Symposium SKM Dissertation Prize 2013 (SYSD)

jointly organized by the divisions of the SKM

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The divisions belonging to the Condensed Matter Section (SKM) of the DPG award a Dissertation Prize in 2013 again. The prize acknowledges outstanding research during the PhD work in the research areas of SKM completed in 2011 or 2012, and its excellent oral presentation. Based on nominations a jury formed by the chairpersons of all SKM divisions has selected four finalists for the award to present their work in this symposium. The winner will be selected after the symposium and publicly announced Tuesday, March 12th, in the afternoon during the ceremonial session.

Overview of Invited Talks and Sessions

(Lecture Room H2)

Invited Talks

SYSD 1.1	Mon	11:30–11:55	H2	**Morphometry and Granular Matter** — •Sebastian Kapfer
SYSD 1.2	Mon	11:55–12:20	H2	**Ultrafast Dynamics of Charge Density Wave Order in $DyTe_3$** — •Laurenz Rettig
SYSD 1.3	Mon	12:20–12:45	H2	**Structure Formation in Reconstituted Active Systems** — •Volker Schaller, Christoph Weber, Erwin Frey, Andreas R. Bausch
SYSD 1.4	Mon	12:45–13:10	H2	**Domino Day at Surfaces: An Atomistic Picture of Charge Density Wave Formation at Surfaces** — •Simone Wall

Sessions

SYSD 1.1–1.4	Mon	11:30–13:10	H2	**SKM Dissertation-Prize 2013**

SYSD 1: SKM Dissertation-Prize 2013

Time: Monday 11:30–13:10 Location: H2

Invited Talk SYSD 1.1 Mon 11:30 H2

Morphometry and Granular Matter — •Sebastian Kapfer — Ecole normale supérieure, Paris, France — FAU Erlangen, Germany

Morphometry is the theory of the quantitative description of shape. Such a framework is essential for the understanding of the relation between spatial structure and physical properties of complex materials. This talk discusses the application of the so-called Minkowski tensors to soft and granular matter; Minkowski tensors are tensor-valued shape descriptors stemming from integral geometry. With these new tools, it is possible to pinpoint the critical packing fraction for crystallization in hard-sphere packings, which is higher than the current consensus for the value of the 'random close packing' (Phys. Rev. E **85** (2012) 030301). I will also discuss the relevance of these results for the statistical mechanics picture of granular matter and further directions of study.

Invited Talk SYSD 1.2 Mon 11:55 H2

Ultrafast Dynamics of Charge Density Wave Order in $DyTe_3$ — •Laurenz Rettig — Universität Duisburg-Essen, Lotharstr. 1, 47048 Duisburg

Understanding the collective behavior connected to symmetry-breaking phase transitions and their microscopic effects is a fundamental goal in condensed matter physics. Here, especially the influence of broken symmetry and collective motions on the electronic structure is of great interest. While the underlying competing interactions are often difficult to disentangle using conventional equilibrium methods such as angle-resolved photoemission spectroscopy (ARPES), ultrafast time-resolved spectroscopies can help separating various contributions in the time domain. Here, we use femtosecond (fs) time-resolved ARPES (trARPES) to study the transient electronic band structure of the prototypical charge density wave (CDW) compound $DyTe_3$ after intense optical excitation. The time-resolved Fermi surface (FS) mapping using a novel position-sensitive time-of-flight spectrometer reveals the collapse of the CDW energy gap within 200 fs.

Furthermore, the momentum-dependent analysis of the transient occupied and unoccupied band dispersion allows for a direct measure of the time-dependent order parameter and reveals an asymmetry in the closing of the CDW energy gap, which depends on the position on the FS. This asymmetry demonstrates a transient modification of the CDW nesting condition on a fs time scale and allows insight into the microscopic orbital overlap during the transition to a state of higher symmetry. This study was supported by the DFG.

Invited Talk SYSD 1.3 Mon 12:20 H2

Structure Formation in Reconstituted Active Systems — •Volker Schaller[1], Christoph Weber[2], Erwin Frey[2], and Andreas R. Bausch[1] — [1]E27, Technische Universität München — [2]ASC and CeNS, Ludwig-Maximilians-Universität, München

The emergence of collective motion is a fascinating phenomenon. Prime examples are the flocking motion of birds and collective motion patterns in bacterial colonies. Numerous theoretical studies have been devoted to elucidate this complex self-organization process. Despite these models are able to qualitatively reproduce many of the phenomena observed in nature, a detailed verification of the theoretic predictions is still hampered by the lack of well-defined and controllable experimental systems. To close this gap, we introduce a set of reconstituted model systems that allow for a quantitative comparison between theory and experiment. The experimental systems are based on biological proteins: actin filaments, molecular motors, and crosslinking proteins.

With these setups we show that filaments that are propelled by motor proteins, above a critical density, self-organize to form collectively moving polar structures. This ordered phase is characterized by persistent density modulations and the dynamic propagation of topological defects. Besides, the ordered phase has remarkable statistical properties like the occurrence of abnormally large fluctuations in the particle density. All these phenomena were theoretically predicted but not experimentally verified so far. Finally we show that the large-scale structure formation in cytoskeletal systems sensitively depends on the microscopic properties of the crosslinker.

Invited Talk SYSD 1.4 Mon 12:45 H2

Domino Day at Surfaces: An Atomistic Picture of Charge Density Wave Formation at Surfaces — •Simone Wall — Fakultät für Physik und CENIDE, Universität Duisburg-Essen, D-47057 Duisburg — Max-Planck-Institut für Kohlenforschung, Kaiser-Wilhelm-Platz 1, D-45470 Mülheim an der Ruhr

Ultrafast time-resolved reflection high energy electron diffraction [1] was employed to investigate the dynamics of the Peierls-instability-driven phase transition on the (8×2) In/Si(111) surface. At 20K, far below the critical temperature of 90K, the (8×2)-(4×1) phase transition is electronically driven through weak excitation with a fs-laser pulse and results in a long-lasting super-cooled excited (4×1) phase. This metastable situation, far away from equilibrium, is only accessible through the excitation by the fs-laser pulse. The immediate recovery of the groundstate is hindered by an activation barrier for the motion of the atoms. The recovery of the (8×2) ground state on a timescale of 500ps is then only triggered by adsorbates that act as nucleation seeds - the same way that super-cooled water in a bottle freezes upon the insertion of seeds. With increasing density of pre-existing adsorbates the recovery to the groundstate proceeds much faster. Density functional theory calculations reveal the microscopic scenario of the phase transition, which occurs one-dimensionally along the Indium chains. The surface unit cells fall back into their ground state one at a time, like a row of falling dominoes. The phase front propagates at about 800m/s, comparable to the speed of sound [2]. [1] A. Janzen et al., Surf. Sci. 600, 4094 (2006) [2] S. Wall et al., Phys. Rev. Lett. 109, 186101 (2012)