Awards Symposium (SYAW)

jointly organized by
the Atomic Physics Division (A),
the Molecular Physics Division (MO),
the Plasma Physics Division (P), and
the Quantum Optics and Photonics Division (Q)

Overview of Prize Talks and Sessions

(Lecture room: Kinosaal)

Prize Talks

SYAW 1.1	Wed	14:00–14:30	Kinosaal	**Semicrystalline polymers - pathway of crystallization and deformation properties** — •Gert Strobl
SYAW 1.2	Wed	14:30–15:00	Kinosaal	**A measurement of the evolution of Interatomic Coulombic Decay in the time domain** — •Till Jahnke
SYAW 1.3	Wed	15:00–15:30	Kinosaal	**A one-dimensional liquid of fermions with tunable spin** — •Massimo Inguscio
SYAW 1.4	Wed	15:30–16:00	Kinosaal	**Non-equilibrium: from heat transport to turbulence (to life).** — •David Ruelle
SYAW 2.1	Wed	16:30–17:00	Kinosaal	**Investigation of charge transfer efficiency of CCD image sensors for the scientific small satellite mission “AsteroidFinder”** — •Andrej Krimlowski
SYAW 2.2	Wed	17:00–17:30	Kinosaal	**Metrology of atomic hydrogen: from the Rydberg constant to the size of the proton** — •François Biraben

Sessions

SYAW 1.1–1.4	Wed	14:00–16:00	Kinosaal	**Awards Symposium I**
SYAW 2.1–2.2	Wed	16:30–17:30	Kinosaal	**Awards Symposium II**

SYAW 1: Awards Symposium I

Time: Wednesday 14:00–16:00 Location: Kinosaal

Prize Talk SYAW 1.1 Wed 14:00 Kinosaal

Semicrystalline polymers - pathway of crystallization and deformation properties — •Gert Strobl — Physikalisches Institut, Albert-Ludwigs-Universität Freiburg, 79104 Freiburg — Laureate of the Robert-Wichard-Pohl Prize

On cooling a polymer melt, plate-like crystals with thicknesses in the nano-range are nucleated and grow in the two lateral directions. The final structure is semicrystalline and composed of stacks of such crystallites separated by entangled fluid chain sequences. Structure parameters vary with the crystallization temperature which can be chosen far below the equilibrium melting point, down to the transition into the glassy state. The question about the mechanism of polymer crystallization has always been a central issue in polymer physics. Time- and temperature dependent X-ray scattering experiments carried out during the last two decades now led to the establishment of a set of laws which control the structure formation out the entangled melt, recrystallization processes, and the final melting. The laws indicate the participation of an intermediate mesomorphic phase in the crystal formation process. The peculiar deformation behaviour of polymeric materials reflects their semicrystalline structure, including in a coupled fashion both the rubber-like properties of the fluid parts and the elasto-plastic properties of the crystallites.

Prize Talk SYAW 1.2 Wed 14:30 Kinosaal

A measurement of the evolution of Interatomic Coulombic Decay in the time domain — •Till Jahnke — Institut für Kernphysik, Johann Wolfgang Goethe Universität, Frankfurt, Germany — Laureate of the Gustav-Hertz-Prize

Interatomic (or intermolecular) Coulombic Decay (ICD) has become an extensively studied atomic decay process during the last 10 years. In ICD an excited atom or molecule deexcites by transferring its excitation energy to a loosely bound atomic neighbor and leads to the emission of an electron from that neighbor. Originally proposed by Cederbaum et al. [1] it was first experimentally observed by two groups using different techniques [2,3]. Since that time a wealth of experimental and theoretical studies have shown that ICD is a rather common decay path in nature, as it occurs almost everywhere in loosely bound matter.

