential approximation. Important experimental insight has been gained into DEA of polyatomic molecules high above threshold, proceeding via Feshbach resonances, but theory providing cross sections for these processes is not yet available. An important recent experimental development for DEA is the momentum imaging technique.
We study the dissociative photoionization of D₂ by an attosecond pulse train (APT) in the presence of a near-infrared (IR) field. Strong oscillations in the D⁺ kinetic energy release spectrum with a half period of the optical cycle of the infrared field are observed and attributed to interferences between ionization pathways involving different harmonic or derivatives of the APT due to the IR-induced coupling between the 1sσᵥ and 2pσᵤ ionization channels.

SR: Confining the double ionization dynamics of argon to half of a laser cycle


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The sub-cycle dynamics in non-sequential double ionization of argon are studied by combining a reaction microscope with a single-shot carrier-envelope phase measurement technique.

PR: New perspectives in attosecond physics

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Attosecond pulses can be generated control-ling the precise time evolution of femtosecond pulses; such a control allows to steer the electron motion in atoms and molecules irradiated by ultrashort, intense light on a sub-cycle timescale and results in the emission of coherent bursts of extreme ultraviolet radiation with duration as short as 80 as [1]. So far, the application of attosecond pulses in time resolved experiments has been mainly limited by either their low peak intensity, that has prevented the demonstration of attosecond-attosecond experiments, or by the low average photon fluxes that have made challenging the investigation of processes characterized by low cross-sections. The development of high energy few-cycle laser systems for harmonic generation on solids and of high repetition rate systems represents two of the most promising directions to overcome such technological bottle-necks. Irradiation with attosecond pulses almost inevitably leads to photo-ionization or complex excitation mechanisms. Coincidence measure-ments of electrons and ions, originating from the same reaction, allow to perform kinematically complete experiments and to distinguish among competing reaction channels [2]. The combination of attosecond pulses with such a technique opens the way for the time resolved characterization of electron correlation that is fundamental in processes such as autoionization, shake-up and shake-off processes, Auger and interatomic-coulombic decay.

PR: Multiple photoionization of rare-gas clusters by EUV-FEL at Spring-8

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The response of matters to intense pulses of laser light in the short wavelength region is an issue of fundamental interest. Recent developments of the free electron laser (FEL) light sources based on self-amplified spontaneous-emission (SASE) enable us to study the multiple ionization processes of atoms, molecules and clusters in vacuum ultraviolet (VUV) and extreme ultraviolet (EUV) regions. We report here some latest results of our investigation on rare-gas clusters at Spring-8 Compact SASE Source (SCSS) free electron laser [1] in the wavelength region of 51 to 61nm. We observed intense EUV-FEL induced multiple ionization and dissociation dynamics leading to emission of energetic fragment ions. We will report on the multiple photoionization of giant rare-gas clusters and the charge transfer in Ar-core Ne-shell clusters.


PR: XUV-pump XUV-probe experiments at FELs

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The free electron laser (FEL) at Hamburg (FLASH) (with intensities up to $10^{16}$ W/cm$^2$ and pulse durations of 10–30 fs) in combination with a dedicated XUV-pump XUV-probe setup and our multi-particle detection system – the Heidelberg reaction microscope – enables unique experiments on XUV induced fragmentation of small molecules with femtosecond time resolution, a hitherto non-accessible regime of ultra-fast laser science. Here we present first results on the time-dependent dissociation of N$_2$ molecules and on the time-evolution of isomerization and elimination in excited C$_2$H$_2$ [1] and C$_2$H$_4$ molecules. In addition, a series of FEL pulse length measurements has been performed using our setup as non-linear autocorrelator [2, 3]. Present studies demonstrated the feasibility and the potential possibilities leading to time-resolved studies of molecular dynamics and chemical reactions in the XUV regime. In the near future it becomes possible to visualize, control and manipulate molecular reactions in the XUV regime in real time.

We report on the formation of fast, energetic Rydberg Hydrogen atoms in the ion impact dissociation of water molecules. The kinetic energies of the neutral atoms have been determined by position sensitive time of flight measurements. The energies of the fast neutral atoms are similar to those observed in extra-solar planets. These can also act as a source of low energy electrons, which play an important role in cellular damage in living systems.

Mutual projectile and target ionizations (MPTI) of 1MeV/amu N$^{4+}$ and N$^{5+}$ + He collisions have been studied in kinematically complete experiments, the data is presented in four-particle (4-D) Dalitz plots. Comparison to eikonal approximation (EA) calculation results shows qualitatively good agreement.

Mobilities of OH$^+$ and OD$^+$ ions in cooled helium gas have been measured at gas temperature of 4.3 K. Measured mobilities of both ions as a function of an effective temperature $T_{\text{eff}}$ show a minimum around 80 K, and they are approaching to the polarization limits at very low $T_{\text{eff}}$. These findings will be related to the extremely strong anisotropy of the interaction potential between the molecular ion and helium atom.

We measure the probability of “shake-off” ionization of the daughter nucleus in the $\beta$ decay of $^6$He$^+$ ions confined in a transparent Paul trap. This measurement, in good agreement with theoretical calculations, allows to reduce systematic error contributions in previous $\beta$–$\nu$ correlation experiments dedicated to the search for physics beyond the Standard Model.
When energetic ions pass through a crystal, they experience a temporally oscillating Coulomb field arising from the periodical atomic arrangement in the target. If the oscillating frequency corresponds to a transition energy of the ions, resonant coherent excitation (RCE) may take place. Because the oscillating frequency in the projectile frame increases with their velocity, the use of high-energy ions allows the RCE of higher transition energies up to the x-ray domain. The typical range of transition energies in RCE available with ~400 MeV/u incident energy is 1-10 keV. For this reason, the RCE process is expected to be useful for atomic physics in the short wavelength region not accessible by conventional laser equipments.

Recently, control of magnetic substate population was achieved by changing the polarization direction of the oscillating field, resulting in an anisotropic de-excitation x-ray emission from aligned H-like and He-like Ar and Fe ions [1]. The use of double resonance technique offered a variety of population control and probing scheme in three-level configurations, that enabled the observation of quantum optical phenomena even in the x-ray energies [2]. The observation of RCE of Li-like U\(^{89+}\) (2s-2p\(^{3}/2\)) showed that the RCE method can be effectively used for testing of the quantum electrodynamics (QED) theory via the high-resolution spectroscopy of highly charged high-Z ions [3].


PR: Asymmetry in multiple-electron capture revealed by radiative charge transfer in Ar dimers

Xavier Fléchard

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In the last two decades, much interest has been devoted to the relaxation processes of multi-ionized diatomic molecules. For most of those studied so far (N\(_2\), CO), a strong preference for the symmetric fragmentation channels XY\(^{2q+}\) \(\rightarrow\) X\(^{q+}\) + Y\(^{q+}\), energetically more favorable, has been established [1]. In contrast with these results, we measured for the first time larger branching ratios for the asymmetric fragmentation channels of Ar\(_2\)\(^{4+}\) molecular ions produced by multiple-electron capture in Ar\(^{9+}\) + Ar\(_2\), low energy collisions. Moreover, for the dissociation channel Ar\(_2\)\(^{2+}\) \(\rightarrow\) Ar\(^{+}\) + Ar\(^{+}\), two well separated peaks were observed in the fragmentation kinetic energy release spectrum. They could be unambiguously attributed to the presence of two competing processes: the removal by the projectile of one electron on each centre of the dimer, leading to direct coulombic explosion, and the double electron capture from one centre, followed by radiative charge transfer and ionic dissociation [2]. These results can be interpreted in terms of “low electron mobility” within the noble gas dication, giving here a unique access to the primary collision process. Combined with the measurement of the dimer initial orientation, they provide new insights of multiple-electron capture in ion-molecule low energy collisions.

PR: Generation of microjoule isolated attosecond pulses by infrared two-color laser field synthesis

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To make a breakthrough for XUV attosecond nonlinear optics, one of the most important issues is the development of high-power isolated attosecond pulses (IAPs) and/or attosecond pulse trains (APTs). At present high-power APTs have been successfully generated thanks to research on harmonic energy scaling using a loosely focusing geometry [1]. Although IAPs were already obtained using a state-of-the-art Ti:sapphire laser system, output energy is still not sufficient for inducing nonlinear phenomena. In this paper, we demonstrated the generation of microjoule-level IAPs by combining infrared two-color laser fields synthesis [2] and an energy-scaleup method [1]. As we previously reported [2], our two-color scheme enables us not only to relax the requirements for the pump pulse duration but also to reduce ionization of the harmonic medium. These are major advantages for efficiently generating intense IAPs, because the use of neutral media allows us to use the phase matching technique. In the experiment, we employed a loosely focused pumping geometry with f = 4000 mm. The target Xe gas was statically filled in the interaction cell of 10 cm length. TC laser field consists of 800 nm, 30 fs, and 1300 nm, 35 fs. At the optimized condition, the total pulse energy of a continuum harmonic spectrum (18th-23rd) was evaluated to be ∼1 µJ. If the cutoff harmonic spectrum is extracted, IAPs of 600 as pulse duration are obtained.


PR: Electronic and nuclear dynamics revealed by ultrafast tuneable-XUV and strong-field laser pulses

Will Bryan

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We will present recent advances in two interrelated areas of the ultrafast regime. (1) A novel XUV-pump NIR-probe measurement in krypton will be presented whereby a laser-driven high harmonic source is monochromated while preserving the temporal characteristics of the drive laser [1]. Shake-up excitation and ionization are initiated by the single XUV harmonic and probed by a strong-field NIR pulse. By varying the harmonic order, multi-electron processes are time and energy resolved. The ability to estimate the photexcitation cross-section of satellite state production is a significant advance for ultrafast XUV physics, and opens the door to vibronic studies in electronically complex molecules. (2) We have also demonstrated that controlling the motion of a bound vibrational wavepacket in D$_2^+$ by an ultrashort control pulse can be experimentally implemented and quantified [2]. The redistribution of vibrational population can be recovered using a relatively simple quasi-classical model that incorporates tunnel ionization and dynamic Stark-shift deformation of the potential surface [3]. We will discuss increasing the fidelity of the vibrational manipulation with multiple control pulses. The outcomes of (1) and (2) will be combined to suggest routes to imaging and selectively manipulating matter on nuclear and electronic timescales, with specific reference to electron localization [4]. The relevance of such strong-field coherent control methods to the manipulation of electron localization and attosecond science is discussed.

SR: Electron diffraction self imaging of molecular fragmentation in two step double ionization of water


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We doubly ionize H₂O by single photon absorption at 43 eV leading to H⁺ + OH⁺. A direct double ionization and a sequential process in which single ionization is followed by rapid dissociation into a proton and an autoionizing OH⁺ are identified. We obtain information about the internuclear distance at which the decay of the OH⁺ occurs from the angular distribution of the autoionization electron.

SR: Confinement resonances in photoionization of endohedral Xe@C₆₀⁺


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Experimental evidence is presented for confinement resonances predicted in photoionization of the endohedral Xe@C₆₀⁺ molecular ion at photon energies corresponding to the giant 4d resonance of Xe.
PR: Electron induced chemistry in molecular solids
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At high energy, electron induced dissociations proceed through excitation and ionisation of the molecular targets. But interestingly, selective and efficient dissociative processes are induced at sub-excitation energies by Dissociative Electron Attachment (DEA). When the electron energy is resonant with an unoccupied molecular orbital, a transient negative molecular ion can be formed. One efficient decay channel is its dissociation into neutral and anionic fragments. Generally there is a dominant dissociative channel, leading to the selective formation of reactive fragments [1]. Upon interaction with molecular films deposited on substrates, the formed reactive species may interact either within the film to synthesize new molecules (electron induced synthesis) or with the substrate surface (electron induced surface functionalization) [2]. Electron interaction mechanisms and induced chemistry are studied for different types of supported molecular films: (i) molecular ices, i.e. small organic molecules physisorbed onto a substrate cooled down to typically 25 K, (ii) self-assembled monolayers (SAMs) of acid function terminated thiols on gold [3], and (iii) lyophilized layers of molecules of biological interest. The UHV experimental setup at the ISMO houses two complementary techniques: a High Resolution Electron Energy Loss (HREEL) Spectrometer and an analysis system for Electron Stimulated Desorption (ESD) of neutral fragments.


PR: Transmission of low-energy electrons through Al₂O₃ nanocapillaries
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We have investigated guiding of low-energy electrons (2-350 eV) through high aspect ratio Al₂O₃ nanocapillaries of different diameters (40, 140 and 250 nm). Various measurements of angular, energy, time and current dependence of either total or only elastically transmitted electron intensity have been performed. In addition, we have measured kinetic energy distributions of electrons transmitted through the nanocapillaries both in the straightforward direction and at large tilt angle. The guiding of highly charged positive ions by insulating nanocapillaries was first demonstrated in 2002 [N Stolterfoht et al 2002 Phys. Rev. Lett. 88 133201.], while the experimental investigation of electron guiding by insulating nanocapillaries has been reported more recently [A. R. Milosavljević et al 2007 Phys. Rev. A 75 030901(R) ; S. Das et al 2007 Phys. Rev. A 76 042716 ; A. R. Milosavljevic et al 2009 Europhysics Letters 86 23001]. The present results suggest a more complex nature of low-energy electron transmission through insulating nanocapillaries in comparison with highly charged positive ions, which is also shown by the recent theoretical study [K. Schiessl et al 2009 Phys. Rev. Lett. 102 163201].
SR: A kinematically complete (e,2e)-experiment on small rare gas clusters

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Single ionization of small argon and neon clusters at intermediate energies (i.e. 100eV and 61eV, respectively) have been performed and triple differential cross-sections have been acquired over the complete solid angle. First 3D emission patterns show significant out-of-plane intensities and structural differences compared to the ionization of the respective atomic target were observed.

SR: Environment assisted electron capture

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Electrons scattering off isolated atoms or positive atomic ions may be captured in the non-resonant photorecombination or resonant dielectronic recombination processes with the excess energy carried off by a photon. We demonstrate that in a medium a new interatomic process becomes important, where in the electron capture by an atom or atomic ion the energy is transferred to a neighbouring species ionising it. We discuss different manifestations of this interatomic Coulombic electron capture and estimate its efficiency for a number of realistic systems.
Relativistic collisions involving heavy high-Z ions provide a unique testing ground for our understanding of elementary atomic processes related to ultrafast electromagnetic interactions [1,2]. Under these conditions processes such as electron excitation, transfer and recombination are strongly affected by the magnetic field components of the rapidly moving projectile charge. In particular, the coupling the electron spin to the magnetic field strongly affect the population and depopulation mechanisms of atomic levels. Experimentally, this can be investigated by studying the associated radiation and its properties, i.e. angular distribution, polarization, and energy.

In this talk, I will review the recent experimental progress on state selective studies of relativistic atomic collision. Examples include resonant and radiative recombination (capture), transfer as well as Coulomb and electron impact excitation and ionization [2-5]. Special emphasis will be given to the alignment of atomic states and the angular differential and polarization analysis of the emitted x-rays.

IUPAP Young Scientist Prize Talk

Modifying interatomic interactions using Raman coupling: a tale of slowly colliding Bose-Einstein condensates

Ian Spielman

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Interactions between particles can be strongly modified by their environment; for example, in metals the Coulomb interaction between a pair of electrons is screened by the collective response of the remaining electrons. Although the fundamental Coulomb interaction is unchanged, the electrons effectively interact with this new screened potential that is relevant to the physics of the many-body system. Ultracold atoms are among the most pristine of quantum systems, ideally suited for quantitatively studying these interaction-dominated many-body phenomena. Atomic interactions have a characteristic strength and range, and can in principle couple states with non-zero angular momentum. At the lowest low temperatures, atomic collisions are generally very simple: atoms interact only when they occupy the same volume of space (zero range) and have zero angular momentum (s-wave interactions). Somewhat ironically, this simplicity apparently excludes many-body systems such as supersolids (requiring a non-zero range) or p-wave superconductors (requiring interactions at non-zero angular momentum). While Feshbach resonances are a powerful tool for controlling the strength of atomic interactions, the characteristic range of the potential is unchanged and only the s-wave interactions are usefully altered. Here we demonstrate a completely different technique for modifying atomic interactions essentially by screening the native atomic interaction with light; this vastly increases the range of the interactions and allows coupling of states of higher angular momentum. We optically dressed neutral atomic Bose-Einstein condensates (BECs) with a pair of lasers, linking together three different internal atomic states. So dressed, slowly moving atoms collide just as before, but at slightly higher energies the collisions are strongly altered. We demonstrated this effect by colliding pairs of BEC's with equal, but opposite, momenta. The resulting halo of scattered atoms showed the contribution of d- and g-waves in the scattering process, in agreement with our theoretical description. Although demonstrated here with bosons, these modified interactions are even more significant in Fermi systems and can lead to p-wave pairing, a prerequisite for the long-sought chiral p-wave superconductors.
PR: Calculations for charge transfer and ionization in heavy-particle collisions from water molecules

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Ion-molecule collision systems are everything but readily amenable to theoretical calculations: they have many degrees of freedom, a rather complex geometry, and the electron dynamics might be nonperturbative and involve electron-electron interaction effects. Nevertheless, the interest in accurate calculations has been growing recently, in part due to the relevance of ion-molecule collisions, e.g., in atmospheric science and radiobiology.

A new approach has been developed to meet this challenge [1]. It disregards rovibrational motion, but it does address the multi-centre geometry of the system and the generally nonperturbative nature of the electron dynamics. The key ingredients are an expansion of the initially populated molecular orbitals in terms of a single-centre basis and a spectral representation of the molecular Hamiltonian. This facilitates a separation of molecular geometry and collision dynamics and makes it possible to adapt ion-atom methods, such as the basis generator method (BGM) to the latter.

In this progress report I will summarize this approach and discuss results for ionization and fragmentation of water molecules by proton and singly-charged helium ion impact, which are obtained from BGM calculations for the collision dynamics. For the case of the helium ions the discussion will include an analysis of Pauli blocking effects which arise due to the presence of the projectile electron.


PR: Partial localization and symmetries in coherent electron emission from molecules

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The Young two-slit experiment is in the foundations of Quantum Mechanics. Interference patterns appearing after the passage of electrons through the slits are explained by the wave nature of these particles. In a related way, in order to interpret the origin of undulations present in measured photoabsorption spectra of O_2 and N_2 molecules, the atoms composing each one of these molecules were considered as independent photon absorbers, constituting in turn separate sources of photoelectrons. Then, it was suggested that the analysed behaviour could be related to the coherent photoelectron emission from the proximities of the molecular centres [H. D. Cohen and U. Fano, Phys. Rev. 150, 30 (1966)]. Thirty-five years later, evidence on the existence of this effect was experimentally determined for ionization of hydrogen molecules interacting with high-energy Kr^{34+} ions impact [N. Stolterfoht et al., Phys. Rev. Lett. 87, 023201 (2001)]. Plentiful research was then carried out by considering photon and charged-particle beams, investigating different aspects related to coherent emission from molecular targets. We will focus here our interest in some of these aspects for charged particle beams, like the influence of the preferential initial localization of the ionized electron, around one of the molecular centres, on the resulting corresponding spectra for heteronuclear targets. Another investigation to be reported is about the role played by the initial or final gerade or ungerade character of the corresponding bound states for homonuclear molecules.
PR: Radiative double electron capture (RDEC) in ion-atom collisions

Anna Simon

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Radiative double electron capture (RDEC) observed in collisions of bare ions with atoms is a charge exchange process, during which two target electrons are captured into a bound state of the projectile and a single photon is emitted [1]. This process can be described as a time inverse of double photoionisation. During the last twenty years the RDEC process was addressed not only experimentally but also theoretically [1, 2 and references therein]. However, significant discrepancies between theoretical predictions of the RDEC cross section and experimental results were noted. The more recent calculations [3-5] not only explained those discrepancies, but also suggested the choice of low energy mid-Z (Z ≤ 35) collision systems to be the best for observation of the RDEC process. Based on these calculation, an experiment was conducted at Western Michigan University that provided the first experimental confirmation of RDEC process [6]. Here, a brief review of the RDEC investigation will be given and the recent experimental results will be presented.


PR: Imaging of H$_2^+$ vibrational wavefunctions via dissociative electron transfer

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Chemical textbooks depict molecules as simple ball and stick models which suggest that they have well defined geometrical structures in real space but the quantum mechanical properties of the nuclear dynamics of the molecule yield a quantized distribution of internuclear distances. We measured the reaction 2.5 keV H$_2^+$ + He → H + H + He$^+$ in a kinematically complete experiment which allows us to determine the initial vibration energy of the molecule. We will present kinetic energy release distributions for vibrationally selected molecules which show a number of minima equal to the number of nodes of the vibrational wave function. We used this structure to test and improve the reflection approximation, which connects the internuclear vector to the kinetic energy release of the molecular breakup using classical mechanics. An independent experimental approach to gather information on the internuclear distances occurring in H$_2^+$ is the analysis of interference fringes caused by the coherent superposition of the scattering of the Helium atom at the two molecular centers [1]. We found the results of the two experimental methods to be consistent even though a quantum mechanical treatment of the dissociation does not show a close correlation between kinetic energy releases and internuclear distance.

