Fachbereich Physik

GOETHE UNIVERSITÄT FRANKFURT AM MAIN

Vorträge im Physikalischen Kolloquium

Sommersemester 2017

Mittwochs 16 Uhr c.t., Hörsaal _.111 (EG), Max-von-Laue-Str. 1

19.04.2017 **Dr. Maksim Kunitski,** Institut für Kernphysik Goethe -Universität

Preisverleihung des Rudolf – Kaiser - Preises 2016für die Entdeckung des Efimov Zustandes von He3

Observation of the Efimov State of the Helium Trimer

In 1970 Vitali Efimov predicted remarkable counterintuitive behaviour of a three-body system made up of identical bosons. Namely, a weakening of pair interaction in such a system brings about in the limit appearance of infinite number of bound states of a huge spatial extent. The helium trimer has been predicted to be a molecular system having an excited state of this Efimov character under natural conditions without artificial tuning of the attraction between particles by an external field.

I will discuss the experimental observation of the Efimov state of 4He3 by means of Coulomb explosion imaging of mass-selected clusters. Helium trimers were prepared under supersonic expansion of the gaseous helium through a 5 µm nozzle. The clusters were selected from the molecular beam by means of matter wave diffraction. Each atom of a trimer was singly ionized by a strong ultrashort laser field resulting in Coulomb explosion of the cluster. The momenta, the ions acquired during Coulomb explosion, were measured by COLTRIMS. These momenta were utilized for reconstruction of the initial spatial geometry of the neutral trimer at the instant of ionization using Newton's equation of motion.

The structure of the excited Efimov state of the 4He3 is about eight times larger than that of the ground state, which is in accordance with theory. Whereas the ground state corresponds to an almost randomly distributed cloud of particles, the excited Efimov state is dominated by configurations in which two atoms are close to each other and the third one farther away.

26.04.2017 **Ass.Prof. Priv.-Doz. DI Dr. Harald Plank,** Department Head for FIB and AFM, Institute for Electron Microscopy and Nanoanalysis (FELMI) Graz University of Technology Graz Centre for Electron Microscopy (ZFE), Austrian Cooperative Research (ACR), Graz, Austria

3D Nano-Printing via Focused Electron Beams

During the last decade, Focused Electron Beam Induced Deposition (FEBID) has evolved from a new technology into a highly versatile tool for direct-write, bottom-up fabrication of high-resolution nanostructures, virtually applicable on any substrate material and morphology. This is of particular relevance as it complements situations in which traditional nanofabrication approaches (e.g. wet chemical lithography) can barely be applied. While the fundamental understanding of FEBID based fabrication for planar and bulky 3D structures has made tremendous progress in recent years, this technology also allows the fabrication of complex, freestanding 3D nano-architectures as discussed in this colloquium. First, the audience is introduced into the working principle of FEBID with strong focus on 3D fabrication including a discussion on current limitations. In the second part, we focus on new applications ranging from 3D plasmonics, gas / mass sensing concepts towards high-resolution 3D nano-probes for advanced atomic force microscopy. Finally, we give an outlook on remaining challenges with the vision to leverage this technology into the status of a predictable, generic 3D fabrication technology for entirely new applications in research and development.

03.05.2017 **Prof. Dr. Carlo Baccigalupi,** Head of Astrophysics, SISSA, Trieste, Italy

Records of Primordial Gravitational Waves in the Cosmic Microwave Background: Status, Challenges and Prospects for present and future B-mode CMB experiments

We review the mechanisms leading to Gravitational Waves imprint in the B-modes of Cosmic Microwave Background Polarization Anisotropy. We discuss the current status of measurements, and the main challenges towards future precision measurements, focusing on the diffuse polarization emission from our own Galaxy. Finally, we outline the path ahead in terms of operating and planned CMB B-mode experiments.

