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.