PR: Time-resolved photoelectron emission from surfaces

Christoph Lemell

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The development of table-top sources of ultrashort pulses from the XUV to the IR regime (100 as and 4.5 fs respectively) provides novel tools to study photoelectron emission from surfaces in unprecedented accuracy and detail. E.g., using the streaking technique, it has become possible to determine the timing structure of electron emission [1], measurements of the carrier-envelope phase using metallic targets have shown the dependence of the response of the electronic system on the exact shape of the electric field [2]. We present theoretical studies of laser-metal interactions (XUV pump-IR probe settings, IR multiphoton vs. tunneling emission) using methods ranging from semi-classical simulations of electron transport in solids [3] to time-dependent density-functional theory studies of the response of conduction band electrons to ultrashort laser pulses [4,5].


PR: Cluster autoionization via ultrafast energy transfer and charge transfer

Uwe Hergenhahn

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Autoionization of weakly bonded systems has received a lot of interest, because decay channels have been discovered that are qualitatively different from those in atoms or covalently bonded systems. Best known among them is Interatomic/Intermolecular Coulombic Decay (ICD). This term designates autoionization processes in which two sites in a weakly bonded cluster or liquid are simultaneously involved. The essential point in ICD is the creation of a charge separated final state as a result of ultra-fast energy transfer between sites. An electron of low kinetic energy is emitted. I will give a progress report on our research on ICD, covering recent experiments on water clusters and heterogenous rare gas clusters. Besides ICD, we have discovered autoionization channels that involve ultra-fast charge transfer, instead of energy transfer. This so-called Electron Transfer Mediated Decay [1,2] is an example for a charge transfer process driven solely by electron correlation, greatly different from the established picture of charge transfer processes.

Interatomic Coulombic decay (ICD) is an ultrafast non-radiative electronic decay process for excited atoms embedded in a chemical environment [1, 2, 3]. Via ICD, the excited system can get rid of the excess energy and this excess energy is transferred to one of the neighbors and ionizes it. Whereas the same excited atom when isolated relaxes only by emitting a photon in a time range of picoseconds to nanoseconds, ICD takes place in the femtosecond range. Thus, ICD is generally the most favorable decay process. Through ICD, the energy transfer between the two involved atoms can take place over large distances. A question which arises is how far can atoms exchange energy? The giant extremely weakly bound helium dimer is a perfect candidate to investigate this issue. After simultaneous ionization and excitation of one helium atom, the excited ion can relax through ICD and thus ionize the neighboring neutral helium atom. The resulting two He\(^+\) then undergo a Coulomb explosion and fly apart. As it will be shown, the two helium atoms can exchange energy via ICD over distances of more than 45 times their atomic radius. Oscillatory structures in the kinetic energy release spectra reflect the nodal structures of vibrational wavefunctions involved in the decay process [4].


SR: The RMT method for describing many-electron atoms in intense short laser pulses

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We describe how we have developed an ab initio R-Matrix incorporating Time (RMT) method to provide an accurate description of the single ionization of a general many-electron atom exposed to short intense laser pulses. The new method implements the “division-of-space” concept central to R-matrix theory and takes over the sophisticated time-propagation algorithms of the HELIUM code. We have tested the accuracy of the new method by calculating multiphoton ionization rates of He and Ne and have found excellent agreement with other highly accurate and well-established methods.

SR: Angular distributions and correlations in sequential three-photon triple atomic ionization

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Angular correlations between photoelectrons in sequential triple three-photon ionization of noble gas atoms are calculated and analyzed. Angular distributions of first-, second- and third-step electrons are obtained. Preferential experimental geometries to observe the angular correlations are proposed.
Spectra using a tunable-energy positron beam show that annihilation on most molecules occurs via vibrational Feshbach resonances that greatly enhance annihilation rates and provide a measure of positron-molecule binding energies, $\varepsilon_b$ [1]. Values of $\varepsilon_b$ vary from millielectronvolts to $\geq 0.3$ eV. For molecules with small permanent dipole moments $\mu$ and modest polarizabilities per atom, $\varepsilon_b = 12.4(\alpha + \mu + 2.4 N_\pi - 5.6)$ [meV], where $\alpha$ is the molecular dipole polarizability and $N_\pi$ is the number of $\pi$ bonds in aromatic molecules. Recent experiments on molecules with larger $\alpha$ and $\mu \geq 2$ debye show a much stronger dependence on $\alpha$ and $\mu$ [2]. These data are interpreted as implying that $\varepsilon_b$ has become sufficiently strong so as to localize the positron near a portion of the molecule. Similarities and contrasts with an analogous class of electron-molecule (negative ion) states will be discussed (e.g., positron binding is 3–100 times larger) [3], as well as comparison with recent theoretical predictions [4]. In collaboration with J. R. Danielson, J. J. Gosselin, and A. C. L. Jones and supported by the U. S. NSF, grant PHY 07-55809.

More than fifty years ago, J. A. Wheeler [1] proposed the existence of several kinds of exotic systems that are composed of three particles with equal masses and bound through Coulomb interaction. The positronium negative ion (Ps⁻) is the only system that has been observed so far [2]. Although many theoretical studies have challenged to explore the nature of Ps⁻, measurements of the lifetime have been the only experiments conducted so far, limited by the extremely weak beam intensity. In the present work, we have succeeded in the first observation of the photodetachment of Ps⁻ [3] using a new method to produce Ps⁻ efficiently [4-6]. We have observed the change of the annihilation photon energy spectrum and detected high energy neutral Ps atoms produced by the photodetachment of accelerated Ps⁻. We have also estimated the photodetachment cross section. The success of the Ps⁻ photodetachment technique opens the door to a new era of the production of energy-tunable Ps beams.


In this work, we show that multimode vibrational couplings in resonant positron annihilation can arise from positron-induced distortions of the potential energy surface.

In this work, we show that multimode vibrational couplings in resonant positron annihilation can arise from positron-induced distortions of the potential energy surface.

The total cross section of positronium scattering from a variety of atoms and molecules has been found to be unexpectedly close to that of a bare electron moving at the same velocity, despite Ps being neutral and having twice the mass [Science 330, 789 (2010)]. This behaviour appears to extend to velocities where effects such as the Ramsauer-Townsend minima and shape resonances occur for electrons. The latter has now been observed in collisions with CO₂. Results are presented along with recent production efficiency measurements of Ps at high energies.
The increasing wavelength range and resolution of large space instruments such as Chandra, Newton, SOHO, Suzaku, Herschel, Spitzer, and the upcoming ASTRO-H and James Webb Space Telescope have, and will, continue to place demands for a broad expanse of laboratory collision-physics data required to interpret the observed astrophysical phenomena. X-ray investigations of the Sun and stars have revealed a rich array of highly-charged ion emissions requiring level lifetimes, as well as excitation, ionization, and recombination cross sections. Simulation of the interaction of the solar wind with comet neutral gases and planetary exospheres requires accurate single- and multiple-charge exchange cross sections, as well as laboratory X-ray emission spectra. Detection of simple and complex molecules in nebulae and circumstellar clouds requires an understanding of atom-dust grain interactions, and molecular formation via superthermal atom collisions with grain-adsorbed species. Space observations will be presented, and combined with results of measurements at JPL to illustrate these conjunctions of astronomical observations and collision physics. This work was carried out at JPL/Caltech, and was supported through agreement between Caltech and NASA.

Re: Charge exchange processes involving highly-charged ions and targets of astrophysical and fusion plasma interest

Sebastian Otranto

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In this talk, we will present classical trajectory Monte Carlo theoretical studies of charge exchange processes following highly charged ion impact on diverse targets as Ar, H$_2$O, H(1s), H(2s), Li(2s) and Na(3s) and Na*(3p) at collision impact energies in the range 0.1-100 keV/u. The reactions under study are relevant to the astrophysical community and the fusion plasma program as well. State selective charge exchange cross sections will be presented and discussed and the validity of well established scaling laws revisited for very highly charged projectiles. The present studies are contrasted to the available experimental data (X-ray spectra, state-selective cross sections) from different laboratories worldwide. The role of the multiple electron capture process in astrophysical X-ray spectra is discussed and modeled within the nCTMC approximation.
Ion-atom multiple ionization is one of the most complicated processes to study. It demands not only elaborated collision theory, but also a detailed knowledge of the post-collisional processes which determine the ultimate charge measured by the experiments. There are different mechanisms that produce time-delay electron emission (Auger and Coster–Krönig processes, electron shake-off, excitation followed by double Auger), which are related to the post-collisional state of the target [1], and are independent of the ion nature or impact energy. In recent years the combination of theoretical ionization probabilities with experimental rates of post-collisional electron emission in photoionization experiments [2–3], has given new impulse to the theoretical and experimental research on this subject [4–7]. Our calculations combine full CDW-EIS impact parameter probabilities and recent photoionization branching ratios [8]. In this opportunity we will present results for single to quintuple ionization cross sections for Ne, Ar, Kr, and Xe bombardered by different ions and charge states, in the intermediate to high energy range, and compare them with the available experimental data.


SR: Measurement of the associative detachment reaction \( \text{H}^- + \text{H} \rightarrow \text{H}_2 + e^- \) using a merged-beams method

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Using a merged-beams method, we have performed absolute, energy-resolved measurements for the associative detachment reaction \( \text{H}^- + \text{H} \rightarrow \text{H}_2 + e^- \). Our results remove a long-standing discrepancy between theory and experiment for this fundamental reaction. In particular, we find excellent agreement with theoretical results which previously seemed to be ruled out by a recent flowing afterglow experiment.

SR: Radiative association of \( \text{H}^+ \) and \( \text{H}_2^- \) – experimental study

Radek Plašil*, Illia Zymak*, Dieter Gerlich†, Juraj Glosik*

*Faculty of Mathematics and Physics, Charles University, Prague, Czech Republic
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The radiative association of \( \text{H}^+ \) and \( \text{H}_2^- \) was studied at low temperature in 22 pole radiofrequency trap. The rate coefficient measured at 11 K is \((1.4 \pm 0.7) \times 10^{-16} \text{ cm}^3 \text{s}^{-1}\).
Tuesday, 2 August 2011

PL: Few-body highly correlated dynamics

Chris H. Greene

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Progress in the theoretical description of nonperturbatively-correlated collision physics at low energies has made rapid strides, through the introduction of novel conceptual techniques and also the continuing improvement in computational power. Two areas that have utilized quite different techniques will be addressed in this lecture. The first is the fundamental chemical rearrangement process of dissociative recombination of a small polyatomic molecule target ion with a low-energy electron and subsequently dissociates into two or three neutral fragments in the sub-electron volt energy range. The second is the recombination of a small number of neutral atoms that collide at temperatures in the sub-microkelvin range, especially in resonance configurations intimately connected with the universal Efimov effect that was predicted decades ago in the context of nuclear physics. Both of these areas have benefited from exciting advances in experimental methods, which will also be reviewed.
In ion traps, the translational motion of molecular ions can effectively be sympathetically cooled to temperature in the mK range through the Coulomb interaction with laser cooled atomic ions. At such low temperatures the molecular ions typically become part of spatial ordered structures (Coulomb crystals) in which the individual molecules can be localized within a few mm$^3$. The extreme situation of having only a single laser-cooled atomic ion interacting with a single molecular ion is an ideal starting point for single molecule studies.

In the talk, I will discuss recent single molecule studies focused on photofragmentation of singly charged Aniline ions (C$_6$H$_7$N$^+$) [1] and on isotope effects in the reaction of $^{26}$Mg$^+/^{40}$Ca$^+$ atomic ions with a H$_2$, HD, and D$_2$ molecules [2], as well as present recent results on rotational ground state cooling of vibrationally and translationally cold MgH$^+$ ions applying a laser cooling scheme based on excitation of a single rovibrational transition [3,4].


PR: Negative osmium ions: Spectroscopy and fundamental applications

Alban Kellerbauer

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Atomic anions are generally not amenable to optical spectroscopy because they are loosely bound systems and rarely have bound excited states. Until now, there is only one known negative ion with a strong bound–bound electronic transition [1]. This electric-dipole transition, in the negative osmium ion, provides unique insight into the structure of atomic anions. In addition, it may enable the preparation of ultracold ensembles of negative ions. Currently available cooling techniques for negatively charged particles allow cooling only to the temperature of the surrounding cryogenic environment, typically at 4 K if the apparatus itself is cooled with liquid helium. At these temperatures, the achievable precision of spectroscopic measurements is often limited by inhomogeneous broadening due to thermal motion. Laser excitation of the electric-dipole transition in Os$^-$ ions could be used to laser-cool them to microkelvin temperatures [2]. If demonstrated to be successful, the technique would allow the cooling of any species of negatively charged ions – from subatomic particles to molecular anions – to ultracold temperatures by sympathetic cooling. We have been investigating the bound–bound electric-dipole transition in Os$^-$ by high-resolution laser spectroscopy with a view to using it for the first laser cooling of negative ions [3,4]. The principle of the method, its potential applications, as well as experimental results will be presented.

PR: Entanglement of two individual atoms using Rydberg blockade

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When two quantum systems interact strongly, their simultaneous excitation by the same driving pulse may be forbidden: this is called blockade of excitation. Recently, extensive studies have been devoted to the Rydberg blockade between neutral atoms, which appears due to the interaction induced by their large dipole moments when they are in Rydberg states.

This talk will describe our demonstration [1] of the Rydberg blockade between two atoms individually trapped in optical tweezers at a distance of 4 micrometers. The rubidium 87 atoms are prepared in the state |↑⟩ = |F =2, M=2⟩, and subsequently excited to the Rydberg state 58d3/2, |r⟩, by a two-photon transition. A consequence of the blockade mechanism is that the atoms are excited in an entangled state of the form (|r,↑⟩ + |↑,r⟩) / √2. The signature of the production of this state is the enhanced Rabi frequency of the oscillation of the probability to excite only one of the two atoms, with respect to the Rabi frequency of the excitation of one atom when it is alone. We have then mapped the Rydberg state |r⟩ onto a second ground state |↓⟩ = |F =1, M=1⟩ to generate the Bell state (|↓,↑⟩ + |↑,↓⟩) / √2. We analyse the amount of entanglement by global Raman rotations on the two atoms. We have measured a fidelity of the two-atom state produced of 0.74 [2].


PR: Three and four-body Efimov states in an ultracold atomic gas

Randall G. Hulet
Department of Physics & Astronomy, Rice University

We have observed the presence of weakly-bound three and four-body Efimov molecules in an ultracold gas of trapped lithium-7 [1]. Their presence is manifested in the rate of inelastic collisions that produce a detectable loss of atoms from the trap. Efimov molecules can only exist near a two-body scattering resonance, where the s-wave scattering length is much larger than the characteristic length scales of the two-body potential. This universal regime is characterized by extraordinarily small binding energies (~1 neV) and large molecular sizes (~100 nm). Efimov molecules can be accessed experimentally in ultracold atomic gases by using a magnetically-tuned Feshbach resonance, which enables the scattering length to be varied over many orders of magnitude [2]. We have identified two Efimov trimers and four associated four-body tetramers in lithium. Efimov molecules are predicted to occur in an infinite series, whose relation are given by a discrete scale invariance. The experimental relations between Efimov states will be compared with those given by universal theory.

Electron-impact ionization and electron-ion recombination are important atomic processes governing the charge balance in plasmas. The quantitative understanding of the properties of nonequilibrium plasmas requires the knowledge of accurate rate coefficients for these atomic ionization and recombination processes. To date, most of these data come from theory. Experimental benchmarks are needed to assess the theoretical uncertainties and to guide the further improvement of the theoretical methods. Here, an overview will be given over recent progress concerning electron-ion recombination [1] and electron-impact ionization [2] measurements with multiply charged ions of relevance to astrophysics [1,2] and fusion plasmas [3]. The experimental programme is being carried out at the Heidelberg heavy-ion storage ring TSR. As an illustrative example the impact of improved dielectronic recombination (DR) data for iron ions on the interpretation of x-ray spectra from active galactic nuclei will be highlighted. Concerning fusion plasmas, atomic spectroscopy and collision processes involving tungsten ions currently receive much attention, since tungsten is used as a wall material in nuclear fusion reactors. The first storage-ring DR result for a tungsten ion, W^{20+} [3], will be presented and discussed.


PR: Low energy electron scattering from fuels
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Total cross section (TCS) measurements of electrons colliding with gaseous molecules provide fundamental information which is needed in modeling the transport of electrons through these targets. Accurate and precise values of absolute TCSs represent important information in many scientific and technological applications. In our case, we are motivated to provide such information for electron-fuel collision processes which are specifically relevant to modeling spark ignition in alcohol-fuelled internal combustion engines. Many electron scattering TCS measurements are presently available for a diverse range of atomic and molecular targets. However, lack of data for important bio-molecular targets still remains. Disagreements between the available TCS data for the alcohols have prompted several studies of electron scattering collision of slow electrons with these molecules which are currently important in applications as bio-fuels. This relevance, which has attracted much attention, has been one of the subjects of a recent collaboration between experimental and theoretical groups in the USA and Brazil. We address methanol and ethanol TCSs at low energy range and report additional studies of resonant structure in ethanol using the detection of metastable states produced by electron impact excitation with high energy resolution.
A supernova is the explosive death of a massive star. The modeling of these events requires applications from a wide range of numerical and physical disciplines, including hydrodynamics, radiation transport, nuclear physics and atomic physics. In this talk, the role of atomic data is discussed as it pertains to the modeling of radiation emitted by supernovae, which is sometimes referred to as a light curve. Recent applications [1] include the Los Alamos OPLIB opacity database, which has been used to provide atomic opacities for modeling supernova plasmas under local thermodynamic equilibrium (LTE) conditions. Additional discussion of ongoing work to model plasmas under non-LTE conditions will also be provided. More specifically, the Los Alamos suite of atomic physics codes is currently being used to explore options for providing atomic data to model supernovae light curves under these more complicated conditions. This work was performed under the auspices of the U.S. Department of Energy by Los Alamos National Laboratory under Contract No. DE-AC52-06NA25396.


Absolute rate coefficients for dielectronic recombination of Be-like Xe$^{50+}$ have been measured by employing the electron-ion merged beam technique at GSI’s heavy-ion storage ring ESR in the center-of-mass energy range 0 – 600 eV. In addition to ground state ions, resonances from metastable Xe$^{50+}$($2s^2\text{p}_3\text{P}_0$) parent ions have been observed. These may be exploited in future measurements of the E1M1 two photon $2s^2\text{p}_3\text{P}_0 \rightarrow 2s^2\text{S}_0$ transition rate.

SR: Electron scattering from krypton: High-resolution electron scattering experiments and B-spline R-matrix calculations

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For elastic scattering and electron impact excitation of the $4p^25s$ states in Kr, we present independently normalized, absolute angle-differential cross sections over the entire angular range (0°–180°). Excellent agreement is obtained between the present experimental data and theoretical predictions from a fully relativistic B-spline R-matrix (close-coupling) model.
Two of the most prominent advantages that free-electron lasers offer compared to traditional XUV sources are the ultra-high brilliance and the short pulse length of the emitted radiation. Thus, the huge light intensities reachable for the first time, enable the investigation of multi-photon processes in atoms and molecules at photon energies that were not accessible before. One prominent example for such a reaction is the two-photon double ionization (TPDI) of He which attracted tremendous theoretical interest during the last few years (see e.g. [1] and references herein). In addition, XUV-pump – XUV-probe experiments allow to resolve molecular dynamics on time scales on the order of 10 fs like e.g. the tracing of the vibrational motion in even the smallest molecules.

Here we report on two benchmark experiments that both have been performed with a dedicated reaction microscope at the free-electron laser in Hamburg (FLASH). In the first experiment we obtained differential cross sections for non-sequential two-photon double ionization of He at a photon energy of 52 eV finding the first experimental evidence for 'virtual sequential ionization' [2]. Applying a novel split mirror setup we conducted in the second experiment a XUV pump-probe measurement where we were able to trace in real-time the femtosecond nuclear wave packet dynamics in a prototype system, the 1s\(\sigma\)g ground state of D\(_2\) [3].


PR: Shot-by-shot photoelectron spectroscopy of non-linear processes of atoms in intense EUV FEL fields

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The recent advances in free electron laser (FEL) technology allow us to study non-linear optical processes in extreme ultraviolet (EUV). Photoelectron spectroscopy provides a detailed understanding of the multi-photon processes of simple atoms and molecules, because (i) electronic states involved in the ionization process can be identified directly from the photoelectron energy and (ii) the spectral properties of the FEL pulses can be evaluated on the shot-by-shot basis. The shot-by-shot photoelectron spectroscopy [1] is powerful in unveiling wavelength-sensitive nonlinear processes such as resonance effects, which are otherwise smeared out by the fluctuation of FEL operated in the self-amplification of spontaneous emission (SASE) mode. Here we present two applications of the shot-by-shot photoelectron spectroscopy on rare gas atoms in intense EUV-FEL fields (21-24 eV, ~ 5 TW/cm\(^2\)) carried out at RIKEN SCSS test accelerator facility; (I) three-photon double ionization of Ar [1] and (II) time-resolved non-resonant two-color two-photon ionization of He using a femtosecond laser synchronized to FEL.