10.05.2017 **Dr. Paul Neumayer,** GSI Helmholtzzentrum für Schwerionenforschung Darmstadt

- Antrittsvorlesung -

Ionization Potential Depression in Dense Plasmas

Ions embedded in a plasma experience a lowering of the ionization energies, a consequence of the other charged particles perturbing the ionic potential. This ionization potential depression (IPD) can significantly affect the ionization state of the plasma. Modeling of IPD in dense, strongly-coupled plasmas remains a great challenge. In this talk, I will give a short introduction to one of the most widely used IPD models, and present recent experiments at large-scale facilities that have put its predictions to the test in plasmas at unprecedented densities.

17.05.2017 **Dr. Ulrich Schneider,** University of Cambridge, Dept of Physics, Cavendish Lab, Cambridge, Faculty of physics, Ludwig-Maximilians-Universität, Munich, Germany, Max-Planck-Institute for Quantum Optics, Garching, Germany

Many-body localization: How quantum dynamics wins against thermodynamics

The out-of-equilibrium dynamics of interacting many-body systems presents one of the most challenging problems in quantum physics with implications ranging from thermalization dynamics over transport properties to novel transient effects and the formation of order.

Traditionally, however, out-of-equilibrium dynamics was mostly confined to short transients, since typical systems would ultimately relax back into well-understood thermal states. In this talk, I will demonstrate that synthetic many-body systems offers access to intrinsically non-ergodic dynamics, where a quantum non-equilibrium system can beat thermodynamics and never relax to a thermal state.

We use ultracold atoms in optical lattices as a very versatile platform to study quantum many-body physics in a clean and well-controlled environment. One example, connected to 'classical' integrability, is the sudden expansion of hard-core lattice bosons. The second, more generic example is the experimental realization of Many-Body Localization of interacting fermions, where the presence of disorder creates a non-ergodic state that will, in a closed system, never thermalize.

24.05.2017 **Dr. Oliver Passon,** AG Physik und Ihre Didaktik der Bergischen Universität in Wuppertal

Die Geschichte der Quantentheorie: Mythen und Fakten

Das Fach Physik hat eine weitgehend ahistorische Lehrtradition, d.h. sie zielt grundsätzlich auf die Vermittlung von aktuellen Theorien und Praktiken. Die Einbeziehung historischer Aspekte reduziert sich dadurch in der Regel auf anekdotische Bemerkungen und stellt die Physik-Geschichte als zwangsläufige Entwicklung zum aktuellen Wissensstand dar. Dies führt häufig zu Verzerrungen und Mythenbildung. Whitaker (1979) hat für diese Narrative den Begriff „quasi history" geprägt. Der Vortrag stellt das Konzept der Quasi-Geschichte vor und diskutiert typische Lehrbuchdarstellungen der frühen Quantentheorie (1900-1923) als Fallstudie. Es zeigt sich, dass hier neben historischen auch fachliche Ungenauigkeiten auftreten – die Korrektur verbreiteter Mythen kann also auch einen Beitrag zur Steigerung der fachlichen Qualität der Ausbildung leisten.

31.05.2017 **Dr. Christopher Russo,** MRC-LMB, Cambridge, UK

Determining and approaching the physical limits of electron cryomicroscopy in biology

In spite of recent advances in electron cryomicroscopy (cryo-EM), the structures of many proteins cannot be determined by cryo-EM because the individual protein molecules move during electron irradiation. This blurs the images so they cannot be aligned with each other to improve the signal to noise ratio and calculate a 3D density map. I will discuss the types of movement at various length scales that occur in biological specimen during high energy electron irradiation, and show how reducing this movement leads to improved micrographs and density maps. Further, I will discuss several physical limits important to cryo-EM and how they will determine the future design of both specimen and purpose-built microscopes for biology.

07.06.2017 **Dr. John Lee Grenfell,** Dept. Extrasolar Planets and Atmospheres (EPA), German Aerospace Centre (DLR), Berlin

Atmospheric Biosignatures in an Exoplanetary Context

Searching for signs of life beyond the Earth has been a fascination since the dawn of reasoning. We begin by summarizing the challenge of defining life and its various requirements. We then overview the various approaches proposed to detect extra-terrestrial life remotely. Finally, we focus upon potential atmospheric biosignature (life-indicating) species such as oxygen, ozone and nitrous oxide and discuss the potential signals which could be detected by next generation instruments as well as some of the pitfalls when interpreting such signals.

