Prize Talk PRV I Mon 12:30 H32

Absolute energy levels and interface energetics of halide perovskites — •Selina Olthof — Institute of Physical Chemsitry, University of Cologne, Luxemburger Strasse 116, 50939 Cologne, Germany — Laureate of the Gaede-Prize 2019

In recent years, the interest in halide perovskites rose at a rapid pace due to their tremendous success in the field of photovoltaics; but other fields, like light emitting diodes, show great potential as well. In such devices, the function and performance depend on the proper alignment of energy levels throughout the device, i.e. allowing for efficient charge transport across the various interfaces. Here, an advantage of these novel semiconductors is that the electronic structure and band gap can be readily tuned by changing the compositions of the perovskite. In this talk, I will discuss recent findings regarding the variations in electronic structure of halide perovskites measured by a combination of UV-, inverse, and x-ray photoelectron spectroscopy (PES); in this extensive study, we cover all primary lead and tin based halide systems. Combining these results with DFT calculations and a tight binding model we are able to consistently describe variations found in the electronic structure. However, not only the absolute energy levels of these materials are of interest, but also their alignment to adjacent transport layers, as interface dipoles and band bending can significantly alter the electronic landscape within a device. We also performed interface resolved PES studies on the MAPbI3 system. Comparing various bottom contacts we can show that chemical interactions, band bending, and interface dipole formation indeed play an important role in these perovskite systems.

Prize Talk PRV II Mon 13:15 H1

Ultimate Rayleigh-Bénard and Taylor-Couette turbulence — •Detlef Lohse — Physics of Fluids Group, Max-Planck Center Twente for Complex Fluid Dynamics & JM Burgers Center, Department of Science and Technology, University of Twente, P. O. Box 217, 7500 AE Enschede, The Netherlands — Laureate of the Max-Planck-Medal 2019

Rayleigh-Bénard flow - the flow in a box heated from below and cooled from above - and Taylor-Couette flow - the flow between two coaxial co- or counter-rotating cylinders - are the two paradigmatic systems in physics of fluids and many new concepts have been tested with them. While the low Reynolds number regime has been very well explored in the ’80s and ’90s of the last century, in the fully turbulent regime major research activity only developed in the last two decades. We will first briefly review this recent progress in our understanding of fully developed Rayleigh-Bénard (RB) and Taylor-Couette (TC) turbulence, from the experimental, theoretical, and numerical point of view and discuss transitions between different (turbulent) flow states. We will in particular focus on the so-called ultimate regime, in which the boundary layer has become turbulent, and which therefore has enhanced transport properties. In the last part of the talk we will discuss RB and TC turbulence with rough walls. There the results can be expressed in terms of the skin-friction factor, revealing analogy to turbulent flow in rough pipes.

Prize Talk PRV III Tue 9:30 Kunsthalle

Exploring Gamma-detected Magnetic Resonance Imaging — •Robin Yoël Engel — CERN, Geneva, Schweiz — C.v.O. University of Oldenburg, Germany — HS Emden-Leer, Germany — Laureate of the Georg-Simon-Ohm-Prize 2019

In 2016, the proof of principle for a new method of imaging was presented (Nature 537.7622 (2016): 652-655.), which uses many elements of traditional Magnetic Resonant Imaging, but replaces the detection of RF induction signals with that of the anisotropic gamma-emission from a hyper-polarized radioactive noble gas. Since gamma-radiation is in comparison very easy to detect, this method is sensitive to concentrations of imaged nuclei that are up to ten orders of magnitude lower than those needed in conventional MRI. Therefore, it has the perspective of combining the advantages of nuclear tracers, as they are used in SPECT and PET, with the higher spatial resolution of MRI. In addition to a software for numerical simulations of the spin precession and nuclear emission behavior during magnetic resonance experiments on hyper-polarized radioactive xenon, dedicated setups were developed. The main setup is designed for magnetic resonance experiments on hyper-polarized xenon, capable of using both the anisotropic gamma emission from radioactive nuclei as well as induction signals from stable isotopes for detection. It utilizes an existing low-field MRI-scanner and Si-PMT based gamma detectors in combination with elements from a spin-exchange optical pumping setup developed for hyper-polarized MRI on stable Xenon. This talk introduces the principle of gamma detected MRI and presents the developments within the frame of this master thesis.

Prize Talk PRV IV Tue 13:15 H1

Is room temperature magnetism possible without d or f electrons? — •Michael Coey — School of Physics, Trinity College Dublin, Ireland — Laureate of the Max-Born-Prize 2019

There are numerous reports of ’ferromagnetic-like’ magnetization curves originating from materials that do not possess the d or f electrons that are normally associated with ferromagnetic order. The data are characterized by an absence of the temperature dependence and coercivity that generally accompany magnetic order. The saturation magnetization may be orders of magnitude less than the extrapolated saturation filed. Progress towards understanding the phenomenon hinges on finding out what promotes/destroys the phenomenon. Three oxide examples are presented: CeO2 nanoparticles (La-doping/nanoparticle separation); SrTiO3 surfaces (reduction or pulverization/tiron surface treatment); nanoporous amprphous alumina (pore area/salycylic acid treatment), The data establish that surface defects are responsible. Two explanations are considered 1) a spin-split ferromagnetic defect-related impurity band and 2) giant orbital paramagnetism due to coherent electronic state associated with zero-point fluctuations of the vacuum electromagnetic field. The second seems to be more likely.

Prize Talk PRV V Wed 13:15 H1

Heat radiation at the nanoscale - Planck law and Stefan-Boltzmann law reloaded — •Svend-Age Biehs — Institut für Physik, Carl von Ossietzky Universität Oldenburg, Germany — Laureate of the Gustav-Hertz-Prize 2019

The properties of thermal radiation close to the surface of a material can deviate drastically from the well-known textbook characteristics of blackbody radiation. For example, it has been shown that thermal radiation can be quasi-monochromatic in the near-field regime, and can exhibit relatively large correlation times and lengths. Moreover, Planck’s law is no longer applicable in its usual form and needs to be generalized. Even more astonishing is the fact that the Stefan-Boltzmann law does not constitute an upper limit for the power per unit area which can be transferred between two closely spaced bodies; instead, it can be surpassed by several orders of magnitude.

In this talk, I will sketch recent experimental and theoretical advances achieved in the rapidly evolving field of nanoscale heat radiation. In particular, I will briefly discuss thermal imaging with near-field scanning thermal microscopes, peculiarities of thermal radiation between and inside of hyperbolic metamaterials, and the possibility to rectify and amplify the radiative heat flux with thermotronic devices such as diodes or transistors based on the phase-change material vanadium dioxide.

Prize Talk PRV VI Thu 13:15 H1

Spin, charge, and orbital reconstructions in complex oxide heterostructures — •Eva Benckiser — Max Planck Institute for Solid State Research, Stuttgart, Germany — Laureate of the Walter-Schottky-Prize 2019

Transition-metal oxides with strong electron-electron correlations show a variety of technologically interesting phases with sharp metal-insulator transitions, different magnetic orders, and superconductivity. In a heterostructure, the physical properties can be modified by structural distortions induced by the underlying substrate, reduced dimensionality, and interfacial reconstructions in a multilayer. For a targeted material design, a sound knowledge of the individual effects is essential. We have studied in detail such reconstructions in model systems based on rare-earth nickelates. In my talk, I will present results from our investigations of the layer-resolved orbital occupations, the unusual antiferromagnetic order and its interaction with the bond-order instability, and the possibility of layer-specific charge carrier doping.