The combination of intense femtosecond X-ray and NIR pulses produced by Free Electron Lasers (FEL) and synchronized optical lasers, respectively, offers various new possibilities to investigate the dynamics of photoionization and photodissociation processes. Some recent results obtained at the XUV-FEL FLASH in Hamburg and the first X-ray FEL, the LCLS in Stanford, will be presented. In the experiments at FLASH, the strong dressing field (>10^12 W/cm^2) produced by the optical laser, give rise to the so-called two-color Above Threshold Ionization (ATI), which could be studied for the first time in a regime free from unwanted interference effects [1]. In addition, electron spectroscopy was applied to observe via resonant Auger spectroscopy the laser-induced ponderomotive shift of an inner shell resonance, namely the resonant Kr 3d-5p excitation at 91.2 eV. Recent experiments at LCLS have taken advantage of the very short (2-5 fs) pulse durations delivered by this FEL. The duration coincides with the lifetime of the Ne 1s core hole state and with the temporal width of one optical cycle of the 800 nm radiation from the NIR dressing laser. The analysis of the angle-resolved KLL Auger decay in atomic reveals strong interference effects, which result from the coherent emission of electrons produced during one cycle of the superimposed optical field. The experimental results are in excellent agreement with recent theoretical work [2].


Traditional surface science methods have difficulties in studying the surface interaction between spin polarized atoms and anti-relaxation coatings in sealed atomic vapor cells. The average dwell time of atom-wall collisions provides important information for understanding the atom surface interaction. Here we present a simple method for directly measuring the average dwell time of spin polarized rubidium atoms on coated glass surfaces. The method relies on evanescent-wave induced light shift of the Zeeman resonance of Rb atomic spins, and does not depend on the microscopic details of surface interactions. Our measured dwell times are three orders of magnitude longer than the previous theoretical estimates and suggest a new picture of the atom-surface collisional process.
PR: Dynamics of ion guiding through nanocapillaries in insulating polymers

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Recent experiments concerning guiding of highly charged ions through nanocapillaries in insulating polymers are reviewed. The ion guiding phenomenon in insulating capillaries is based on a self-organizing process governing the charge deposition of the incident ions at the inner wall of the capillaries [1]. After the accumulation of a sufficient charge patch the ions are deflected so they do not suffer close collisions with the capillary wall. Scaling laws for the guiding power as a function the projectile energies from 3-50 keV and charge states from 7 - 25 are discussed. Particular emphasis is given to the dynamic aspect of the ion guiding observed in the emission profiles of the transmitted ions (see [2] and references therein). This aspect is revealed by measuring damped oscillations of the ion emission angle relative to the capillary axis. The oscillatory structures provide evidence for temporary charge patches formed inside the capillaries. Each charge patch can be attributed to an extreme of the oscillations. Specific properties of the ion guiding are studied as function of the capillary diameter. Pronounced oscillations are observed for capillaries with a diameter of 200, 300, and 400 nm. The oscillation frequency is found to increase with decreasing capillary diameter and decreasing tilt angle. The experimental results are discussed within the framework of model considerations.


PR: Fast atom diffraction at surfaces

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Recently pronounced diffraction effects for grazing scattering of fast light atoms and molecules with energies up to some keV under axial surface channeling were observed. The rich diffraction patterns provide information on the interatomic spacings between axial surface channels and on the corrugation of the interaction potential. The latter effect can be used to study the structure of surfaces with fast atoms via an interferometric technique. The new method shows similarities to thermal He atom scattering (HAS), but has a number of advantages as simple tuning of the projectile energy (de Broglie wavelength) and, in particular, an orders of magnitude more efficient detection of scattered projectiles. As examples for the application of Fast Atom Diffraction (FAD) for studies on the structure of surfaces, we present results for the accurate positions of adsorbed O and S atoms on Fe(110) and Ni(110) surfaces as well as for the structure of an ultra-thin silica film on a Mo(1112) substrate. The quantum coherence in the scattering process is preserved by specific features of surface channeling which is investigated in detail via the coincident detection of the diffraction patterns with the energy loss of scattered atoms. It turns out that the suppression of electronic excitations owing to the band gap of insulator surfaces play a key role for coherent scattering and the application of FAD in surface science.
Posters
1. Photon Impact (Weak Field)

1.1 General

We145 MQDT study of channel interactions in systems involving 3 non-degenerate and many degenerate closed channels
Chun-Woo Lee, Jeongjin Kim

We146 Complete characterization of the process of single-photon two-electron ionization of helium
I.A. Ivanov, A.S. Kheifets

We147 High-resolution threshold photoelectron and photoion spectroscopy of molecular nitrogen in the 15-52.7 eV photon energy range
Andrew J. Yencha, Kate Ellis, George C. King

We148 Confinement resonances in photoionization of endohedral Xe@C_{60}^{+}

1.3 Photoionization of atoms

We149 Asymmetric photoelectron emission from krypton 4p shell in the vicinity of 3d resonant excitations
S. Ricz, T. Buhr, K. Holste, A. A. Borovik Jr., D. Bernhardt, S. Schippers, Á. Kövér, D. Varga, A. Müller

We150 Strong quadrupole interaction between the krypton 4p photoionization and 3d resonant excitation channels
S. Ricz, T. Buhr, K. Holste, A. A. Borovik, Jr., D. Bernhardt, S. Schippers, Á. Kövér, D. Varga, A. Müller

We151 Photoionization cross sections of hydrogen impurity in spherical quantum dots
C. Y. Lin, Y. K. Ho

We152 Near-threshold photoionization from the excited mp^{5} (m+1)p J=0-3 levels of Ar, Kr, and Xe (m=3-5)

We153 Channel interaction between valence photoionization and resonant excitation of a deep inner shell in krypton atoms
T. Buhr, S. Ricz, Á. Kövér, K. Holste, A. A. Borovik, Jr., D. Bernhardt, S. Schippers, D. Varga, A. Müller

We154 The angular correlation width in double photoionization of helium atom and atomic hydrogen negative ion
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We155 K-shell X-ray spectroscopy of atomic nitrogen
M M Sant’Anna, A S Schlachter, G Ohrwall, W C. Stolte, D W Lindle, B M McLaughlin

We156 The Ba 5s photoionization in a correlation minimum energy region
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We157 Effect of interchannel coupling and confinement on the photoionization of Kr
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We158  5s correlation confinement resonances in Xe-endo-fullerenes
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We159  Full relativistic calculations of energy levels and oscillator strengths up to autoionization region of atomic fluorine
Qing Bo, Gao Xiang, Yan Jun

We160  Single photon double core-hole photoionization of atomic beryllium
F.L. Yip, F. Martin, C.W. McCurdy, T.N. Rescigno

1.4  Photoionization of molecules

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We162  The electronic structure of polynuclear cobalt trimethylacetate complexes by Co3s and Co3p X-Ray photoelectron spectroscopy
T.M. Ivanova, A.G. Kochur, P.V. Linko, A.A. Sidorov, M. A. Kiskin, V.M. Novotortsev, I.L. Eremenko

We163  Vibrational Fano resonances in the photodetachment of dipole-bound anions
Stephen T. Edwards, John C. Tully, Mark A. Johnson

We164  Ultrafast electronic and nuclear dynamics In dissociative photoionization of molecular hydrogen and deuterium
Pierre Billaud, Yan J. Picard, Marie Geleoc, Jean-François Hergott, Bertrand Carre, Pierre Breger, Thierry Ruchon, Kévin Veyrinas, Marc Roulliay, Franck Delmotte, Martin Bottcher, Alain Huetz, Danielle Dowek

We165  Recoil-frame photoelectron angular distributions of probing the inner-valence dissociative ionization of carbon monoxide
M. Lebech, J. C. Houver, G. Raseev, D. Dowek, A. S. dos Santos, R. R. Lucchese

We166  New features in the ionic states of N₂O₄ : Experimental and theoretical study
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We167  Interference between differently localized electrons in N₂O
Andre Knie, Philipp Reiss, Arno Ehresmann

We168  Circular Dichroism in Photoionization of H₂ and D₂
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2.  Photon Impact (Strong Field)

2.1  General

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We126  Transporting near-circular Bohr-like wave packets using chirped sine waves
B. Wyker, S. Ye, F. B. Dunning, S. Yoshida, C. O. Reinhold, J. Burgdörfer
2.3 Photoionization of atoms

We134 Closure approximation in the theory of two-photon double ionization of atoms
O. Chuluumbaatar, H. Bachau, Yu.V. Popov, B. Piraux

We135 Interaction of atomic hydrogen with a UV pulse: model based calculations of the energy transfers from the laser field into both the electron kinetic energy and the harmonics.
H.M. Tetchou Nganso, Yu.V. Popov, B. Piraux, J. Madronero, M.G. Kwato Njock

We136 Angular correlations in the sequential two-photon double ionisation of atomic xenon
S. Fritzsche, A. N. Grum-Grzhimailo, E. V. Gryzlova, N. M. Kabachnik

We137 Theoretical study of multi-photon double electron excitation of He by intense ultrashort EUV pulses
Chien-Nan Liu, Toru Morishita, Shinichi Watanabe, Akiyoshi Hishikawa

We138 Ionization of atoms by ultrashort UV laser pulses - Iterative solution of the time dependent Schrödinger equation
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We139 Atomic photoionization: When does it actually begin?
A. S. Kheifets, I. A. Ivanov, Igor Bray

We140 Ionization of atomic hydrogen with up to four excess photons by circularly and linearly polarized light
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We141 Investigating temporal structure of FEL pulses by XUV pump–probe autocorrelation measurements

We142 Competition of sequential and direct paths in two-photon ionization of He

We143 Quantum dynamics studies of high-order harmonic generation from a coherent superposition of states
S L Zeng, S Y Zou, J Yan

We144 Above-threshold ionization of atoms and molecules in intense laser field
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We130  Time-resolved XUV-induced isomerization and $\text{H}_3$ formation in $\text{C}_2\text{H}_4$ cation  

We131  Strong field dissociation dynamics of $\text{NO}^{2+}$: A multiphoton electronic or vibrational excitation?  
Bethany Jochim, M. Zohrabi, B. Gaire, U. Ablikim, K.D. Carnes, E. Wells, Tereza Uhlíková, B.D. Esry, I. Ben-Itzhak

We132  Low kinetic energy release upon dissociation of benchmark molecular ions  
B. Gaire, M. Zohrabi, J. McKenna, A.M. Sayler, Nora G. Johnson, K.D. Carnes, F. Anis, J.J. Hua, B.D. Esry, I. Ben-Itzhak

We133  Competition between dissociation paths of $\text{I}_2^+$ and $\text{NO}^+$ using fast laser fields  

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We001  Dramatic resonances in low-energy electron scattering from Tm, Lu and Hf atoms: Manifestation of multiple excited anions  
Z. Felfli, A. Z. Msezane, D. Sokolovski

We002  Slow electron scattering from Ag, Pd, Pt, Ru and Y atoms: Search for nanocatalysts  
A. Z. Msezane, Z. Felfli, D. Sokolovski

We003  Distorted wave method applied to e-Xe elastic scattering  
C. S. Singh

We004  Total cross section for electron scattering from Ar, Kr, Ne and N$_2$ in cold electron collisions  

We005  Elastic electron – Au-atom scattering at 100-2000 eV collision energies  
I. Yu. Yurova, A. Z. Devdariani, A. K. Belyaev, V. P. Pronin

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We006  Electron excitation of the valence subshell in potassium at low impact energies  
A A Borovik, G C King

We007  Ejected-electron excitation functions of the $(4p^5\ 5s^2)P_{3/2,1/2}$ autoionizing states of rubidium atoms excited by 15 to 640 eV electrons  
A. Borovik, V. Ilyashevytch, A. Kupliauskiene
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We057 Measurements of energy distribution of molecular ions and their fragments produced by electron impact with a new spectroscopic technique. |
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We059 Electron collisions with the interstellar molecular radicals CN, C$_3$N and C$_2$H using the R-Matrix method
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We060 Electron collisions with the formamide dimer and the HCOOH...HCONH$_2$ complex
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We042 VUV Study of dissociative excitation of S-containing molecules following electron impact
S J Brotton, J D Hein, J W McConkey

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We044 O($^1$D) production following electron impact on oxygen-containing molecules
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We047 Dissociative electron attachment to H$_2$ molecules involving the $^2\Sigma^+_g$ resonant Rydberg electronic state.

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We055 Electron induced reactions in gas phase MeCpPtMe$_3$ and Pd(hfac)$_2$  
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We056 Bond formations and rearrangement reactions in DEA experiments  
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We023 Electron-impact excitation of the Ne$^{2+}$ O-like ion  
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We028 The linear polarization of emission lines from EIE and DR of highly charged tungsten ions  
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We029  Electron impact excitation of the Fe-peak ions Ni III and Ni IV
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We030  Electron-impact excitation of the astrophysically important singly ionized Fe-peak ions Sc and Ti
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We073  Cross sections for single electron capture, transfer ionization and direct ionization in Li$^{3+}$ - Ne collisions
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Interaction of slow HCI with gaseous targets: absolute x-ray emission cross sections and contribution of multi-capture processes

Universal behavior of the electron-electron interaction in the simultaneous projectile and target ionization
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We091 Nonadiabatic nuclear dynamics in the ammonia cation studied by the branching classical trajectory method.
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We092 Laboratory studies of the cosmic origins of organic chemistry
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We082 State-selective electron capture by O$^{3+}$ ions on He and H$_2$

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We115 Free-free transitions in the presence of laser fields and Debye potential at very low incident electron energies
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We116 Electron-helium free-free scattering in the presence of a laser field
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We122 Laser-induced ionization of simple atoms and molecular ions
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We102 Coincidence investigation of electron impact excitation of He atoms to triplet states in full range of scattering angles - feasibility study
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We103 Split and delay system for soft X-ray pump/soft X-ray probe experiments at the LCLS free electron laser
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Th132 Quasi free mechanism in single photon double ionization of helium

Th133 Multiphoton ionization of xenon at the LCLS Free-Electron Laser

Th134 High-order harmonic spectroscopy: Experimental and theoretical study of Cooper minimum in argon
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Th135 X-Ray M-emission of Au atoms induced by photons in energy range 5 – 30 keV
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Th136 K-Shell photoabsorption of magnesium ions
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Th137 Resonant double photoionisation spectroscopy of magnesium
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Th146 Attosecond control in photoionization of D_{2}

Th147 Electron diffraction self imaging of molecular fragmentation in two step double ionization of water

Th148 Photofragmentation of the K-shell excited perfluorocyclobutane probed by a multiple-ion coincidence technique
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Experimental and theoretical asymmetry parameters for photoionization of H$_2$ showing interference from the Q$_1$ and Q$_2$ doubly excited states
T. J. Reddish, A. Padmanabhan, M. A. MacDonald, L. Zuin, J. Fernandez, F. Martin

A dissociative photoionization study of the e$^4\Sigma_u^-$ state in O$_2^+$ using the TPEPICO technique
A. Padmanabhan, M. A. MacDonald, C. H. Ryan, L. Zuin, T. J. Reddish

Theoretical study of the vibrationally resolved photoionization cross section for the valence shells of N$_2$ and CO
E. Plésiat, S.E. Canton, J. D. Bozek, B. S. Rude, P. Decleva, F. Martín

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New H$^-$ Photodetachment and radiative attachment computations for astrophysical environments
B M McLaughlin, H R Sadeghpour, P C Stancil, A Dalgarno, R C Forrey

Valence-shell photoionization of Cl-like Ar$^+$ Ions

Observations of bound and unbound states of Ce$^-$

Photoionization of singly and multiply charged tungsten ions
A. Müller, S. Schippers, A. L. D. Kilcoyne, A. Aguilar, D. Esteves, R. A. Phaneuf

High-resolution photoionization of Xe$^+$ ions: Experiment and theory

Photo-multidetachment and fragmentation of C$_{60}$ anions

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The X-ray extended range technique – a model for investigating X-ray and electron collision processes at a synchrotron.
Christopher T Chantler

Interatomic Coulombic decay of NeAr dimers following Auger decay

Strong impact of protonation and deprotonation on intermolecular Coulombic decay
Nikolai V. Kryzhevoi, Lorenz S. Cederbaum
Interatomic Coulombic decay and electron-transfer-mediated decay following triple ionization in Ne$_2$, NeAr, and Ar$_2$
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Interaction of soft x-ray photons with free alkali-halide molecular clusters
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2. Photon Impact (Strong Field)

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Madalina Boca, Victor Dinu

Electron distribution in non-linear Compton scattering
Victor Dinu, Madalina Boca, Viorica Florescu

Hydrodynamical description of strong field-driven electron dynamics
P. Botheron, B. Fons

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Multiphoton ionization and stabilization of helium in superintense xuv fields
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Path integral based evaluation of the short pulse photo-ionization probability in hydrogen and helium atoms
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Ultrafast correlated-electron dynamics and atomic structure
Steven Hutchinson, Michael A. Lysaght, Hugo W. van der Hart

Multi-electron dynamics using time dependent R-matrix theory
Steven Hutchinson, Michael A. Lysaght, Hugo W. van der Hart

Stochastic enhancement of high-order harmonic generation
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Doubly-differential intracycle interference in above threshold photoionization
Diego G. Arbo, Kenichi L. Ishikawa, Emil Persson, Joachim Burgdoerfer

Exploring single-photon ionization on the attosecond time scale

Confining the double ionization dynamics of argon to half of a laser cycle

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Th124  Extracting electron-ion differential scattering cross sections for partially aligned molecules by laser-induced rescattering photoelectron spectroscopy  
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Th125  Multiple ionization and double core-hole production in molecules using the LCLS X-ray FEL  

Th126  High harmonic generation from 2D diatomic molecules  
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Th127  Siegert-state method for ionization of molecules in strong field  
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Th128  Investigation of the helium dimer vibrational wavefunction using strong laserfields  

Th129  Alignment dependence in the breakup of the H\textsubscript{2} molecule by an xuv laser pulse  
  Xiaoxu Guan, Klaus Bartschat, Barry I. Schneider

Th130  Breakup of the H\textsubscript{2} molecule by xuv laser pulses: A time-dependent treatment in prolate spheroidal coordinates  
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Th028  Anomalously large low-energy elastic cross sections for electron scattering from the CF\textsubscript{3} radical  

Th029  Short range polarization potential for positron molecule scattering  
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Th030  Absolute differential and integral cross sections for CCl\textsubscript{4} molecules by low energy electron impact  

Th031  Electron collisions with hexafluoroacetone C\textsubscript{3}F\textsubscript{6}O molecules  
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Th032  Electron collisions with nitromethane  
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Th033  Electron collisions with the HCOOH...H₂O complex
T. C. Freitas, K. Coutinho, S. Canuto, M. A. P. Lima, M. H. F. Bettega

Th034  Electron scattering by glycine and electron affinity in clusters gly-(H₂O)ₙ
Josué Silva dos Santos, Romarly F. da Costa, Márcio T. do N. Varella

Th035  Absorption effects in intermediate energy electron scattering by n–butane (C₄H₁₀)

Th036  Low energy electron collisions with the N₂H radical
B M McLaughlin, R C Forrey

Th037  Elastic electron scattering from the DNA bases: cytosine and thymine
C J Colyer, S M Bellm, F Blanco, G Garcia, B Lohmann

Th038  Elastic scattering of low-energy electron by lignin precursors
Eliane M. de Oliveira, Márcio H. F. Bettega, Sergio d’A. Sanchez, Marco A. P. Lima, Márcio T. do N. Varella

Th039  Total and elastic electron scattering cross sections of pyrimidine
W. Y. Baek, H. Rabus

4.3 Excitation and ionization (diatomic molecules)

Th040  Electron impact excitation of carbon monoxide in the atmospheres of Mars and Venus
Laurence Campbell, Michael J. Brunger, Michael Allan

Th041  Observation of inelastic scattering from the Li dimer in electron energy-loss spectra of lithium below the first ionization threshold
A.A. Borovik, G.C. King

Th042  Electron impact vibrational excitation cross sections for CO
C M Cassidy, J Tennyson

Th043  Triple differential cross section calculations for the ionization of molecular nitrogen by electron impact
I. Toth, L. Nagy

Th044  Oscillation involved in (e,2e) cross sections of H₂ at large momentum transfer

Th045  Electron impact processes in the Earth’s ionosphere – Micro-to-macro approach
Siddharth H. Pandya, K. N. Joshipura

6. Collisions Involving Exotic Particles

6.2 Collisions involving positrons

Th079  Magnetic field-free measurements of the total cross sections for positron-neon and positron-argon scattering
K. Nagumo, Y. Nitta, M. Hoshino, J. P. Sullivan, H. Tanaka, Y. Nagashima

Th080  Unnatural parity resonances in the positron-excited hydrogen system
Y. Zhou, J. Ma, Y. C. Wang
Th081  Resonance Structures in positron-hydrogen scattering  
R. Yu, Y. Zhou, L. Jiao, Y. Cheng