ICD is predicted to have a highly complex temporal behavior. The efficiency and thus the decay times of ICD depend strongly on the size of the system, i.e. the number of neighboring particles and the distance between them and the excited particle. However, even for most simple model systems consisting of only two atoms the temporal evolution of the decay is non-trivial: as ICD happens on a timescale that is fast compared to relaxation via photon emission, but comparable to the typical times of nuclear motion in the system, the dynamics of the decay is complicated and so far only theoretically explored. Here we present an experimental study resolving ICD in helium dimers (He2) in the time domain [4].

The talk will give a short introduction on ICD and show experimental investigations separating different contributions to the ICD transition matrix element [5]. The final part of the talk will show our time resolved studies of the dynamics of the nuclei of the decaying dimer and give a brief view on possible future applications of ICD [6].

[1] Cederbaum, L. S., Zobeley, J., and Tarantelli, F., Phys. Rev. Lett., 79, 4778 (1997).
[2] Marburger, S., Kugeler, O., Hergenhahn, U., and Möller, T., Phys. Rev. Lett., 93, 203401 (2003).
[3] Jahnke, T., Czasch, A., Schöffler, M. S., Schössler, S., Knapp, A. Käsz, M., Titze, J., Wimmer, C., Kreidi, K., Grisenti, R. E., Staudte, A., Jagutzki, O., Hergenhahn, U., Schmidt-Böcking, H., and Dörner, R., Phys. Rev. Lett., 93, 163401 (2004).
[4] F. Trinter J. B. Williams, M. Weller, M. Waitz, M. Pitzer, J. Voigtsberger, C. Schober, G. Kastirke, C. Müller, C. Goihl, P. Burzynski, F. Wiegandt, T. Bauer, R. Wallauer, H. Sann, A. Kalinin, L. Ph. H. Schmidt, M. Schöffler, N. Sisourat, and T. Jahnke, Phys. Rev. Lett., 111, 093401 (2013)
[5] T. Jahnke, A. Czasch, M. Schöffler, S. Schössler, M. Käsz, J. Titze, K. Kreidi, R. E. Grisenti, A. Staudte, O. Jagutzki, L. Ph. H. Schmidt, Th. Weber, H. Schmidt-Böcking, K. Ueda, and R. Dörner., Phys. Rev. Lett., 99, 153401 (2007)
[6] F. Trinter, M. S. Schöffler, H.-K. Kim, F. Sturm, K. Cole, N. Neumann, A. Vredenborg, J. Williams, I. Bocharova, R. Guillemin, M. Simon, A. Belkacem, A. L. Landers, Th. Weber, H. Schmidt-Böcking, R. Dörner, and T. Jahnke, doi:10.1038/nature12927, Nature (2013)

Prize Talk SYAW 1.3 Wed 15:00 Kinosaal

A one-dimensional liquid of fermions with tunable spin — •Massimo Inguscio — LENS & Dipartimento di Fisica e Astronomia, Università di Firenze, Firenze, Italy — INRIM Istituto Nazionale di Ricerca Metrologica, Torino, Italy — Laureate of the Herbert-Walther-Prize

Ultracold atoms offer an exceptionally rich experimental platform, allowing the most precise metrological measurements and the investigation of fundamental quantum effects in interacting many-body systems [1]. An example is given by ultracold two-electron atoms, which are used to build the most accurate and precise atomic clocks to date. The rich internal structure of these atoms also allows for novel advances in quantum simulation, for instance the investigation of large-spin atomic systems with SU(N) interaction symmetry. We will report on the realization of one-dimensional liquids of fermionic 173Yb with tunable spin, evidencing for the first time intriguing effects arising from the interplay between strong interactions and quantum statistics [2].

[1] M. Inguscio and L. Fallani, Atomic Physics: Precise Measurements and Ultracold Matter, Oxford University Press (2013). [2] G. Pagano et al., A one-dimensional liquid of fermions with tunable spin, Nature Physics (2013, accepted).