14.06.2017 **Prof. Dr. Francesca Calegari,** Attosecond Science group DESY - Photon Science Division, University of Hamburg

Attosecond tracing of electron dynamics in bio-relevant molecules and nanoparticles

Observing electron dynamics in matter on its natural time scale requires attosecond technology. We show how isolated attosecond pulses can be used in combination with phase-stable infrared pulses to track ultrafast charge dynamics in bio-relevant molecules such as amino acids and nucleobases as well as in nanoparticles. Our results open new important perspectives for a future understanding of the role of the electronic motion in the photochemistry of complex molecules.

21.06.2017 **Dr. Ágnes Mócsy,** Department of Math and Science, Pratt Institute, Brooklyn NY

Who is doing science, who isn`t, and why?

Gender and racial diversity remains very limited in the physical sciences. Why are certain groups so under-represented? Why is it important for the scientific community to be more representative of the population at large? How can diversity be increased? In this talk, I will discuss modern understandings of challenges to diversity, like stereotype threat and unconscious bias. I will also present findings on the status of women and minorities specific to the nuclear physics community.

28.06.2017 **Dr. Alex Nielsen,** Albert-Einstein-Institut Max-Planck-Institut für Gravitationsphysik und Leibniz Universität Hannover

Gravitational wave astronomy

Gravitational waves have now been detected by the Advanced LIGO detectors. This opens up a new observational window onto many phenomena not previously visible. The collisions of black holes provide ideal laboratories for testing ideas about the behaviour of strong gravitational fields and the nature of black holes. The first observations also begin to constrain formation models of black hole binaries and their properties. Gravitational waves have the potential to detect far more than just black holes. As this new field opens up, I will provide a review of the basic physics and observational techniques employed, discuss some of the latest results and provide a glimpse into what the future of the field of gravitational wave astronomy may bring.

05.07.2017 **Prof. Heinz-Wilhelm Hübers,** Deutsches Zentrum für Luft- und Raumfahrt e.V., Institute of Optical Sensor Systems, Berlin and Humboldt-Universität zu Berlin, Department of Physics

High-resolution terahertz spectroscopy with the Stratospheric Observatory for Infrared Astronomy

Heterodyne spectroscopy is a powerful technique for high-spectral-resolution remote sensing in astronomy and atmospheric research. An emission of particular importance is the atomic oxygen (OI) fine-structure line at 4.7448 THz. This is a major cooling line of the interstellar medium and an important constituent of planetary atmospheres. The German Receiver for Astronomy at Terahertz Frequencies, on board of SOFIA, the Stratospheric Observatory for Infrared Astronomy, is the only spectrometer which can observe this line with MHz spectral resolution. The heterodyne spectrometer is based on a quantum-cascade laser as local oscillator and superconducting hot electron bolometric mixers. The design and the performance of the 4.7-THz spectrometer will be presented. In particular the QCL-based local oscillator will be discussed, because this unique laser system enables observations of the OI line for the first time. Since May 2014, the system has served on 27 successful flights leading to exciting new discoveries, for example OI in the Martian atmosphere. Some of the highlights of these observations will be presented.

12.07.2017 **Prof. Ulrich Achatz,** Institut für Atmosphäre und Umwelt, Goethe-Universität Frankfurt, Frankfurt/Main

Gravity Waves: From the Laboratory to the Atmospheric Surf Zone

Even with present and foreseeable computational capabilities, the spatial resolution of atmospheric weather-forecast and climate models is and will remain insufficient to capture many essential processes. Next to clouds and turbulence, subgrid-scale waves and their parameterization are one of the grand challenges of the field. Here, especially buoyancy-driven gravity waves are in the focus. The talk will give an overview of the fundamental properties and atmospheric impacts of these waves. It will describe the lead issues in their handling in models, and it will discuss recent developments towards their solution, ranging from laboratory experiments over theory to atmospheric modeling.