Th082  Feshbach resonances in positron scattering from sodium  
L. Jiao, Y. Cheng, R. Yu, Y. Zhou

Th083  Total cross sections for positron-sodium scattering at low energies  
Y. Cheng, Y. Zhou, L. Jiao

Th084  Low energy positron scattering by carbon monoxide  
E. M. de Oliveira, S. d’A. Sanchez, M. A. P. Lima, M. T. do N. Varella

Th085  Convergent close coupling calculations for positron-magnesium scattering  
Jeremy Savage, Igor Bray, Dmitry Fursa, Alisher Kadyrov, Andrey Lugovskoy, Ravshanbek Utamuratov

Th086  Triply differential measurements for single ionization of molecular nitrogen by 250 eV positron impact  
R.D. DuBois, O.G. de Lucio

Th087  Kinematically complete picture of positron-impact ionisation of hydrogen  
A. S. Kadyrov, I. Bray

Th088  Multimode vibrational couplings in resonant positron annihilation  
S. d’A. Sanchez, M. A. P. Lima, M. T. do N. Varella

Th089  Two-center convergent close-coupling calculations for positron-lithium and positron-sodium collisions  

Th090  The search for Wigner cusps, resonances, and other compound states in positron scattering by atoms and molecules  
P. Caradonna, C. Makochekanwa, A. Jones, J. R. Machacek, J. P. Sullivan, S. J. Buckman

Th091  Trends in positron scattering from biomolecules  
J R Machacek, P Palihawadana, C Makochekanwa, J P Sullivan, M J Brunger, S J Buckman

Th092  Threshold behaviors in positron scattering from atomic lithium near the rst inelastic threshold  
F. Liu, Y. Cheng, Y. Zhou

7. Ion-Atom Collisions

7.1 General

Th055  Multiple ionization of noble gases by protons: ionization probabilities and postcollisional effects  
André C. Tavares, G. M. Sigaud

Th056  Measurement of the associative detachment reaction $H^- + H \rightarrow H_2 + e^-$ using a merged-beams method  
Kenneth A. Miller, Hjalmar Bruhns, Holger Kreckel, Xavier Urbain, Daniel Wolf Savin

Th057  Deviations from Bragg’s rule for ion energy loss in hydrocarbons  
Yu.A.Belkova, Ya.A.Teplova

Th058  Fully quantal close-coupling approach to antiproton-hydrogen collisions  
7.3 Ionization
Th059 Monte Carlo event generators in atomic physics: A new tool to tackle the few-body dynamics
M. F. Ciappina, M. Schulz, T. Kirchner

Th060 Complete fragmentation of ortho Ps – He\(^+\) ion system and the ELC process
C Sinha, S Mukhopadhyay, D Ghosh

Th061 Systematic analysis of four-particle Dalitz plots for double ionization
M. Schulz, D. Fischer, K. Schneider, R. Moshammer, J. Ullrich, M.F. Ciappina, T. Kirchner

Th062 Charge state distributions for heavy atoms of residues produced in nuclear fusion-evaporation reactions
Roman Sagaidak

7.4 Charge transfer
Th046 X-ray emission cross sections following charge exchange collisions on neutral targets: the role of multiple electron capture
S. Otranto, R. E. Olson

Th047 Transfer ionization process in collision of fast protons with helium at mil-liradian scattering angles
S. Houamer, Yu. V. Popov, C. dal Cappello

Th048 Soft X-ray emissions related to the solar wind charge exchange observed by the X-ray satellite observatories

Th049 Image of electron emission in He\(^{2+}\) – He collisions at intermediate energies

Th050 Charge transfer and ionization in proton-argon atoms collisions
Mukesh Kuamar Pandey, Y. K. Ho

Th051 Few-body dynamics studied with the in-ring reaction microscope at the TSR of MPIK
Katharina Schneider, Daniel Fischer, Manfred Grieser, Aditya Kelkar, Martin Sell, Xincheng Wang, Robert Moshammer, Joachim Ullrich

Th052 Electron transfer and ionization in collisions of He-like ions with Na(3s) and Na(3p)
I. Blank, S. Otranto, C. Meinema, R. E. Olson, R. Hoekstra

Th053 State-selective charge exchange in slow collisions of Si\(^{3+}\) ions with H atoms: A molecular state close coupling treatment
Dwayne C. Joseph, Bidhan C. Saha

Th054 Charge transfer in collisions between diatomic molecular ions and atomic H or \(\overset{\text{D}}{\text{D}}\) using merged beams
V.M. Andrianarivaona, I.N. Draganic, D.G. Seely, C.C. Havener
8. Atom-Atom and Ion-Ion Collisions

8.2 Elastic scattering

Th003  $^7$Li $-$ H scattering calculations at ultracold temperatures using CCA model
Santamay Panda, Sumana Chakraborty

Th004  Effect of mass in cold hydrogen-hydrogen system
Tapas Ray, Sumana Chakraborty

Th005  Evaporative cooling of ions in a Penning trap
M. Hobein, A. Solders, M. Suhonen, Y. Liu, K. Yao, R. Schuch

8.3 Excitation, de-excitation, and energy transfer

Th006  Low-Energy Inelastic Na $+$ H Collisions
A. K. Belyaev, P. S. Barklem, F. X. Gadea, D. V. Vlasov

Th007  Ab initio cross sections for low-energy inelastic Mg $+$ H Collisions
A. K. Belyaev, P. S. Barklem, M. Guitou, A. Spielfiedel, N. Feautrier, D. V. Vlasov, D. S. Rodionov

Th008  Collisional shift and broadening the Rb and Tl hyperfine lines in an atmosphere of the inert gas
Khetselius O.Yu., Florko T.A., Sukharev D.E.

8.4 Charge transfer, particle interchange, and association

Th001  State-selective charge transfer and excitation in ion-ion interactions at intermediate and high energies
R. Samanta, M. Purkait

Th002  Merged-beam study of mutual neutralization of H$^-$ and H$^+$
X. Urbain, J. Lecointre, F. Mezdari, K. A. Miller, D. W. Savin

9. Ion-Molecule or Atom-Molecule Collisions

9.5 Dissociation and reactive collisions

Th063  Statistical and non statistical dissociation processes of tungsten hexacarbonyl W(CO)$_6$ in collisions with protons, fluorine and chlorine ions.
Richard Brédy, Li Chen, Jérôme Bernard, X Zhu, Serge Martin

Th064  Energetic Rydberg neutrals from water dissociation
Jyoti Rajput, C P Safvan

Th065  Fragment kinetic energy distributions in ion induced CO$_2$ fragmentation
M. Jana, P. N. Ghosh, C.P. Safvan

Th066  Fragmentation of OCS$^{3+}$ formed by 150 keV Ar$^+$ ion impact on OCS
C. P. Safvan, M. R. Jana

Th067  Detachment rate coefficients for negative ions in BF$_3$

Th068  Radiative association of H$^+$ and H$_2$ – experimental study
R. Plasil, I. Zymak, D. Gerlich, J. Glosik
Coincidence measurements between fragment ions and the number of emitted electrons in heavy ion collisions with polyatomic molecules
T. Murai, T. Majima, T. Kishimoto, H. Tsuchida, A. Itoh

Density functional theory study of neutral, singly, and multiply charged polycyclic aromatic hydrocarbon molecules
Henning Zettergren, Anne I. S. Holm, Henrik Johansson, Henrik Cederquist

Sticking and fragmentation cross-sections of water clusters
Sébastien Zamith, Pierre Labastie, Jean-Marc L’Hermite

9.6 Ionization

Fragmentation of the CH$_2$Cl$_2$ molecule by attosecond proton beams and synchrotron radiation

Multiple-scattering phase distortion in the ionization of molecules
E. Altszyler, R. O. Barrachina, J.-Y. Chesnel, F. Fremont

Effect of projectile coherence on atomic fragmentation processes

Scattering angle dependence of double differential cross sections for dissociative Ionization of H$_2$ by proton impact
M. Schulz, K. Egodapitiya, S. Sharma, A.C. Laforge

Secondary electron emission from water vapor under 6.0 MeV/u C$^6+$ ion impact

Transfer ionization in swift D$^+$ on H$_2$ collisions - dependence of the electron emission on the internuclear distance
Markus Waitz, Florian Trinter, Christian Mueller, Christoph Goihl, Annika Jung, Hong-Keun Kim, Jasmin Titze, Markus S. Schoeffler, Till Jahnke, Achim Czasch, Lothar Ph. H. Schmidt, Horst Schmidt-Boecking, Reinhard Doerner

Efficient production of low energy electrons in ion-dimer collisions

11. Ultracold Atomic and Molecular Physics

11.1 General

Direct path-integral Monte-Carlo simulations of H$_5^+$/D$_5^+$ clusters: thermal equilibrium state properties
Rita Prosmi, Patricia Barragan, Ricardo Perez de Tudela, Pablo Villarreal, Gerardo Delgado-Barrio

11.2 Collisions at ultracold temperatures

The effect of long-range forces on cold-atomic interactions
Hasi Ray, Amuradha De
11.3 Cold molecules
Th158 Advanced modeling of He droplets
   Kersti Hermansson, Daniel Spångberg

Th159 Control of tunneling in a double-well potential with chirped laser pulses
   Mihaela Vatasescu

11.4 Laser trapping and cooling
Th163 A cryogenic Paul trap for highly charged ions and molecular ions
   Maria Schwarz, José R. Crespo López-Urrutia, Franziska R. Brunner, Tim Ballance, Michael
   Drewsen, Piet O. Schmidt, Joachim Ullrich

Th164 Analytical solution of dynamic equations for smooth motion of ions in traps
   Yu.V. Rozhdestvensky, K. S. Tikhonov

Th165 Collective modes in sculpted ultracold neutral plasmas
   P. McQuillen, J. Castro, T.C. Killian

12. Collisions Involving Condensed Matter
12.1 General
Th009 Laser asisted scattering of an optical polaron in presence of an impurity center
   S. Mukhopadhyay, C. Sinha

Th010 Gaussian-broadened plasmon (e,2e) spectra from thin films
   JF Williams, S Samarin, L Pravica, V Petrov

12.3 Lepton collisions with clusters
Th021 Total ionization cross sections of C_{60} cluster due to electron impact
   Surekha Tomar, Neelam Tiwari, Yogesh Kumar

Th022 Energy harvesting in doped helium nano-droplets
   Samuel Zöttl, Harald Schöbel, Peter Bartl, Christian Leidlmair, Matthias Daxner, Stephan
   Denifl, Tilmann D. Märk, Paul Scheier, Daniel Spångberg, Andreas Mauracher, Diethard K.
   Bolome

12.6 Lepton collisions with surfaces
Th027 Angular and time dependence of electron transmission through a macroscale tapered glass capillary
   G.G. De Silva, B.S. Dassanayake, D. Keerthisinghe, A. Ayyad, J.A. Tanis

12.7 Heavy particle collisions with surfaces
Th018 Reactive scattering of H_2(v\geq0,J\geq0) from metal surfaces under fast-grazing incidence conditions
   D. Stradi, C. Diaz, F. Martin

Th019 Influence of surface electronic states on electron emission from metallic targets
   C. D. Archubi, M. S. Gravielle, V. M. Silkin
Th020  Ion guiding and formation of neutrals in PET polymer nanocapillaries
Z. Juhášz, B. Sulik, S. Bíri, K. Tőkési, R. J. Bereczky, R. Rácz, Á. Kövér, J. Pálinkás, N. Stolterfoht

12.9 Lepton collisions with solids

Th023  Theoretical and experimental developments in the determination of electron energy loss functions and inelastic mean free paths in elemental solids and binary compounds.
Jay D Bourke, Christopher T Chantler

Th024  Coherent-states calculation of electronic density fluctuations associated to the excitation of plasmons
Juana L. Gervasoni, Silvina Seguí, Néstor R. Arista

Th025  Angular distribution of diffracted channeling radiation in Si and LiF crystals at axial channeling
K.B. Korotchenko, Yu.L. Pivovarov, T.A. Tukhfatullin

Th026  On moderate energy electron dechanneling in thick Si crystals
O.V. Bogdanov, S.B. Dabagov

12.10 Heavy particle collisions with solids

Th011  Model for oscillations in the guidance of ions through insulating nanocapillaries
Grigory Pokhil, Hocine Merabet, Nikolaus Stolterfoht

Th012  Stopping power of Zn for heavy ions
E. D. Cantero, C. C. Montanari, M. Behar, R. C. Fadanelli, G. H. Lantschner, J. E. Miraglia, N. R. Arista

Th013  Nanomelting and track formation in insulators by swift heavy ions
Georg Wachter, Károly Tőkési, Gerhard Betz, Christoph Lemell, Joachim Burgdörfer

Th014  Convoy electron emission following ionization of highly-charged ions excited by resonant coherent excitation

Th015  High energy heavy ion bombardment in polycrystalline Fe$_3$O$_4$ thin film
Jianrong Sun, Zhiguang Wang, Yuyu Wang, Cunfeng Yao, Kongfang Wei, Tielong Shen

Th016  Cherenkov radiation from relativistic heavy ions: new features caused by ion stopping in radiator
O.V. Bogdanov, Yu.L. Pivovarov

Th017  Low-energy electron emission from condensed targets induced by fast ions
J.L. Shinpaugh, R.A. McLawhorn, S.L. McLawhorn, K.D. Carnes, M. Dingfelder, L.H. Toburen

14. Related Topics

14.2 Structure and spectroscopy (atoms, atomic ions)

Th101  Relativistic atomic data for lines in Ge-like Sm and Eu ions
O. Nagy, Fatma El-Sayed

Th102  E1, E2 and M1 transitions in low lying levels in Fe VII
Keka Basu Choudhury, N. C. Deb, A. Z. Msezane
Th103 Series of singlet and triplet S-wave doubly-excited states of B$^{3+}$ below the N=2 threshold of B$^{4+}$
T. T. Gien

Th104 Towards a storage-ring measurement of the hyperfine induced 2s2p $^3P_0 \rightarrow 2s^2 \, ^1S_0$ transition rate in beryllium-like sulfur
S. Schippers, D. Bernhardt, C. Krantz, M. Lestinsky, O. Novotný, A. Müller, A. Wolf

Th105 log($gf$) values for astrophysically important transitions in Fe II
Narayan C. Deb, Alan Hibbert

Th106 Probing two-electron screening and two-photon diagrams with mid-Z He-like ions
K. Kubicek, J. R. Crespo Lopez-Urrutia, J. Ullrich

Th107 Interaction of variational localised correlation functions for atomic properties of Be I
S. Verdebout, P. Rynkun, P. Jönsson, G. Gaigalas, C. Froese Fischer, M. Godefroid

Th108 Ab-initio multi-configuration Dirac-Hartree-Fock calculation on the lifetimes of levels in 2p$^5$3s configuration of neutral neon
J. G. Li, S. Verdebout, M. Godefroid

Th109 Relativistic calculations on isotope shifts in barium
Cedric Naze, Jiguang Li, Michel Godefroid

Th110 Theoretical study of hyperfine structure constants of Ga isotopes
1. Photon Impact (Weak Field)

1.2 Photoexcitation of atoms, molecules and ions

Fr134 The absolute cross section of the Fluorescence, Dissociation, and Ionization of H$_2$ super excited states

Fr135 High resolution resonant x-ray scattering on diluted targets
M. Zitnik, M. Kavcic, K. Bucar, A Mihelec, R. Bohinc

Fr136 Laser spectroscopy of the green coronal line of Fe$^{13+}$ ions
Kirsten Schnorr, Volkhard Mäckel, José R. Crespo López-Urrutia, Joachim Ullrich

Fr137 The effect of the spin-orbit and Stark mixing on photon yield spectra of photoexcited helium
Andrej Mihelec, Matjaz Zitnik

Fr138 Laser spectroscopy of the methylene blue cation in an electrostatic ion storage ring

Fr139 Valence and inner-valence photoionization and autoionization of Sb$_4$ clusters at 4d$\rightarrow$n/l resonances
Samuli Urpelainen, Johannes Niskanen, Jussi Antti Kettunen, Marko Huttula, Helena Aksela

Fr140 Laser spectroscopy of Be-like Ar at the Stockholm EBIT
S. Mahmood, S. Ali, I. Orban, S. Tashenov, R. Schuch

Fr141 Calculation of the effective Lande-g factors for entangled states in hydrogen and hydrogen-like atoms
Salwa Alsaleh, Laila Babsail, Leda Bousiakou, Mesude Saglam

Fr142 Intrinsic luminescence of diamondoids in the ultra-violet spectral region
A. Ehresmann, Ph. Reiß, D. Wolter, R. Richter, T. Rander, P. Schreiner, T. Möller

Fr143 Propagation of a laser pulse train under electromagnetically induced transparency conditions
Gabriela Buica

Fr144 Suppression of multiphoton intrashell resonances in Li Rydberg atoms
Abdul Waheed, Daniel Fregenal, Øyvind frette, Morten Førre, Bjørn Tore Hjertaker, Erik Horsdal, Ingjald Pilskog, Jana Preclikova

1.3 Photoionization of atoms

Fr145 Differential cross-sections for the double photoionization of lithium
A. S. Kheifets, D. V. Fursa, Igor Bray, J. Colgan, M. S. Pindzola

Fr146 Two-photon ionization of ground state hydrogen from the photoelectric threshold up to 40 keV
V. Florescu, O. Budriga, H. Bachau

Fr147 Disintegration of positronium: Low energy Compton scattering and photoabsorption
Zoran Kaliman, Krunoslav Pisk, Richard H. Pratt, Tihomir Surić
Fr148 Auger decay of 3p-ionized krypton
Valdas Jonauskas, Sigitas Kučas, Romualdas Karazija

Fr149 Semi-classical approach to the PCI distortion of the photoelectron spectrum associated with double Auger decay
L. Gerchikov, S. Sheinerman

Fr150 Double photoionization of Be
Rajesh Kumar, R. P. K. Ray, S. N. Tiwary

Fr151 Angular distributions of low kinetic energy photoelectrons in one- and two-photon ionisation of rare gas atoms
Patrick O’Keeffe, Paola Bolognesi, Robert Richter, Angelica Moise, Piero De Cleva, Andrej Mihelič, Lorenzo Avaldi

1.4 Photoionization of molecules

Fr152 High-energy non-Franck-Condon vibrational excitation of CH$_4$ by intramolecular photoelectron diffraction
L. Argenti, E. Plésiat, E. Kukk, K. Ueda, P. Decleva, F. Martín

Fr153 Soft X-ray interaction with organic molecules of biological interest: the pyrimidine and halogenated pyrimidines cases
P. Bolognesi, P. O’Keeffe, V. Feyer, M. Coreno, K. Prince, L. Avaldi

Fr154 Tracing vibrational wave packets in excited electronic states of H$_2$ with xuv-pump/xuv-probe schemes
Alicia Palacios, Alberto González-Castrillo, Fernando Martín

Fr155 Non-resonant breakdown of the Franck-Condon approximation as seen in vibrational branching ratios

Fr156 Quenching H$_2$ autoionization interferences with ultrashort xuv laser pulses
Alberto Gonzalez-Castrillo, Alicia Palacios, Henri Bachau, Fernando Martín

Fr157 Relativistic theoretical study on atomic structure and photoionization of A@C$_{60}$
Bo-Wen Li, Chen-Zhong Dong

Fr158 Inner shell ionization X-ray photoelectron spectroscopy in vibrationally excited triatomic molecules

2. Photon Impact (Strong Field)
2.2 Photoexcitation of atoms, molecules, and ions

Fr115 Ab initio determination of K alpha line strengths and energies in transition metal atoms
John A Lowe, Christopher T Chantler, Ian P Grant

Fr116 Harmonic generation in time dependent R-matrix theory
Andrew C. Brown, Steven Hutchinson, Michael A. Lysaght, Hugo W. van der Hart
2.3 Photoionization of atoms

Fr117  Intense laser-induced dissociation pathways of CD$^+$

Fr118  X-ray laser spectroscopy with an electron beam ion trap at the free electron laser LCLS

Fr119  (Semi-)classical double ionization in intense laser fields
Lisa Beran, Bruno Eckhardt

Fr120  Probing autoionizing decay in He atom with ultrashort laser pulses
C.M. Granados, J.L. Sanz-Vicario

Fr121  Interference effects in laser assisted photo-ionization of atoms
Pablo A. Macri, Vladimir D. Rodríguez

Fr122  Angular distributions and correlations in sequential three-photon triple atomic ionization
E. V. Gryzlova, A. N. Grum-Grzhimailo, S. Fritzche, N.M. Kabachnik

Fr123  Above-threshold ionization of one-active electron atomic systems in the x-ray regime: a non-perturbative treatment
M. Dondera, H. Bachau

Fr124  Low energy peak features in atomic ionization by mid-infrared laser pulses
K. I. Dimitriou, C. Lemell, S. Gräfe, S. Nagele, J. Burgdörfer

Fr125  The RMT method for describing many-electron atoms in intense short laser pulses
M. A. Lysaght, L. R. Moore, L. A. A. Nikolopoulos, J. S. Parker, H. W. van der Hart, K. T. Taylor

Fr126  Time delay between photoemission from the 2p and 2s subshells of Neon atoms

2.4 Photoionization of molecules

Fr127  Three-dimensional momentum imaging for adaptive femtosecond control

Fr128  Coherent control over dissociation of a molecular ion beam - $\omega-2\omega$ laser field
J. McKenna, M. Zohrabi, B. Gaire, D. Ray, K. D. Carnes, D. Ursrey, J. Hernandez, F. Anis, B. D. Esry, I. Ben-Itzhak

Fr129  Transition limit regimen between multiphoton and barrier suppression ionization. Analysis of benzene, coronene and circumcoronene.
Juan C. Poveda I, Leonardo Muñoz, Ignacio Álvarez, Carmen Cisneros
Fr130  Ionization of endohedrals H@C\textsubscript{60} and H@C\textsubscript{36} by intense VUV femtosecond pulses  
E. V. Gryzlova, A. N. Grum-Grzhimailo, S. I. Strakhova

Fr131  Laser-induced ionization of simple atoms and molecular ions  
Della Picca Renata, Fiol Juan, Fainstein Pablo D.