Prize Talk SYAW 1.4 Wed 15:30 Kinosaal

Non-equilibrium: from heat transport to turbulence (to life). — •David Ruelle — IHES, 91440 Bures sur Yvette, FRANCE — Laureate of the Max-Planck-Medal

We review some problems in non-equilibrium physics from the point of view of statistical physics and differentiable dynamics. Specifically, we discuss the specific mathematical difficulties which inherently underlie applications to heat transport, to hydrodynamic turbulence, and to the study of life. The microscopic dynamics of transport phenomena (in particular heat transport) is necessarily non hyperbolic, which explains why it is a difficult problem. The 3D turbulent energy cascade can be analyzed formally as a heat flow, and experimental intermittency data indicate that this requires discussing a Hamiltonian system with ~10000 degrees of freedom. Life is a non-equilibrium statistical physics phenomenon which involves chemical reactions and not just transport. Considering life as a problem in non-equilibrium statistical mechanics at least shows how complex and difficult the study of non-equilibrium can be.

SYAW 2: Awards Symposium II

Time: Wednesday 16:30–17:30 Location: Kinosaal

Prize Talk SYAW 2.1 Wed 16:30 Kinosaal

Investigation of charge transfer efficiency of CCD image sensors for the scientific small satellite mission "AsteroidFinder" — •Andrej Krimlowski — Deutsches Zentrum für Luft und Raumfahrt — Laureate of the Georg-Simon-Ohm-Prize

Im Rahmen des Projekts AsteriodFinder wurde die Ladungstransporteffizienz von EMCCD-Sensoren des Typs CCD201-20 der Firma e2v technologies PLC vor und nach Bestrahlung mit hochenergetischer Teilchenstrahlung mit einer Dosis von 1,26 10^{10} Protonen/cm^2 bei einer Temperatur von -80°C und einer Bildwiederholungsrate von 5,6 fps gemessen. Insbesondere wurde nach einer Kalibration mit der Fe-55-Methode und einer Photon-Transfer-Kurve der Einfluss einer homogenen Hintergrundbeleuchtung in der Größenordnung des Signallevels von zirka 10 Elektronen auf die durch die Teilchenstrahlung induzierten

Potentialmulden im Gitter des Detektorfestkörpers untersucht, welche die Ladungstransporteffizienz innerhalb von Detektoren erheblich hemmen. Die Messungen zeigten eine signifikante Verbesserung der Transporteffizienz um eine Größenordnung unter Einsatz der Hintergrundbeleuchtung, so dass der bestrahlte Sensor wieder ein vergleichbares Verhalten aufwies wie ein unbestrahlter Sensor gleichen Typs.

Prize Talk SYAW 2.2 Wed 17:00 Kinosaal

Metrology of atomic hydrogen: from the Rydberg constant to the size of the proton — •François Biraben — Laboratoire Kastler Brossel, ENS, CNRS, UPMC, 4 place Jussieu, 75252 Paris Cedex 05, France — Laureate of the Gentner-Kastler-Prize

The hydrogen atom has a central position in the history of 20th-century physics and hydrogen spectroscopy is associated with the successive advances in the understanding of the atomic structure. Thanks to optical frequency measurements and Doppler free techniques, several optical frequencies of hydrogen are now known with a fractional accuracy better than 10-11 and thus it is possible to extract from these data not only the value of the Rydberg constant but also the energy shift due to the finite size of the proton. The value of the proton radius extracted from hydrogen measurements (Rp=0.8764(89)fm [1]) is in agreement with the value deduced from scattering experiments (Rp=0.8791(79) fm [2]). On the contrary these values are in disagreement with the recent result deduced from the measurement of the Lamb shift in muonic hydrogen (Rp=0.84087(39)fm [3]). This discrepancy has renewed the interest in hydrogen spectroscopy. In this lecture, we present the most recent experiments and describe the analysis of the data used to deduce the Rydberg constant, the Lamb shifts and the size of the proton. We report also the recent development of our 1S-3S experiment.

1 P.J. Mohr et al, Rev. Mod. Phys. 84, 1527 (2012).
2 J.C. Bernauer et al, Phys. Rev. Lett. 105, 242001 (2010).
3 A. Antognini et al, Science 339, 417 (2013).