Fr132  Coulomb explosion dynamics of triatomic molecules in laser pulses ranging from 7 to 200 fs  
Reza Karimi, Benji Wales, Eric Bissone, Francois Légaré, Jean-Claude Kieffer, Joseph Sanderson

Fr133  LIAD-FS: A new technique for gas-phase studies of biomolecules  
CR Calvert, O Kelly, L Belshaw, MJ Duffy, RB King, ID Williams, JB Greenwood

3. Electron-Atom Collisions

3.1 General

Fr005  Theoretical study of the 5p\textsuperscript{6}-core autoionizing states of Cs excited by electron impact  
A. Kupliauskienè

Fr006  New spectroscopic classification of lowest autoionizing levels in Cs atoms  
A. Borovik, A.Kupliauskienè, O. Zatsarinny

Fr007  Electron impact excitation of rubidium  
Branko Predojevic, Vladimir Pejcev, Dragutin Sevic, S. Lekic, Rajesh Srivastava, Al Staufer, Bratislav Marinkovic

Fr008  Electric-field effects on the doubly-excited states of He in Debye plasmas  
Sabyasachi Kar, Y. K. Ho

Fr009  Explicitly correlated Sturmian functions for structure and collision three-body problems  

Fr010  A theoretical examination of the GOS method for normalizing relative cross section data - the case of indium  
Tapasi Das, Rajesh Srivastava, A. D. Stauffer

Fr011  Electron excitation collision strengths for N II and Si VIII  
S. S. Tayal

Fr012  Progress towards a practical optically pumped electron spin filter  
M. H. Pirbhai, D. Tupa, J. M. Dreiling, T. J. Gay

Fr013  Calculations of electron scattering from cadmium  
M.J. Berrington, D.V. Fursa, I. Bray, R.P. McEachran, A.D. Stauffer

Fr014  Linear polarization of the high-energy end of bremsstrahlung in electron-atom collisions  

Fr015  On the applicability of the Exterior Complex Scaling method for scattering problems including Coulombic potentials  
G. Gasaneo, L. U. Ancarani, D. M. Mitnik

Fr016  An analytically solvable model to test the hyperspherical Sturmian approach for break up processes  
3.3 Excitation
Fr001 Electron impact excitation of the lowest autoionizing state of potassium using a distorted wave method
Jobunga, E, Okumu, J, Singh, C S
Fr002 AGFA calculation of electron impact excitation of Ar
S. N. Tiwary
Fr003 PCI induced spin-dependent effects observed in the excitation of zinc atoms
L. Pravica, J. F. Williams, S. Samarin, D. Cvejanovic
Fr004 Super-elastic scattering studies in a resonant optical enhancement cavity
Martyn Hussey, Sarah Jhumka, Alex Knight-Percival, Andrew Murray, William MacGillivray

3.4 Ionization
Fr020 Second Born effects in electron momentum spectroscopy
Konstantin A. Kouzakov, Yuri V. Popov, Pavel S. Vinitsky
Fr021 Electron scattering from cold atoms – Design and operation of the AC driven Magneto Optical Trap (AC-MOT)
Matthew Harvey, Andrew Murray, John Agomuo

4. Electron-Molecule Collisions
4.3 Excitation and ionization (diatomic molecules)
Fr039 Cross section calculations for electron scattering from cyanoacetic acid
Bożena Żywicka, Paweł Możejko
Fr040 Supression of binary and recoil peaks by quantum interferences in ionization of hydrogen molecules by electron impact
O. A. Fojón, C. Stia, R.D. Rivarola
Fr041 Resonant electron–molecule vibrational excitation cross sections and rate coefficients for atmospheric plasmas
Vincenzo Laporta, Roberto Celiberto
Fr042 Electron impact induced break-up of aligned H₂: molecular frame (e, 2e) studies
X. Ren, T. Pfüger, S. Xu, A. Senftleben, J. Colgan, M.S. Pindzola, A. Dorn, J. Ullrich
Fr043 Ionization of H₂ and He in collision of 3 keV electrons and the Bethe binary-encounter peak
Fr044 The external complex scaling method in prolate spheroidal coordinates for the electron impact ionization of molecular hydrogen
Vladislav V. Serov, Boghos B. Joulakian
Fr045 Dependence of the molecular orientation in the ionization of H$_2^+$ by fast electron impact  
Della Picca Renata, Dubois Alain, Fainstein Pablo D.

Fr046 Rate coefficients for electron impact excitation of the a $^3\Pi$ state of CO  
M. Vojnović, M. M. Ristić, G. B. Poparić, D. S. Belić

Fr047 Electron-Impact study of $S_2$ molecule using the R-Matrix method  
J. S. Rajvanshi, K. L. Baluja

Fr048 Near threshold excitation of molecular nitrogen  
C. P. Malone, P. V. Johnson, B. Ajdari, I. Kanik, M. A. Khakoo

4.4 Excitation and ionization (polyatomic molecules)

Fr049 Efficient diagonalization of the sparse matrices produced within the framework of the UK R-matrix codes  
P G Galiatsatos, J Tennyson

Fr050 Low-energy electron collisions with pyrazine  
Zdeněk Mašín, Jimena Gorfinkiel

Fr051 Electron-impact dissociation and ionization of NH$^+$ and ND$^+$  
J. Lecointre, D.S. Belic, J.J. Jureta, S. Cherkani-Hassani, P. Defrance

Fr052 Electron-impact excitation of gas-phase uracil  
IV. Chernysheva, J.E. Kontros, P.P. Markush, A.A. Borovik, O.B. Shpenik

Fr053 Vibrational excitation of triatomic molecules near the shape resonance region  
Y. Ishijima, M. Ohkawa, M. Hoshino, L. Campbell, M.J. Brunger, H. Tanaka

Fr054 Electron impact excitation of gas-phase adenine molecule  
O.B. Shpenik, M.M. Erdevdi, V.V. Zvenigorodsky, A.A. Borovik

Fr055 Electron impact cross sections for surrogates of DNA sugar phosphate backbone  
Pooja Bhowmik, K N Joshipura, Siddharth Pandya

Fr056 Electron impact ionization of Si and SiCl$_X$ (X=1-4) targets: Theoretical investigations  
Harshit N Kothari, Siddharth H Pandya, K N Joshipura

Fr057 Electronic excitation of C$_4$F$_6$ isomers by electron impact  

Fr058 Multi-center interference effects on generalized oscillator strengths for the valence-shell electronic excitations of CF$_4$  
Noboru Watanabe, Daisuke Suzuki, Masahiko Takahashi

5. Electron-Ion Collisions

5.1 General

Fr022 Electron energy dependence of extreme ultraviolet spectra from highly charged tungsten ions in an electron beam ion trap  
Fr023  Studies of electron-W$^{q+}$ studies using the Shanghai permanent magnet Electron Beam Ion Trap (SH-PermEBIT).
Z. Fei, J. Xiao, Y. Yang, X. Jing, D. Lu, Y. Shen, L. Liljeby, R. Hutton, Y. Zou

Fr024  2-D R-matrix propagator: Application and future developments
M W McIntyre, M P Scott, H W van der Hart, P G Burke, B McLeod, F Scoupe, I Spence, N S Scott

Fr025  The status of the permanent magnetic electron beam ion trap for low energy electron collision spectroscopy in Shanghai
J. Xiao, Z. Fei, Y. Yang, X. Jing, D. Lu, Y. Shen, L. Liljeby, R. Hutton, Y. Zou

5.3 Ionization

Fr026  Electron impact ionization measurements at the Heidelberg heavy ion storage ring TSR
M. Hahn, D. Bernhardt, M. Grieser, C. Krantz, M. Lestinsky, A. Müller, O. Novotný, R. Repnow, S. Schippers, A. Wolf, D. W. Savin

Fr027  Electron-impact single and double ionization of W$^{17+}$ ions
J. Rausch, A. Becker, K. Spruck, J. Hellhound, S. Schippers, A. Borovik Jr., K. Huber, A. Müller

Fr028  Electron-impact single and double ionization of tin ions
A. Borovik, Jr., P.-M. Hillenbrand, J. Rudolph, M. F. Gharabeih, J. Rausch, K. Huber, S. Schippers, A. Müller

Fr029  Electron-impact single and multiple ionization of xenon ions
A. Borovik, Jr., J. Rausch, J. Rudolph, M. F. Gharabeih, S. Schippers, A. Müller

Fr030  Spectroscopic studies of the charge breeding process in high current electron beam ion traps
T.M. Baumann, J.R. Crespo López-Urrutia, S. Schwarz, A. Lapierre, G. Bollen, O. Kester, J. Dilling, J. Ullrich

Fr031  Electron-impact single-ionization of Ar$^{5+}$ ions
K. Spruck, A. Becker, A. Borovik, Jr., S. Schippers, A. Mueller

Fr032  Electron-impact single-ionization of Ar$^{6+}$ ions
A. Becker, K. Spruck, A. Borovik, Jr., S. Schippers, A. Müller

5.4 Recombination (atomic ions)

Fr033  Dielectronic recombination of xenonlike tungsten ions

Fr034  Storage ring meets astrophysics: Dielectronic recombination of L-shell and M-shell iron ions
S. Schippers, D. Bernhardt, A. Müller, C. Krantz, A. Wolf, M. Lestinsky, M. Hahn, O. Novotný, D. W. Savin

Fr035  Cross section of double electron capture by bare nucleus
E. A. Chernovskaya, O. Yu. Andreev, L. N. Labzowsky

Fr036  Environment assisted electron capture
Kirill Gokhberg, Lorenz S. Cederbaum
Fr037  Progress of dielectronic recombination experiment at CSRm

Fr038  Collisional radiative recombination of Ar$^+$ ions, experimental study at 40-300K

6. Collisions Involving Exotic Particles
   6.1 General
        Fr112  Neutrino-atom ionizing collisions in searches for physics beyond the Standard Model
               Konstantin A. Kouzakov, Alexander I. Studenikin, Mikhail B. Voloshin
        Fr113  Energy loss and transient phenomena induced by exotic particles
               Sorina Lazanu, Ionel Lazanu
        Fr114  Neutron impact ionization of helium
               J. Feist, M. Liertzer, S. Nagele, J. Burgdörfer

   6.2 Collisions involving positrons
        Fr101  Positron annihilation in hydrogen-like ions
               D. G. Green, G. F. Gribakin
        Fr102  Vertex enhancement of positron annihilation with core electrons
               D. G. Green, G. F. Gribakin
        Fr103  Positron-impact ionization studied by means of recoil-on momentum distributions
               R. O. Barrachina, J. Fiol, F. O. Navarrete
        Fr104  Accurate semi-empirical potentials for positron scattering by atoms
               Denise Assafrao, Adriano daq Silva Dutra, Felipe Arretche, H. R. James Walters, José Rachid Mohallem
        Fr105  Low energy positron scattering from krypton and xenon
        Fr106  Positron-impact excitation of hydrogen atom with screened Coulomb potentials
               Sujay Nayek, Arijit Ghoshal
        Fr107  Double differential ionization cross sections of positron impact on argon
               R.I.Campeanu, M.Alam
        Fr108  Energy and angular differential recoil ion spectra in collisions between positron and helium atom
               K. Tökési
        Fr109  New investigations of resonant positron annihilation on molecules
               A. C. L. Jones, J. R. Danielson, C. M. Surko
        Fr110  Positronium formation in positron—metastable hydrogen (2s ) atom collision
               Sumana Chakrabory
Fr111 Ab initio quantum Monte Carlo study of the binding of a positron to alkali-metal hydrides
Yukiumi Kita, Masanori Tachikawa

7. Ion-Atom Collisions

7.1 General
Fr065 Semiclassical charge transfer and general relativity
SFC Shearer, CJ McGrath, DSF Crothers

Fr066 Transmission of fast highly charged ions through a single glass macrocapillary and polycarbonate nanocapillary foils
A. M. Ayyad, B. S. Dassanayake, D. Keerthisinghe, G. G. DeSilva, T. Elkaafrawy, A. N. Kayani, J. A. Tanis

Fr067 Analytical wave functions for atoms by fitting numerical results with genetic algorithm
Takeshi Mukoyama

Fr068 Direct determination of the magnetic quadrupole contribution to the Lyman-α transition in U^{91+}
Günter Weber, Harald Bräuning, Andrey Surzhykov, Stephan Fritzsche, Renate Märtin, Regina Reuschl, Uwe Spillmann, Danyal Winters, Thomas Stöhlker

Fr069 The quantum trajectory approach in description of ion-atom collisions
V.A.Khodyrev, I.K.Gainullin

Fr070 K shell hyper-satellite lines of Cu induced by 300MeV/u C ions
Zhao Yongtao, Zhou Xiaoming, Cheng Rui, Lei Yu, Sun Yuanbo, Wang Xing, Xu Ge, Wang Yuyu, Zhang Xiaohan, Xu Zhongfeng, Li Fuli, Xiao Guoqing

7.2 Excitation
Fr059 Polarization of Lyman-Alpha and Balmer-Alpha in proton-hydrogen collision measured under three-body Faddeev type formalism
R.Fathi, M.A.Bolorizadeh, F.Shojaei Akbarabadi

Fr060 Testing atomic and collision physics, QED, plasma physics, laboratory astrophysics and fundamental constants – a visible, VUV, X-ray synchrotron source allied with an Electron Beam Ion Trap.
Christopher T Chantler

Fr061 Quantum correlations in the two-photon decay of few-electron ions
F. Fratini, A. Surzhykov, T. Jahrsetz, M. Tichy, A. Buchleitner, S. Fritzsche

Fr062 Electron- and proton-impact excitation in stored hydrogenlike uranium ions

Fr063 Resonant coherent excitation of 191.1 MeV/u U^{89+} ions planar-channeled in a silicon crystal
A. Bräuning-Demian, A. Ananyevna, T. Azuma, H. Bräuning, D. Dauvergne, Y. Kanai, Y. Nakano, T. Shindo, S. Suda, Y. Yamazaki
Fr064 Unexpected mobility of OH\(^+\) and OD\(^+\) molecular ions
R. Isawa, J. Yamazoe, K. Ohtsuki, H. Tanuma

7.3 Ionization
Fr071 Multiple ionization of Ne in coincidence with partially stripped B\(^{2+}\) ions in the intermediate energy regime

Fr072 The role of interference in the ionization of atoms by proton and antiproton
Shiyang Zou, Chunjie Liu, Jianguo Wang

Fr073 Double ionization of Helium by bare ions: theoretical study of the fully differential cross sections.
S. D. López, C. R. Garibotti, S. Otranto

Fr074 L and M-shell ionization of very heavy targets
C. C. Montanari, D. M. Mitnik, J. E.Miraglia

Fr075 Test run of 185 MeV/u Ni\(^{19+}\)-Kr collisions at CSRe internal target
Deyang Yu, Yingli Xue, Caojie Shao, Zhangyong Song, Fangang Ruan, Wei Wang, Jing Chen, Yehong Wu, Xiaohong Cai

9. Ion-Molecule or Atom-Molecule Collisions
9.4 Charge transfer
Fr076 Demethylation enhancement of 3-methyl-uracil and 1-methyl-thymine in atom-molecule collisions
D. Almeida, G. Martins, F. Ferreira da Silva, Y. Nunes, G. García, P. Limão-Vieira

Fr077 Site and bond selective H\(^-\) formation in methylated pyrimidine bases driven by potassium molecule collisions
F. Ferreira da Silva, D. Almeida, G. Martins, Y. Nunes, G. García, P. Limão-Vieira

Fr078 Double capture into autoionizing states in Li\(^{3+}\)-H\(_2\) and B\(^{5+}\)-H\(_2\) collisions
Ingjald Pilskog, Nicolas Sisoulat, Alain Dubois

Fr079 Ab initio treatment of ion-water molecule collisions with a three-center pseudo-potential
P. Martínez, L. F. Errea, L. Méndez, I. Rabadán

Fr080 Electron-transfer in MeV p-N\(_2\) collisions: Kinetic-energy releases and effects of the molecular orientation

Fr081 Negative ion productions in high velocity collision between small carbon clusters and helium atom target.
Chabot M, Béwoff K., Pino T., Féraud G., Dothi N., Le Padellec A., Martinet G., Bouneau S., Carpentier Y.

Fr082 Charge exchange in proton collisions with the water dimer
A. Ravazzani, L. F. Errea, L. Méndez, I. Rabadán
9.6 Ionization

Fr083 Young-type interference in ionizing collisions between helium and hydrogen molecular ions

Fr084 Interference effects in single ionization spectra of N\textsubscript{2} and O\textsubscript{2} molecular targets by proton impact
C. A. Tachino, F. Martín, R. D. Rivarola

Fr085 Classical calculation of total and differential cross sections for electron capture and ionization in proton - molecule collisions
Henok Getahun, L. F. Errea, Clara Illescas, L. Méndez, I. Rabadán

Fr086 Absolute double differential ionization cross sections of gas-phase nucleobase molecules by 0.5- to 2.0-MeV protons
Y. Iriki, Y. Kikuchi, K. Doi, M. Imai, A. Itoh

Fr087 Differential cross sections for single ionization of H\textsubscript{2} by 75 keV proton impact
U. Chowdhury, M. Schulz, D. H. Madison

Fr088 Similarities in fragmentation dynamics of SF\textsubscript{6} under various perturbations
Bhas Bapat, R K Kushawaha, S Sunil Kumar, C P Safvan

Fr089 Fragmentations study of single and doubly ionised halo-uracil molecules
J-P Champeaux, P Carçabal, M Sence, P Moretto-Capelle, P Cafarelli

Fr090 Low energy electron emission from Uracil and oxygen in collisions with 42 MeV bare C ions
A. N. Agnihotri, S. Kasthurirangan, A. Kumar, S. Nandi, L. C. Tribedi

Fr091 Ionization and fragmentation of RNA base molecule uracil in collisions with carbon ions of energies between 100 keV and 60 MeV

Fr092 Electron DDCS in ionization of O\textsubscript{2} by 4.5 MeV/u bare O-ions: A comparative study of the angular asymmetry between O\textsubscript{2} and H\textsubscript{2}

14. Related Topics

14.1 General

Fr159 Asymmetry and interference effects in plasmon excitation by external charged particles for incoming and outgoing trajectories
J. L. Gervasoni, R. O. Barrachina, W. Werner

Fr160 A new view of Minkowski space
Felix T. Smith

Fr161 Time evolution of ion transmitting through a tapered glass capillary

Fr162 Measurement of the \textsuperscript{6}Li charge state distributions following the \textsuperscript{6}He\textsuperscript{+} beta decay
Fr163  The data evaluation for obtaining accuracy and reliability
Chang Geun Kim, Kyun Shik Chae, Sang Tae Lee, Gun Woong Bhang

Fr164  Studying the convergence of the relativistic J-matrix method in elastic scattering of electron from model potentials
Pawel Syty, Jozef E. Sienkiewicz

Fr165  Dynamics of charged chains in rf ion traps
R. V. Khmelev, Yu.V. Rozhdestvensky
1. Photon Impact (Weak Field)

1.2 Photoexcitation of atoms, molecules and ions

Mo133  Field-induced dissociation of Rydberg ion-pair states
        C. O. Reinhold, S. Yoshida, F. B. Dunning

Mo134  Inelastic x-ray scattering study on valence-shell excitations of atomic neon

Mo135  Magnetic moments of bound electrons and nuclei by double resonance spectroscopy of highly charged ions in a Penning trap
        Manuel Vogel, Gerhard Birkl, David von Lindenfels, Wolfgang Quint

Mo136  Double-Auger emission of fixed-in-space carbon monoxide following core-excitation and ionization

Mo137  Distinguishing single photonic transitions from the multiphotonic cases for (ns^2S_{1/2}) \rightarrow (np^2P_{3/2}) \rightarrow (n's^2S_{1/2}) photonic transitions in hydrogen-like atoms
        Ziya Saglam

Mo138  Spin dependent selection rules for photonic transitions in hydrogen-like atoms
        Mesude Saglam, Ziya Saglam

Mo139  Calculation of Zeeman-fine energies of atomic potassium
        Salwa Alsaleh, Mesude Saglam

Mo140  Metastable hydrogen in the 2s state as a probe for dissociative doubly excited states of molecules
        Yoshiaki Kumagai, Takeshi Odagiri, Takehiko Tanabe, Motoyoshi Nakano, Isao H Suzuki, Noriyuki Kouchi

Mo141  Structure and conditional dynamics of interacting Rydberg atoms
        Sigrid Ina Simonsen, Jana Preclikova, Ladislav Kochbach, Jan Petter Hansen

Mo142  Optical absorption spectrum of Ce@C_{82}
        Zhifan Chen, Alfred Z Msezane

Mo143  Time-resolved pump–probe spectroscopy to follow valence electron motion
        A. D. Dutoi, K. Gokhberg, L. S. Cederbaum

1.3 Photoionization of atoms

Mo144  Role of cascade double Auger decay in the PCI distortion of the Ar 2s photoelectron line
        P. Lablanquie, F. Penent, S. Sheinerman, J. Palaudoux, L. Andric, M. Huttula, S.M. Huttula

Mo145  Dipole polarization of electron shells: manifestation in the resonant Auger effect in Kr
        Lagutin B.M., Sukhorukov V.L., Petrov I.D., Schmoranzer H., Schartner K.-H., Ehresmann A.
Role of electron correlation on the satellite structure of 2p inner-shell ionized sodium
Xiao-Bin Liu, Chen-Zhong Dong, Xiao-Bin Ding, Fumihiro Koike

Photoionization of Xe and Xe@C₆₀
Zhifan Chen, Alfred Z Msezane

Atomic magneto-dipole photoionization
M. Ya. Amusia, A. S. Baltenkov

Dipole and quadrupole photoionization of intermediate subshells of atomic mercury
T Banerjee, Hari R Varma, P C Deshmukh, S T Manson

1.4 Photoionization of molecules

Theoretical treatment of molecular photoionization based on the R-matrix method
Motomichi Tashiro

Photofragmentation of a DNA nucleoside thymidine; valence- vs. core ionization
Eero Itälä, Kuno Kooser, Toni Hägerth, Elisabeth Rachlew, Michael Huels, Edwin Kukk

Unveiling residual molecular binding in triply charged hydrogen bromide
F. Penent, P. Lablanquie, J. Palaudoux, L. Andric, G. Gamblin, Y. Hikosaka, K. Ito, S. Carniato

Time- and frequency-dependent analysis of the nuclear dynamics in laser-excited diatomic molecules
Maia Magrakvelidze, Uwe Thumm

Site-specific Auger electron spectra of ethyl trifluoroacetate molecules studied by magnetic bottle electron spectrometer
Hiroshi Iwayama, Eiji Shigemasa, Yasumasu Hikosaka, Motoyoshi Nakano, Kenji Ito, Pascal Lablanquie, Francis Penent, Lidija Andric, John H.D. Eland

Relationship between Cooper minima and Young-type interference
Della Picca Renata, Fainstein Pablo D., Dubois Alain

X-ray FEL-induced double core-hole formation in polyatomic molecules

Dissociation dynamics of doubly charged CO₂ and CS₂ molecules as studied by electron-ion coincidence spectroscopy and simulations
Edwin Kukk, Kuno Kooser, Eero Itälä, Dang Trinh Ha, Samuli Urpelainen, Elisabeth Rachlew

Dissociative photoionization of methane at the carbon K-edge

Multiconfiguration time-dependent Hartree-Fock treatment of electronic and nuclear dynamics in diatomic molecules
C. William McCurdy, Daniel J. Haxton, Keith V. Lawler
Mo160 Oscillatory behavior of the valence photoionization properties of N\textsubscript{2} and O\textsubscript{2} due to coherent photoelectron emission from two sites
Jens Viefhaus, Markus Ilchen, Sascha Deimert, Leif Glaser, Frank Scholz, Peter Walter, Markus Braune, Andre Meissner, Lokesh Tribedi, Uwe Becker

Mo161 Appearance of plasmons in fullerenes
Sanja Korica, Axel Reinkoester, Markus Braune, Jens Viefhaus, Daniel Rolles, Giovanna Fronzoni, Daniele Toffoli, Mauro Stener, Piero Decleva, Omar M. Al-Dossary, Burkhard Langer, Uwe Becker

Mo162 Coherent localization exhibited by unequal Auger Doppler components
Burkhard Langer, Rainer Hentges, Oliver Kugeler, Markus Braune, Sanja Korica, Jens Viefhaus, Daniel Rolles, Uwe Hergenhahn, Hironobu Fukuzawa, Xiaojing Liu, Yusuke Tamenori, Masamitsu Hoshino, Hiroshi Tanaka, Christophe Nicolas, Catalin Miron, Omar M. Al-Dossary, Kiyoshi Ueda, Uwe Becker

2. Photon Impact (Strong Field)

2.1 General
Mo112 Attosecond strong-field interferometry of electron dynamics
Christian Ott, Philipp Raith, Andreas Kaldun, Thomas Pfeifer

Mo113 Attosecond twin-pulse control by kinetic heterodyne mixing
Philipp Raith, Christian Ott, Andreas Kaldun, Thomas Pfeifer

Mo114 The dependence of the process of doubly charged ions formation under ionization of barium atoms in the IR spectral range on the concentrations of neutral atoms and singly charged ions
Bondar I.I., Suran V.V.

Mo115 Above-threshold two-colour ionization signal of singly charged neon
V. Richardson, J. T. Costello, L. A. A. Nikolopoulos, S. Duesterer, D. Cubaynes, M. Meyer, W. B. Li

2.3 Photoionization of atoms
Mo116 Two-photon double ionization of lithium at FLASH
M. Schuricke, G. Veeravalli, G. Zhu, Ch. Dornes, K. Joachimsnueyer, A. Dorn, J. Ullrich

Mo117 Above-threshold ionization in atomic hydrogen using intense, few-cycle laser pulses

Mo118 Calculation of the harmonic spectrum for one and two-electron atoms in two-colour laser fields
D J Robinson, J S Parker, L R Moore, K T Taylor

Mo119 Double-electron above-threshold ionization resonances as interference phenomena
G S J Armstrong, J S Parker, K T Taylor

Mo120 Single discrete level coupled to the continuum: comparison between velocity and length gauge calculations
M. G. Bustamante, V. D. Rodríguez, R. O. Barrachina
Mo121 Improved Weiskopf-Wigner approximation for atomic ionization by short laser pulses
M. G. Bustamante, V. D. Rodríguez

Mo122 Experimental and theoretical study of 3-photon ionization of the 1s2s $^3S^e$ and 1s2p $^3P^o$ states of helium
M. Terao-Dunseath, K.M. Dunseath, X. Urbain

Mo123 Controlling and reading interference structures created by strong field ionizing attosecond electron wave packets
X. Xie, S. Roither, D. Kartashov, L. Zhang, E. Persson, S. Gräfe, M. S. Schöffler, J. Burgdörfer, A. Baltuska, M. Kitzler

Mo124 Observing the influence of the Coulomb binding potential on momentum spectra of strong-field driven electronic wave packets
X. Xie, S. Roither, D. Kartashov, L. Zhang, E. Persson, S. Gräfe, M. S. Schöffler, M. Lezius, A. Baltuska, J. Burgdörfer, M. Kitzler

Mo125 Photoionization of hydrogen by a chirped, short X-ray pulse in the presence of a laser field
S. Bivona, G. Bonanno, R. Burlon, C. Leone

2.4 Photoionization of molecules
Mo126 Femtosecond laser induced ionisation and fragmentation of amino acids and DNA bases
L. Belshaw, O. Kelly, M. J. Duffy, R. B. King, I. D. Williams, C. R. Calvert, J. B. Greenwood

Mo127 High energy proton ejection from hydrocarbon molecules driven by highly efficient field ionization
S. Roither, X. Xie, D. Kartashov, L. Zhang, M. S. Schöffler, H. Xu, A. Iwasaki, T. Okino, K. Yamanouchi, A. Baltuska, M. Kitzler

Mo128 Near-threshold $^3H_2$ electron and nuclear dynamics induced by attosecond pulse trains and probed by IR pulses
P. Rivière, P. Ranitovic, A. Palacios, J. F. Pérez-Torres, C. W. Hogle, M. M. Murnane, H. C. Kapteyn, F. Martín

Mo129 Observation of competition from dissociative ionization of CH$_3$I in intense femtosecond laser fields
Dongdong Zhang, Haifeng Xu, Steven Stolte, Mingxing Jin, Dajun Ding

Mo130 Attosecond snapshots: imaging charge transfer in molecules using EUV light
J F McCann, B M McLaughlin, C R Calvert, R B King, W A Bryan, W R Newell, J B Greenwood, I D Williams

Mo131 Prevalence of different double ionization pathways in driven atomic and molecular systems
Agapi Emmanouilidou, Deyana Tchitchekova, Constantinos Lazarou

Mo132 Alignment dependent ionization of hydrogen molecules in intense laser field
Ying-Jun Kin, Xiao-Min Tong, Nobuyuki Toshima
4. Electron-Molecule Collisions

4.2 Elastic scattering

Mo025  Differential cross sections of an electron scattering by two-centre Coulomb potentials
Haruhide Miyagi, Toru Morishita, Shinichi Watanabe

4.4 Excitation and ionization (polyatomic molecules)

Mo026  Electron impact excitation cross sections for C_6H_6

Mo027  Doubly excited states of H_2O in the inner-valence range produced by photon and electron interactions
Toshinori Tsuchida, Takeshi Odagiri, Lisa Ishikawa, Kazufumi Yachi, Naruhiro Ohno, Motoyoshi Nakano, Kouichi Hosaka, Masashi Kitajima, Noriyuki Kouchi

Mo028  Synthesis of polycyclic aromatic hydrocarbons in He nanodroplets
D. Gschliesser, F. Ferreira da Silva, P. Bartl, S. Deniïl, P. Scheier

Mo029  Comparison of experiment and theory for electron impact ionization of isoelectronic atoms and molecules
Haari Chaluvadi, Kate Nixon, S. M. Amami, Andrew Murray, Don Madison

Mo030  Electron impact ionization of isoelectronic molecules: N_2, CO, HCN, and BF
Foram A Shelat, Pooja Bhowmik, K N Joshipura

Mo031  The spectroscopy of GeF_4 molecule as studied by electron impact
A. Suga, H. Kato, M. Hoshino, P. Limão-Vieira, H. Tanaka

Mo032  Cross sections for below threshold electron excitation of furan

Mo033  Cross sections for electronic excitation of water by low-energy electrons
L.R. Hargreaves, K. Ralphs, M.A. Khakoo, C. Winstead, V. McKoy

Mo034  Inner valence shell excited resonance observed via the CF_2^+ ion channel from electron impact ionization of CF_4.
S. V. K. Kumar, K. C. Rao

Mo035  Scattering of low energy electrons with SiCl_2 molecule by R matrix methodology
Harshit N Kothari, K N Joshipura, Minaxi Vinodkumar, Kirti Korot

Mo036  (e,2e) experiments on C_60
P. Bolognesi, L. Pravica, R. Camilloni, D. Cvejanovic, J. Berakdar, Y. Pavlyukh, L. Avaldi

Mo037  Excitation of gas phase uracil by electron impact
V.V. Stetsovych, M.I. Sukhoviya, R.O. Fedorko, N.N. Chavarga, I.Y. Minda, I.I. Shafranyosh

Mo038  Electron scattering in Pt(PF_3)_4: Elastic scattering, vibrational and electronic excitation
Michael Allan
Mo039 Experimental and theoretical investigation of the triple differential cross section for electron impact ionization of thymine molecules  
Susan Bellm, Christopher Colyer, Birgit Lohmann, Christophe Champion

Mo040 Electron impact ionization studies of acetic acid  
M A Rahman, E Krishnakumar

Mo041 Isotropically electron impact ionization cross sections of CO2 clusters  
S.Pal

Mo042 Multiple differential cross sections for the ionization of liquid water molecules by fast electron impact  
M. L. de Sanctis, O. Fojón, C. Stia, R. Vuilleumier, M. -F. Politis

Mo043 Probing the orbital electron momentum distribution for pure gauche conformer in ethanethiol by electron momentum spectroscopy  
Xu Shan, Ya-Guo Tang, Xiang-Jun Chen

Mo044 Electron impact ionization of guanine: temperature effects  
O.B. Shpenik, A.A. Borovik

Mo045 Vibrationally inelastic collisions of slow electrons with cyclopropane and diacytelene  
Roman Curik, Petr Carsky, Michael Allan

6. Collisions Involving Exotic Particles

6.2 Collisions involving positrons

Mo088 Elastic positron-hydrogen collisions with exponential cosine-screened Coulomb potentials  
Arijit Ghoshal, Y. K. Ho

Mo089 Positron scattering from methane  
Luca Chiari, Antonio Zecca, Anindya Sarkar, Emanuele Trainotti, Michael J. Brunger

Mo090 Positronium formation with excitation  
D. A. Cooke, D. J. Murtagh, P. Fransman, G. Laricchia

Mo091 Differential cross section for positronium formation in positron – molecular hydrogen ion  
F. Shojaei Akbarabadi, M.A. Bolorizadeh, R. Fathi

Mo092 Extension of a theory of resonant $Z_{eff}$ values to positron CH3Cl scattering  
E A G Armour

6.3 Collisions involving muons or antiprotons

Mo079 Semiclassical calculations of the product-state distributions in the capture of antiprotons and negative muons by atoms  
K Sakimoto
6.4 Collisions involving neutral exotic atoms

Mo084 The time evolution of $\mu t$ energetic atom in hydrogen multilayered target
Rouhollah Gheisari, Saeed Fahimi, Kobra Ghanbari

Mo085 Higher-lying Rydberg resonances in Ps-H scattering below the $(e^+{-}H^-)$ threshold
Z.-C. Yan, Y. K. Ho

Mo086 The production of positronium and its resonant scattering
S.J. Brawley, A.I. Williams, M. Shipman, G. Laricchia

Mo087 Tests of CPT and Lorentz invariance and the principle of equivalence using antihydrogen
E A G Armour

7. Ion-Atom Collisions
7.3 Ionization

Mo056 Electron loss by fast heavy ions: Target scaling dependence
R.D. DuBois, A. C. F. Santos, G.M. Sigaud, E. C. Montenegro

Mo057 Kinematically complete studies on mutual projectile and target ionization

Mo058 Three-body dynamics in single ionization of atomic hydrogen by 75 keV proton impact
Aaron LaForge, Kisra Egodapitiya, Michael Schulz, Ahmad Hasan, Marcello Ciapini, Alexander Godunov

Mo059 Orientation effects in collisions with protons and positrons
D. Fregenal, R. O. Barrachina, G. Bernardi, P. Focke, S. G. Suárez, J. Fiol
7.4 Charge transfer

Mo060  The PRIOC experiment – precision studies on ion collisions using a magneto-optically trapped lithium target
Renate Hubele, Dominik Globig, Aaron LaForge, Martin Sell, Daniel Fischer

Mo061  Alignment of atomic inner-shell vacancies following nuclear $\alpha$ decay
Sean McConnell, Anton Artemyev, Andrey Surzhykov

Mo046  Four body charge transfer process in proton helium collision
U. Chowdhury, A.L.Harris, J. L. Peacher, D. H. Madison

Mo047  Fully differential cross section for four body charge transfer process
U Chowdhury, A. L Harris, J. L. Peacher, D. H. Madison

Mo048  Kinematically complete measurements for electron capture in collision of keV energy ions with atomic and molecular targets
Aditya H. Kelkar, Xincheng Wang, Daniel Fischer, Robert Moshammer, Joachim Ullrich

Mo049  Energy- and angle-resolved spectroscopy of electrons from ion-atom collisions
K. Holste, S. Ricz, S. Schippers, A. Müller

Mo050  Charge-state-specific EUV spectra of Xe ions

Mo051  Observation of atomic-size Fraunhofer-type diffraction for single-electron-capture in He$^{2+}$+He collision
Q. Wang, X. Ma, X. L. Zhu, S. F. Zhang

Mo052  Charge state distribution of carbon ions after penetration of C-foil targets

Mo053  Ultrafast charge transfer dynamics induced by low energy collisions. Application to ion-atom and ion-molecule systems.
Marta Labuda, Jesús González–Vázquez, Leticia González

Mo054  Fast computation of large-scale close-coupling systems on the example of $N^{7+} - H$ collisions
Markus Wallerberger, Katharina Igenbergs, Josef Schweinzer, Friedrich Aumayr

Mo055  Atomic-orbital close-coupling calculations of charge exchange and ionisation in collisions of H(1s) and highly charged neon and argon ions
Katharina Igenbergs, Markus Wallerberger, Josef Schweinzer, Friedrich Aumayr
8. Atom-Atom and Ion-Ion Collisions
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Mo001  Range distributions for heavy atoms of residues produced in nuclear fusion-evaporation reactions
Roman Sagaidak
Mo002  Paradoxes of the standard adiabatic Born-Oppenheimer approach to collision processes. Their origin and possible solutions.
A. K. Belyaev
Mo003  Novel approach to theoretical investigation of heavy quasi-molecules
A. N. Artemyev, A. Surzhykov, P. Indelicato, G. Plunien, Th. Stöhlker
Mo004  Effect of screened Coulomb potentials on the dispersion coefficients for interaction between hydrogen and helium atoms
Sabyasachi Kar, Zishi Jiang, Y. K. Ho
Mo005  Application of multiple scattering approximation
S. A. Pozdneev
Mo006  Nonadiabatic nuclear dynamics of atomic collisions based on branching classical trajectories
A. K. Belyaev, O. V. Lebedev
Mo007  Resonance phenomena in heavy ions collisions and structurization of positron spectrum
Glushkov A.V.

9. Ion-Molecule or Atom-Molecule Collisions
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Mo072  Young-type interference in projectile–electron loss in energetic ion-molecule collisions
A. B. Voitkiv, B. Najjari, D. Fischer, A. Artemyev, A. Surzhykov
Mo073  Periodic variations in the wavelength distributions following photon interferences: analogy with electron interferences
M. Vabre, S. Girard, H. Gilles, B. S. Frankland, Ph. Leprince, F. Poree, J.-Y. Chesnel, R. O. Barrachina, F. Frémont
Mo074  Interaction of multiply charged ions with isolated polycyclic aromatic hydrocarbon molecules
Mo075  Interaction of nucleobase clusters with multiply charged ions: Insight into base pairing
Mo076  Production of H− fragments in collisions of OH+ ions with atoms and molecules
Zoltán Juhász, B. S. Frankland, Francois Frémont, Jimmy Rangama, Jean-Yves Chesnel, Béla Sulik
Mo077 Influence of the environment on the fragmentation of amino acids provoked by low-energy ions

Mo078 Highly charged ion–induced water cluster fragmentation
R Maisony, M Capron, E Lattouf, A Lawicki, S Maclot, V Bernigaud, A Domaracka, B Manil, A Méry, J Rangama, S Legendre, O Bjorneholm, S Svensson, P Rousseau, BA Huber, L Adoui

9.5 Dissociation and reactive collisions

Mo062 Hemiquantal treatment of low energy p+H$_2$ collisions
L F Errea, Clara Illescas, A Macias, L Mendez, B Pons, I Rabadan

Mo063 Ultrafast non-adiabatic fragmentation dynamics of doubly charged uracil in gas and liquid phase.

Mo064 Experimental investigation of the reaction window in double charge transfer process involving biomolecule target FeTPPCl
B Li, L Chen, R Brédy, J Bernard, G Montagne, X Ma, S Martin

Mo065 Coincidence momentum imaging of the Coulomb explosion of OCS induced by collision of 15 keV/q Ar$^+$ and Ar$^{8+}$ ions
Benji Wales, Tomonori Motojima, Jun Matsumoto, Haruo Shiromaru, Joseph Sanderson

Mo066 Charge-asymmetric dissociation of nitrogen molecules colliding with highly charged ions
Jun Matsumoto, Katsuki Nakadai, Tomonori Motojima, Youji Achiba, Haruo Shiromaru

Mo067 Fragmentation of acetonitrile in collisions with H$^-$ and O$^-$ ions
Leigh Graham, Peter L.M van der Burgt, John Alexander, C. Adam Hunniford, Sean Haughey, Tom A. Field, Robert W. McCullough

Mo068 High level ab initio and DFT calculations of formation energies for small protonated water clusters
T. Wroblewski

Mo069 Ionization and fragmentation of cold clusters of PAH molecules: collisions with keV ions

Mo070 Molecular isomer effects in ionization and fragmentation of PAH monomers and clusters: pyrene and fluoranthene

Mo071 Fragmentation of multiply-charged small hydrocarbon molecules in C$_n$H$_q$\(^{n+}(n=1-3, q=2-6)$ produced in high velocity collisions: Branching ratios and associated kinetic energy release of the H$^+$ fragment
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12.5 Photon collisions with surfaces

Mo164 Interplay between electronic correlations and coherent structural dynamics during the insulator-to-metal phase transition in VO$_2$ studied by means of fs-IR/EUV pump probe core-level photoemission
U. Heinzmann, H. Dachraoui, N. Müller, C. Oberer, G. Obermeier, S. Horn, V. Eyert

Mo165 Fragmentation and desorption from condensed alcohols due to soft X-rays and electron interactions: Relevance to solid state astrochemistry
Guilherme C. Almeida, Alexandre B. de Souza, Leandro A. Amaral, Andressa M. Nazareth, Diana Andrade, Heloísa M. Boechat-Roberty, Maria Luiza Rocco

Mo166 Electron emission in laser-nanotip interaction
Georg Wachter, Christoph Lemell, Joachim Burgdörfer

Mo167 Band-structure based model for photoelectron emission from metal surfaces
C. A. Rios, M. S. Gravielle, D. M. Mitnik, V. M. Silkin

Mo168 Photoelectron emission from LiF surfaces by ultrashort pulses
M. Acuña, M. S. Gravielle

12.6 Lepton collisions with surfaces

Mo018 Production of narrow electron beams using glass optics
B. S. Dassanayake, A. Ayyad, J. A. Tanis

Mo019 Electron transmission through polycarbonate nanocapillaries
D. Keerthisinghe, B. S. Dassanayake, G. G. De Silva, A. Ayyad, J. A. Tanis

Mo020 Broadening of electron beams through a macroscopic glass capillary
B. S. Dassanayake, A. Ayyad, S. Das, R. J. Bereczky, K. Tökési, J. A. Tanis

Mo021 Guiding of electrons through a single glass macrocapillary: investigation of the time dependent transmission
R. J. Bereczky, B. S. Dassanayake, S. Das, A. Ayyad, K. Tökési, J. A. Tanis

Mo022 Plasmon excitation in single wall carbon nanotubes by penetrating charged particles
Silvina Segui, Duncan J. Mowbray, Juana L. Gervasoni, Zoran L. Miskovic, Néstor R. Arista

Mo023 Spin-related effects in scattering of spin-polarized low-energy electrons from magnetic and nonmagnetic surfaces
S. Samarin, J.F. Williams, O. Artamonov, A. Suvorova

Mo024 The role of diffraction in (e,2e)
F.O. Schumann, Z. Wei, R. S. Dhaka, J. Kirschner

12.7 Heavy particle collisions with surfaces

Mo008 Light emission from ion-bombarded aluminum surface
Xu Qiu-mei, Yang Zhi-hu, Song Zhang-yong, Wu Ye-hong, Cai Xiao-hong

Mo009 Nano-craters due to impact of individual highly charged ions on surfaces and thin films
Mo010 Fast atom diffraction for multi-electronic atoms scattered from a LiF surface  
M.S. Gravielle, A. Schüller, H. Winter, J.E. Miraglia

Mo011 Surface modification on KBr(001) with slow highly charged ions in high fluence and high potential energy regime  
R. A. Wilhelm, R. Heller, S. Facsko

Mo012 The effect of temperature on guiding of slow highly charged ions through a mesoscopic glass capillary  
R. J. Bereczky, G. Kowarik, F. Ladinig, D. Schrempf, K. Tőkési, F. Aumayr

Mo013 Guided transmission of xenon ions through single nanohole in PC foil  
Y. Y. Wang, Y. T. Zhao, G. Xiao, X. Wang, J. L. Duan, J. Liu, S. F. Zhang, X. Ma

Mo014 Defect formation on BaF$_2$ by single impact of highly charged ions  
Stefan Facsko, Ayman Sherif El-Said, Richard Wilhelm, René Heller

Mo015 Test of image acceleration by distant collision of proton microbeam  
K. Tőkési, I. Rajta, S.Z. Szilasi, R.J. Bereczky

Mo016 Surface damage of silicon after swift heavy ion irradiation  
T. Peters, I. Alzaher, B. Ban d’Etat, A. Cassimi, I. Monnet, H. Lebius, M. Schleberger

Mo017 Angular distribution of MeV heavy ions through tapered glass capillary: experiment and simulation  

12.8 Photon collisions with solids

Mo163 Ionization, dissociation and desorption of pyrimidine ice due to X-ray interaction  
Edgar Mendoza, Guilherme C. Almeida, Diana Andrade, Wania Wolff, Maria Luiza Rocco, Heloísa M. Boechat-Roberty

13. Experimental Techniques

13.1 General

Mo101 Identification of isochronous operating mode for passive electrostatic storage ring  
T L Spanjers, M R Sullivan, T J Reddish, P Hammond

Mo102 A multiple-orbit time-of-flight mass spectrometer based on a low energy electrostatic storage ring  
M R Sullivan, T L Spanjers, P A Thorn, T J Reddish, P Hammond

Mo103 Stable operating conditions for a passive desktop sized electrostatic storage ring  
T J Reddish, M R Sullivan, P Hammond, P A Thorn, G Arora

Mo104 An investigation of guiding of positrons through insulating capillaries  
R.D. DuBois, K. Tőkési

Mo105 Chemical effects on the L$_i$ (i=1-3) sub-shell X-ray relative intensities for some compounds of Hg at 22.6 keV  
Anil Kumar, Sanjiv Puri
Mo106  Photon-ion spectrometer PIPE at the variable polarization XUV beamline of PETRA III

Mo107  Design of a time of flight mass spectrometer with a field free interaction region for electron / ion – molecule ionization studies
K. C. Rao, V. S. Prabhudesai, S. V. K. Kumar

Mo108  Two step laser desorption – laser ionization of PAHs. Experimental setup
Juan C. Poveda I, Alfonso Guerrero, Ignacio Álvarez, Carmen Cisneros

Mo109  Measurement of the absolute sensitivity of a high-sensitivity microchannel plate
Shiro Matoba, Ryota Takahashi, Chiro Io, Tetsuo Koizumi, Haruo Shiromaru

Mo110  Nonlinearly-generated atomic signal for robust laser locking
Fabiano Queiroga da Silva, Weliton Soares Martins, Itamar Vidal, Thierry Passerat de Silans, Marcos Oriá

Mo111  High-power electron gun for electron-ion crossed-beams experiments
A. Borovik, Jr., W. Shi, J. Jacobi, S. Schippers, A. Müller
1. Photon Impact (Weak Field)

1.1 General

Tu119 Two-center resonant photoionization
B. Najjari, A.B. Voitkiv, C. Mueller

Tu120 Hyperspherical versus spherical treatment of asymptotic conditions for three–body scattering problems

Tu121 Contribution of surface plasmon decay to secondary electron emission from an Al surface

1.3 Photoionization of atoms

Tu126 Time dependent investigations of double photoionization applied to atomic beryllium
F.L. Yip, A. Palacios, F. Martin

Tu127 Single-photon double ionization of He with generalized Sturmian basis.
F. D. Colavecchia, A. L. Frappicini, J. M. Randazzo, G. Gasaneo

Tu128 Interference of electron pairs in photoinduced N4,5 - O1O2,3 Auger decay in xenon
M. Zitnik, K. Bucar, P. Lablanquie, F. Penent, J. Paladoux, L. Andric, Y. Hikosaka, K. Ito

Tu129 Coherence of L2,3 - M2,3 Auger decay paths by energy selected photoionization of argon
M. Zitnik, K. Bucar, P. Bolognesi, L. Avaldi, V. Feyer, B. Paripas, B. Palasthy

Tu130 Probing scattering phase shifts by attosecond streaking

Tu131 Xe 4d photoionization in Xe@C60, Xe@C240, and Xe@C60@C240
V. K. Dolmatov, D. A. Keating

Tu132 Dipole and quadrupole photodetachment/photoionization studies of the Ar isoelectronic sequence
J. Jose, G. B. Pradhan, V. Radojević, S. T. Manson, P. C. Deshmukh

Tu133 Autoionization resonances in the argon isoelectronic sequence
J. George, G. B. Pradhan, J. Jose, P. C. Deshmukh

Tu134 Photoionization cross-sections for Fe II
V. Fivet, C.P. Ballance, T.W. Gorczyca, M.A. Bautista

1.5 Photoionization of ions

Tu135 Inner and outer-shell photoionization measurements for Br2+ ions

Tu136 K-shell photoionization of singly ionized atomic nitrogen
M F Gharaibeh, J-M Bizau, D Cubaynes, S Guilbaud, N El Hassam, M M Al Shorman, C Blancard, B M McLaughlin
**Tu137**  K-shell photoionization of Be-like B$^+$ ions  

**Tu138**  K-shell photodetachment from O$^-$  
N.D. Gibson, R.C. Bilodeau, C.W. Walter, D. Hanstorp, A. Aguilar, N. Berrah, D.J. Matyas, Y.-G. Li, R.M. Alton, S.E. Lou

**Tu139**  Threshold behaviour in photodetachment of K$^-$  

**Tu140**  Partial photodetachment cross sections in K$^-$  

**Tu141**  Theoretical study of the vibration-dependent electron anisotropy in O$_2^-$ photodetachment  
Michal Tarana, Chris H. Greene

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**Tu122**  Photodissociation of cold fluorescein monoanion studied using an electrostatic storage ring  
Tetsumi Tanabe, Manabu Saito, Koji Noda

**Tu123**  Photodissociation from the ground state of HeH$^+$: comparison with experiment  
X. Urbain, J. Lecointre, J. Loreau, N. Vaeck

**Tu124**  Coulomb explosion imaging of small organic molecules at LCLS  
Benjamin Erk, Artem Rudenko, Daniel Rolles, Benedikt Rudek, Lutz Foucar, Sascha Epp, Max Cryle, Ilme Schlichting, Christoph Bostedt, Sebastian Schorb, John Bozek, Arnaud Rouzee, Axel Hundertmark, Tatiana Marchenko, Mark Simon, Frank Filsinger, Lauge Christensen, Shankar De, Sebastian Trippel, Shinichi Wada, Kiyoshi Ueda, Claus Dieter Schroeter, Joachim Ullrich

**Tu125**  Radiative stabilization and photodissociation of HeH$^+$ in its two lowest $^3\Sigma^+$ states  
Stéphane Vranckx, Jérôme Loreau, Michèle Desoutter-Lecomte, Nathalie Vaeck

### 1.7 Photon interactions with clusters and solids

**Tu142**  Measuring phase transition temperature of fragmented C$_{60}$  

**Tu143**  Theoretical and experimental study of VUV ionization and fragmentation of size-selected selenium microclusters  
D. T. Ha, K. Kooser, E. Itälä, J. Laksman, S. Urpelainen, E. Kukk

**Tu144**  Charge migration and decay of doubly charged ammonia clusters  
M. Gisselbrecht, C. Grunewald, E. Månsson, J. Laksman, A. Sankari, M. Tchaplyguine, O. Björnholm, S.L. Sorensen

**Tu145**  Ion photodesorption from solid Ne with a laser plasma vacuum ultraviolet light source  
Satoshi Jinno, Tetsuo Koizumi, Takato Hirayama
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2.3 Photoionization of atoms

Tu105 Modification of Auger decay of neon under strong X-ray radiation
L. A.A. Nikolopoulos, T. J. Kelly, J. T. Costello

Tu106 Strong field double ionization of helium with ultra short circularly polarized light pulses
M. Schöffer, X. Xie, S. Roith, D. Kartashov, A. Baltuska, M. Kitzler

Tu107 Referencing sub-cycle dynamics of double and single ionization in ultra-short laser fields

Tu108 Controlling the XUV transparency using two pathway quantum interference
Predrag Ranitovic, Xiao-Min Tong, Craig W Hogle, Xibin Zhou, N. Toshima, M. M. Murnane, H. C Kapteyn

Tu109 A zeptosecond phase interferometer

Tu110 Evidence for anisotropic final state interactions in the two-photon ionization of rare gases
Markus Braune, Toralf Lischke, Andre Meissner, Markus Ichen, Sascha Deinert, Jens Viehhaus, Andre Knie, Uwe Becker

2.5 Photoionization of ions

Tu111 Multiphoton detachment from negative ions by few-cycle laser pulses
MC Smyth, SFC Shearer, GF Gribakin

Tu112 Multi-photon ionization of the H$_2^+$ molecule by an XUV laser pulse
Ethan Secor, Xiaoxu Guan, Klaus Bartschat, Barry I. Schneider

Tu113 Nonsequential double ionization of H$^-$ by two-photon absorption
R. Nepstad, M. Førre

2.6 Photodissociation

Tu101 XUV photofragmentation of small water cluster cations at FLASH

Tu102 Dissociation dynamics of O$_2^+$ in intense laser fields
M. Magrakvelidze, S. De, C. L. Cocke, I. Ben-Izhak, U. Thumm

Tu103 Fragmentation of organic molecules by intense femtosecond lasers
Orla Kelly, Chris R Calvert, Ray B King, Martin J Duffy, Louise Belsaw, Will A Bryan, Emma Springate, IC Edmond Turcu, Cephise M Cacho, Ian D Williams, Jason B Greenwood

Tu104 Probing femtosecond non-Born-Oppenheimer dynamics in ethylene with two-color EUV pulse pairs
A. Belkacem, T.K. Allison, J. van Tilborg, R. Falcone, C. Khurmi
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Tu115 Correlation between X-ray yield and electron spectra in laser-cluster interaction

Tu116 Multiple photoionization of rare-gas clusters by EUV-FEL at Spring-8

Tu117 Formation of molecular halide ions from alkyl-halide clusters irradiated by ps and fs laser pulses
G. Karras, S. Danakas, C. Kosmidis

Tu118 Attosecond photoelectron spectroscopy of metal surfaces
Chang-hua Zhang, Uwe Thumm

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3.4 Ionization

Tu001 Single ionization of helium by positron and electron impact
R. Samanta, M. Purkait, C. R. Mandal

Tu002 Electron-impact ionization of the hydrogen atom: dynamical variational treatment
P. Defrance, T. Kereselidze, J. Lecointre, Z. S. Machavariani

Tu003 Double ionization of helium by electrons and positrons: use of the second Born approximation
Ferhat Menas, Claude Dal Cappello, Atika Haddadou

Tu004 Reaction dynamics in double ionization of helium by electron impact
M. Schulz, M. F. Ciappina, T. Kirchner

Tu005 Low energy (e,2e) measurements of Xe in the symmetric non-coplanar geometry
KL Nixon, AJ Murray

Tu006 Calculation of electron impact total ionization cross sections for the atoms Ga, Ge, As, Se, Br and Kr
Rahla Naghma, Minaxi Vinodkumar, Bobby Antony

Tu007 (e,2e) measurements from laser aligned Mg atoms
Kate L. Nixon, Andrew James Murray

Tu008 (e, 2e) on helium: complete agreement between experiment and theory
X. Ren, I. Bray, D. V. Fursa, T. Pfüger, A. Senftleben, A. Dorn, J. Ullrich

Tu009 A kinematically complete (e, 2e)-experiment on small rare gas clusters
Thomas Pfüger, Xueguang Ren, Arne Senftleben, Alexander Dorn, Joachim Ullrich
Tu010 General overview of the strong projectile-target-core interaction in Ne (e, 2e) reaction

Tu011 B-spline R-matrix with pseudo-states calculation for electron-impact ionization of helium
Oleg Zatsarinny, Klaus Bartschat

Tu012 Angular distributions of secondary electrons in fast particle-atom scattering
M. Ya. Amusia, L. V. Chernysheva, L. V. Chernysheva

Tu013 New expression for the K-shell ionization
J. P. Santos, M. Guerra, F. Parente

Tu014 Effective ionization cross section of metastable atoms of cadmium by electrons
R.O. Fedorko, T.A. Snegurskaya, M.O. Margitych, V.V. Stetsovych, I.I. Shafranyosh

Tu015 On the numerical treatment of Coulomb forces in scattering problems
J. M. Randazzo, L. U. Ancarani, F. D. Colavecchia, G. Gasaneo, A. L. Frapiccini

Tu016 Electron scattering in hot-dense plasmas
Mark C. Zammit, Dmitry V. Fursa, Igor Bray

Tu017 Single and double ionization of He by electron-impact
M. J. Ambrosio, F. D. Colavecchia, G. Gasaneo, A. L. Frapiccini

Tu018 K-shell (e, 3e) processes with transversely spin-polarized relativistic electrons
R Choubisa, Munendra Jain

Tu019 B-splines approach of the Sturmian basis: Atomic and scattering calculations.
A. L. Frapiccini, J. M. Randazzo, F. D. Colavecchia, G. Gasaneo

Tu020 Electron impact double-excitation of helium 2ℓ2ℓ' autoionizing states using the (e, 2e) technique
Omer Sise, Mevlut Dogan, Ibrahim Okur, Albert Crowe

4. Electron-Molecule Collisions
4.1 General

Tu042 Polarizable continuum approach to solvated transient anions
Márcio T. do N. Varella

Tu043 Orientation- and alignment-effects in electron-induced ionization of single-oriented water molecule
Christophe Champion, Roberto D. Rivarola

Tu044 Spatiotemporal evolution of reaction fronts trigger by tunneling electrons

Tu045 Electron impact total ionization cross sections for simple bio-molecules (H$_2$CO, HCOOH and CH$_3$COOH) using ICSP-ic method.
Harshad Bhutadia, Minaxi Vinodkumar, Bobby Antony
Tu046  Electron impact total cross sections for hydrogen molecule from 0.01 eV to 2 keV  
Kirti Korot, Minaxi Vinodkumar, Harshad Bhutadia

Tu047  Probing total cross sections for electron impact studies from meV to keV for H₂S and PH₃  
Chetan Limbachiya, Minaxi Vinodkumar, Nigel Mason

Tu048  Electron impact total cross sections for simple biomolecules (HCOOH and H₂CO) over a wide energy range (meV to keV)  
Minaxi Vinodkumar, Harshad Bhutadia, Chetan Limbachiya

Tu049  Low energy electron scattering from fuels  

Tu050  Electron inelastic mean free paths in Ti, TiC, TiN and TiO₂: A Theoretical approach  
B. G. Vaishnav, K. N. Joshipura, Siddharth Pandya

Tu051  Electron scattering from tetrahydrofuran  

Tu052  Isotopical effects in electron and atom molecular scattering  
S.A. Pozdneev

Tu053  Theoretical study of the simple (e,2e) ionization of the 1π₉ molecular level of CO₂ by the introduction of a three-center continuum wave function  
Ochbatrach Chuluunbaatar, Boghos B. Joulakian

Tu054  Electron and positron scattering from pyrimidine  

Tu055  Radiation induced damage by secondary electrons in condensed water molecules  
A.G. Sanz, M.C. Fuss, A. Muñoz, J.C. Oller, F. Blanco, G. García

Tu056  Modelling low energy electron and positrons tracks for biomedical applications  

Tu057  Absolute cross sections for electron collisions with diacetylene: Elastic scattering, vibrational excitation and dissociative attachment  
Michael Allan, Olivier May, Juraj Fedor, Bogdan C. Ibanescu, Lidija Andric, Carl Winstead, Vincent McKoy

4.5 Dissociation, dissociative attachment

Tu038  Post-collision interaction in e⁻ + H₂ → H + H⁻ dissociative electron attachment  
Bernd Nestmann

Tu039  Loss of hydrogen from amino acids upon low-energy electrons attachment  
Violaine Vizcaino, Benjamin Puschnigg, Stefan Huber, Michael Probst, Ilya Fabrikant, Gordon Gallup, Eugen Illenberger, Paul Scheler, Stephan Denifl
Tu040  Dissociative electron attachment to formamide  
E. Szymanska, B.G. Nair, N.J. Mason, E. Krishnakumar

Tu041  Electron attachment to fluorocarbon radicals and unstable molecules: CF$_2$ and C$_2$F$_5$  

5. Electron-Ion Collisions  
5.4 Recombination (atomic ions)

Tu021  Breit interaction in dielectronic recombination of H-like uranium  

Tu022  Effects of configuration interaction for dielectronic recombination of Na-like ions forming Mg-like ions  
Duck-Hee Kwon, Daniel Wolf Savin

Tu023  Dielectronic recombination of metastable berylliumlike xenon ions  

Tu024  Dielectronic recombination in He-like, Li-like and Be-like yttrium and KLM resonances  
Ayse Yumak, Vedat Karakas, Zikri Altun

Tu025  Dielectronic recombination in He-like, Li-like and Be-like iodine and KLM resonances  
Erdi Ata Bleda, Ayse Yumak, Ilhan Yavuz, Zikri Altun

Tu026  Dielectronic recombination in He-like, Li-like and Be-like bismuth and KLM resonances  
Ilhan Yavuz, Ayse Yumak, Erdi Ata Bleda, Zikri Altun

Tu027  KLL dielectronic recombination resonance strengths in He- to O-like gold ions  
Zhimin Hu, Michiharu Ureshino, Xiaoying Han, Yueming Li, Nobuyuki Nakamura

Tu028  Dielectronic recombination of hydrogen-like krypton  
Zhimin Hu, Akira Yamazaki, Yueming Li, Nobuyuki Nakamura

Tu029  Dielectronic recombination of in-flight synthesized exotic isotopes  

Tu030  Higher order resonant intershell electronic recombination for highly charged ions  
**Tu031** Enhanced radiative recombination of $U^{92+}$ ions with cooling electrons for the K-shell

**Tu032** Radiative recombination of ions with electrons in cold magnetized plasma
M. Pajek, D. Banas, C. Brandau, A. Gumberidze, P. Jagodziński, Ch. Kozhuharov, A. Surzhykov, Th. Stöhlker

**Tu033** Electron-ion collision studies with highly charged sulfur ions

### 5.5 Recombination (molecular ions)

**Tu034** Dissociative recombination of $D_2Cl^+$ and other astrophysically relevant polyatomic ions

**Tu035** Collision processes of $e + H_2^+$ and its isotopes
Hidekazu Takagi

**Tu036** Study on dissociative recombination of $HeH^+$ using multichannel quantum defect theory
Motomichi Tashiro, Hidekazu Takagi

**Tu037** Dissociative recombination of $Cl_2^+$
M. Zhang, X. Cai, Å. Larson, A. E. Orel

### 7. Ion-Atom Collisions

#### 7.6 Autoionization and electron detachment

**Tu058** Interactions of $H^-$ anions with atomic hydrogen - ion trap study at 10-100K
Štepán Roučka, Pavol Jusko, Illia Zymak, Dmytro Mulín, Radek Plašil, Dieter Gerlich, Juraj Glosík

### 11. Ultracold Atomic and Molecular Physics

#### 11.2 Collisions at ultracold temperatures

**Tu157** Ultra cold collisions helium atoms with helium molecules
S. Pozdneev

**Tu158** Collisions of trapped ions with ultracold atoms in $[YbRb]^+$ systems
H. D. L. Lamb, J. Goold, J. F. McCann, N. Wells, I. Lane

**Tu159** Universal behavior of anomalous cross sections at threshold
Pablo A. Macri, Raúl O. Barrachina

**Tu160** Thermodynamical model for sympathetic cooling of neutral particles
Sergey Borisenok, Yuri Rozhdestvensky

**Tu161** Collisional processes in confined geometry of atomic traps
Vladimir S. Melezhik, Peter Schmelcher
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13.1 General

Tu059 Development of a low energy electron beam source using the photoelectric effect
Tatsuya Konishi, Satoshi Jinno, Takato Hirayama

Tu060 The Double ElectroStatic Ion-Ring ExpEriment, DESIREE

Tu061 Planar position sensitive Ge(Li)- and Si(Li)-detector systems for Compton polarimetry in atomic physics with highly charged ions
U. Spillmann, KH. Blumenhagen, H. Bräuning, G. Weber, Th. Stöhlker

Tu062 KEIRA-CHIMERA: A new method in high resolution mass spectrometry
M. J. Duffy, O. Kelly, L. Belshaw, R. B. King, I. D. Williams, C. R. Calvert, J. B. Greenwood

Tu063 LAMP - LCLS ASG Michigan Project - Next generation endstation for concurrent measurements of charged products and photons in LCLS FEL experiments.
T. Osipov, D. Rolles, C. Bostedt, J-C Castagna, R. Hartmann, J.D. Bozek, I. Schlichting, L. Strüder, J. Ullrich, N. Berrah

Tu064 Temperature diagnostics of ECR plasma by measurement of electron bremsstrahlung spectra
S Kasthurirangan, A N Agnihotri, A Desai, Lokesh C Tribedi

Tu065 A cryogenic electrostatic storage ring project at RIKEN

Tu066 Development of a dose evaluation method for cell irradiation using glass capillaries with end-windows
Tokihiro Ikeda, Walter Meissl, Elfi Meissl, Takao M. Kojima, Tomohiro Kobayashi, Yasunori Yamazaki

Tu067 Laser-induced cesium lithography
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Tu068 Dipole field effects on ion ejections from a Paul ion trap
John A. MacAskill, Stojan M. Madzunkov, Ara Chutjian

Tu069 Pre-retardation effects on the high-sensitivity angle and energy dispersive multichannel electron momentum spectrometer with $2\pi$ angle range
Qiguo Tian, Jing Yang, Yufeng Shi, Xu Shan, Xiangjun Chen

14. Related Topics

14.1 General

Tu146 Excess electron localisation in solvated DNA components: from gas to the condensed phase.
Maeve Smyth, Jorge Kohanoff
Tu147  Electron localization and bond cleavage in solvated DNA fragments
Maeve Smyth, Jorge Kohanoff

Tu148  Excess charge induced proton transfer between thymine and glycine
Bin Gu, Maeve Smyth, Jorge Kohanoff

Tu149  Doppler controlled optical nutation of dipole vectors and dip in electrical
polarizability
R. Bordoloi, R. B. Bordoloi

Tu150  Optical emission spectroscopy and probe laser beam deflection diagnosis
of laser produced zinc and cadmium plasma
S.C. Singh, R. Gopal

Tu151  Non-Hermitian quantum mechanics in the context of the Lindblad equation
Sølve Selstø

Tu152  Parity non-conservation effect in heavy atoms, nuclei and observing P and
PT violation using NMR shift in a laser beam: Nuclear-QED theory
Khetselius O.Yu.

14.2 Structure and spectroscopy (atoms, atomic ions)

Tu070  Laser spectroscopy of highly charged argon at the Heidelberg Electron
Beam Ion Trap
V. Mäckel, G. Bremer, J. R. Crespo López-Urrutia, R. Klawitter, K. Schnorr

Tu071  Ground state for two-electron atoms in exponential-cosine-screened
Coulomb potentials.
K V Rodriguez, L U Ancarani, A L Frapiccini, D M Mitnik, G Gasaneo

Tu072  K X-ray energies and transition probabilities for He-, Li- and Be-like
praseodymium ions
J. P. Santos, A. M. Costa, M. C. Martins, P. Indelicato, F. Parente

Tu073  Spin-forbidden helium I transition rates
Donald C. Morton, Gordon W. F. Drake

Tu074  Recent results on the development of extreme ultraviolet sources for lithog-
raphy and metrology at 6.x nm
G. O’Sullivan, Li Bowen, Padraig Dunne, Takamitsu Otsuka, Takeshi Higashiguchi, Noboru
Yugami, Toyohiko Yatagai, Weihua Jiang, Akira Endo, Emma Sokell, Thomas Cummins, Colm
O’Gorman, Deirdre Kilbane

Tu075  Selective reflection probing of thin film deposition
Weliton Soares Martins, Thierry Passerat de Silans, Itamar Vidal, Martine Chevrollier

Tu076  Computation of resonant states using explicitly correlated coordinates in
Be-like B, C and N
J. C. Cardona

Tu077  Laser spectroscopy at the experimental storage ring – an overview
D.F.A. Winters, Th. Kühl, W. Nörtershäuser, Th. Stöhler

Tu078  Stabilities of four-body systems against arbitrary dissociations
Mohamed Assad Abdel-Raouf
14.3 Structure and spectroscopy (molecules, molecular ions, clusters)

Tu079 Application of the Coulomb spheroidal basis for diatomic molecular calculations
P Defrance, T Kereselidze, J Lecointre, Z S Machavariani

Tu080 What one can learn about clusters using the unique tools of x-ray photoelectron spectroscopy
Maxim Tchaplyguine, Tomas Andersson, Chaofan Zhang, Mikko-Heikki Mikkelä, Leena Partanen, Marko Huttula, Kari Jänkälä, Gunnar Öhrwall, Svante Svensson, Nils Mårtensson, Olle Björnholm

Tu081 Electron dynamics of interatomic Coulombic decay in quantum dots
Annika Bande, Kirill Gokhberg, Nimrod Moiseyev, Lorenz S. Cederbaum

Tu082 Probing IR-Raman vibrationally excited molecules with X-ray spectroscopy
Selma Engin, Nicolas Sisourat, Patricia Selles, Richard Taïeb, Stéphane Carniato

Tu083 Photon energy influence on valence photoelectron spectra of silver clusters
Tomas Andersson, Chaofan Zhang, Mikko-Heikki Mikkelä, Dmitri Anin, Kari Jänkälä, Maxim Tchaplyguine, Gunnar Öhrwall, Marko Huttula, Nils Mårtensson, Svante Svensson, Olle Björnholm

Tu084 Spectral tuning of the photoactive yellow protein chromophore by H-bonding
Jyoti Rajput, D. B. Rahbek, L. H. Andersen

Tu085 Theroretical studies of atomic properties and chemical stabilities in acid solutions of element Uus (Z=117) and Astatine
Zhi-Wei Chang, Ji-Guang Li, Chen-Zhong Dong

Tu086 Absolute electron detachment and fragmentation cross sections for laser excited Al$^{-}_n$ (2 ≤ n ≤ 10)

Tu087 Use of uncorrelated Sturmian basis functions for three-body systems of finite masses
J. M. Randazzo, L. U. Aucarani, G. Gasaneo, F. D. Colavecchia, A. L. Frapiccini

Tu088 Structures of possible highly protonated methane cations
Alfonso Guerrero, Ignacio Álvarez, Carmen Cisneros, Juan Carlos Poveda

14.4 Plasma physics

Tu153 Feshbach-like study of He resonant states in Debye plasmas using explicitly correlated wave functions
J. C. Cardona, A. F. Ordoñez, J. L. Sanz-Vicario

Tu155 Atomic population kinetics in fluctuating plasmas
Fabrice Catoire, Joël Rosato, Yannock Marandet, Mohammed Koubiti, Samad Mekkaoui, Hubert Capes, Roland Stamm

Tu156 The TARANIS laser: A multi-terawatt system for laser plasma physics
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SOCIAL PROGRAMME

Welcome Reception

The local organisers and the City of Belfast cordially invite you to a welcome reception on **Tuesday evening 26 July 2011 from 18:00 to 21:00**. The reception will be held in the Ulster Museum situated in the Botanical Gardens adjacent to Queen’s University. Come face-to-face with dinosaurs, meet Takabuti, the Egyptian mummy, and learn about the history of Ireland. As Northern Ireland’s treasure house of the past and present, the museum is home to a rich collection of art, history and natural sciences. There is no additional cost for registered attendees and accompanying persons.

Public Lectures

A scientific lecture of general public interest will take place on **Wednesday 27 July 2011 from 19:00 to 20:00**. Professor Mike Baillie will speak on ‘How precise tree-ring dating raises issues concerning the frequency of extraterrestrial impacts’. Professor Baillie obtained his first degree in Physics before moving into Palaeocology. He is a leading expert in dendrochronology (tree-ring dating), high-resolution chronology in recent millenium, environmental effects of explosive volcanism, frequency and environmental effects of extraterrestrial impacts in recent millennia, and mythology as a source of information on extreme events.

City of Belfast Reception

The Lord Mayor of Belfast and The Queen’s University of Belfast invite you to a special reception in the City Hall on **Thursday 28 July 2011 from 18:30 to 20:30**. The Belfast City Hall is Belfast City Council’s civic building and is located in the heart of the city centre. Half-an-hour guided tours of this imposing building for groups of up to 50 will be available on the night. Please express your interest when registering at the conference desk upon arrival in Belfast.

Conference Dinner

The conference organisers invite you to a fun-filled evening of great food, plenty of drink, music and dancing but above all loads of Irish ‘craic’. The conference dinner will be held on **Monday 1 August 2011 at the Ramada Hotel, with buses departing from Queen’s at 18:15**. You will be entertained by the renowned Royal Tara Irish Dance Academy followed by a traditional Irish music group. The proceedings will begin at 19:00 with a drinks reception, with dinner served at 20:00. Tickets are £36 for regular participants and accompanying persons, £20 for students, with children aged 12 or under attending at no charge. Tickets can be booked through the conference website at registration. There is a limit on the number of places at the dinner, so early booking is strongly recommended.
Weekend Tours

Causeway Coast, Glens of Antrim and Bushmills

The tour departs from Queen’s at 08:30. Following the northern shore of Belfast Lough, you arrive at Carrickfergus to see Ireland’s oldest Norman castle. The route continues via the Glens of Antrim and through the charming villages of Carnlough, Cushendall, Cushendun and Ballycastle. You will then walk across the famous Carrick-a-Rede rope bridge and continue to Giant’s Causeway. There you explore this astonishing complex of basalt columns, which according to folklore, formed part of a “causeway” across the sea to Scotland, built by the giant Finn McCool. After lunch at the Causeway Hotel you travel to Bushmills, the world’s oldest licenced whiskey distillery, to see how it’s made and sample the produce. You then continue through the seaside resorts of Portrush and Portstewart, and back across the Antrim plateau, arriving in Belfast at 18:30.

Cost: £47.50 on Saturday (including lunch, visits to all sights and tour of Bushmills); £42.50 on Sunday (same, but excluding the tour of Bushmills; you will still be able to see it from the outside and visit the distillery shop with local souvenirs, and of course, whiskey!).

Mount Stewart, Strangford Lough and Downpatrick

The tour departs from Queen’s at 09:30. Travelling south-east through County Down you arrive at the National Trust property of Mount Stewart to visit the stately home of the Londonderry family (see the remarkable embroidered chairs used at the Congress of Vienna in 1815!) and walk through its unique and beautiful gardens. After a drive along the coast of Stranford Lough, you cross the lough on a ferry from Portaferry to Strangford and have lunch at The Cuan. You then continue to Downpatrick to visit St Patrick’s Centre and hear the story of the Ireland’s Patron Saint and visit Down Cathedral and St Patrick’s grave nearby. This is followed by a stop at Inch Abbey to see the ruins of this Cistercian Abbey founded in 1180 by John de Courcy, who led the 1177 Anglo-Norman invasion of East Ulster. Return to Queen’s University at 17:30.

Cost: £47.50 on Saturday and Sunday (inclusive of lunch and visits to the house and garden at Mount Stewart and St Patrick’s Centre).

Marble Arch Caves, Florence Court and Lough Erne

The tour leaves Queen’s at 07:45. After a 1.5 hour drive you arrive in County Fermanagh to visit Marble Arch caves, the heart of one of only two UNESCO Geoparks in Ireland. There you explore the underground world of stalactites and stalagmites on foot and by boat. A short drive will then bring you to Florence Court, an 18th century house built by John Cole, with some fine Rococo plasterwork and many original items of furniture. This is followed by lunch in the beautiful Killyhevlin Hotel in Enniskillen, the capital of Fermanagh. After lunch, you cross Lough Erne by boat and visit Devenish Island, one of the finest monastic sites in Northern Ireland, complete with a 12th century round tower. Return to Queen’s University at 20:00.

Cost: £57.50 Saturday only (including lunch, visit to the caves, Florence Court and boat).

Ulster American Folk Park and Beaghmore Stone Circles

Departing Queen’s at 9:30, you travel by bus through the heartland of Ulster into County Tyrone. There you spend most of the day in the Ulster American Folk Park, an outdoor museum which tells the story of emigration from Ulster to America in the 18th and 19th centuries, and enjoy lunch and interactive exhibition at the An Cregan Visitor Centre. On the way back you stop to wonder at the Beaghmore Stone Circles. This site of over 1000 stones was discovered during peat cutting in 1940’s. It is attributed to the earlier part of the Bronze age, 2,000-1,200 BC, and was built on the the site of an earlier Neolithic settlement. Not on the same scale as Stonehenge, it dates from about the same age and is usually free from crowds, making this a very atmospheric site! Return to Queen’s University at 18:30.

Cost: £42.50 Sunday only (including visit to the museum and lunch).
Accompanying Persons Programme

We invite all accompanying persons to meet in the Great Hall on **Wednesday, 27 July at 9:30**. During the conference the Great Hall will be the hub for the accompanying persons programme. A desk and computer with internet access and a notice board will be available. Tea and coffee will be served every weekday morning from 9:00. A number of activities have been planned for the first four days of the conference.

**Wednesday, 27 July 2011**

*Tour of the Botanic Gardens and Ulster Museum.* First established in 1828, the gardens have been enjoyed as a public park by the people of Belfast since 1895. In addition to two important buildings, the Palm House and the Tropical Ravine, there is an extensive rose garden and long herbaceous borders and the tree enthusiast can seek out the rare oaks planted in the 1880s, including the hornbeam-leafed oak. Situated near Queens University Belfast, the Botanic Gardens is an important part of Belfast’s Victorian heritage and a popular meeting place for residents, students and tourists. The Ulster Museum is situated within the Botanic Gardens. Entrance to both places is free of charge.

**Thursday, 28 July 2011**

*Bus tour to the Walled Garden at Glenarm Castle in the beautiful and historic village of Glenarm in County Antrim.* The Walled Garden is one of Ireland’s oldest walled gardens dating from the 18th century. Originally created to supply the Castle with its fruit and vegetables, it is now filled with exciting flowers and specimen plants to interest the keenest horticulturist. The garden has a Tea Room where you can relax and enjoy a delicious home-made cream tea or a light lunch, overlooking the kitchen garden. Glenarm village is home to the famous Steensons jewellers, one of Ireland’s leading jewellery designers. It will be possible to visit their workshop and visitors centre. On the way to Glenarm we will stop at the Carrickfergus Castle and visit the small village of Gleno which has its own waterfall!
Cost: £15 per person (booked at registration).
Start: at 10:00 from Queen’s, return at 16:00.

**Friday, 29 July 2011**

*Tour of Belfast and Titanic tour.* We start the day with a visit to the historic St George’s Market, one of Belfast’s oldest attractions. It was built between 1890 and 1896 and is one of the best markets in the UK and Ireland. It holds a weekly Friday Variety Market. We then continue on the Titanic boat tour (75 min) to see the historic Harland & Wolff shipyards and the famous Titanic sites around Belfast Harbour. We will finish in the grounds of the Belfast City Hall where we can have lunch at the Bobbin cafe and go on the tour of the grand City Hall building.
Cost: £10 per person (booked at registration).

**Monday, 1 August 2011**

*Tour choice of a trip to Belfast Zoo or to the Ulster Folk Museum.* Belfast Zoo (formerly known as Bellevue Zoo) is located on Cave Hill and offers stunning views over Belfast Lough. Its collection has more than 140 different animal species, and its 55 acre site contains a rich variety of plants and gardens. Admission charge £7.00/£3.60, children under 4 and seniors - free. A private visit for a talk on quilts at the Ulster Folk Museum has been arranged for Monday 1 August. Beautiful examples of quilts, embroidery and lace from the museum's archive collection, not normally on public display, will be shown. No children under 12. Unfortunately, it will not be possible to see the museum itself on this day as it is closed on Mondays.
Belfast Zoo and the Ulster Folk and Transport Museum are easily accessible by public transport (bus or train) and have cafes for lunch.
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For all enquiries contact Steve Knight
Tel: 01295 672529
stevek@laserlines.co.uk
Quantemol is a software company developing a unique software tool, Quantemol-N, that brings full accessibility to the highly sophisticated UK molecular R-matrix codes, which are used to model electron-polyatomic molecule interactions.

Quantemol is based in University College London and was initiated by Professor Jonathan Tennyson FRS and Dr. Daniel Brown in 2004. Since then Quantemol has widened its capabilities to simulations of plasmas and industrial plasma tools, by the development of the Quantemol-D software.

What does the Quantemol-N software do?

It calculates a variety of observables for electron-molecule collisions including:

- Elastic cross sections and electronic excitation cross sections (Recently extended to ionization energies and above).
- Electron impact dissociation rates.
- Resonance parameters.
- Radial charge density calculation.
- Dissociative electron attachment cross sections calculation.
- BEB (Binary-Encounter-Bethe) ionization cross sections.

What are the key advantages of Quantemol-N?

- Based on the world leading UK molecular R-matrix codes, giving highly accurate results.
- Easy to use Java graphical user interface.
- Complete documentation of the theoretical model for publication purposes.
- Results presented in a flexible, user friendly form.
- Requires no expertise in quantum scattering theory.
- Calculations can be performed on a simple desktop machine or laptop.

User Testimonials

Prof. Nigel Mason OBE, Department of Physics and Astronomy, The Open University:

“Quantemol-N provides much needed electron-molecular scattering data, particularly for molecules and molecular species that are difficult to isolate and study experimentally — such as the fluoro-carbon radicals. Such molecular data is in high demand from both academia and industry. Quantemol-N’s uniqueness lies in the fact that one does not have to be a specialist in the underlying scattering theory in order to utilise it.”

Dr Tom Field, Centre for Plasma Physics, School of Maths and Physics, Queen’s University Belfast:

“Good software for finding low energy electron-molecule scattering resonances with excellent user support.”

Contact Us:

Email: info@quantemol.com  Phone: +44 (0)207 679 34 76  Web: www.quantemol.com
<table>
<thead>
<tr>
<th>Time</th>
<th>Wednesday 27 July</th>
<th>Thursday 28 July</th>
<th>Friday 29 July</th>
<th>Monday 1 August</th>
<th>Tuesday 2 August</th>
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<td>Ultrafast processes in atomic dynamics</td>
<td>Antiproton and positron collisions</td>
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<td>Relativistic ion collisions</td>
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<td>IUPAP Young Scientist Prize Talk</td>
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<td>Beroff</td>
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<td>Public Lecture by Professor Mike Baillie (Whitla Hall)</td>
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<td>19:00-22:00 Banquet at Ramada Hotel (buses depart at 18:15)</td>
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