Fachbereich Physik

GOETHE UNIVERSITÄT FRANKFURT AM MAIN

Vorträge im Physikalischen Kolloquium

Sommersemester 2016

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

20.04.2016 **Dr. Felix Karbstein,** Theoretisch-Physikalisches Institut, Friedrich-Schiller-Universität Jena

Optical Signatures of Quantum Vacuum Nonlinearity in Strong Electromagnetic Fields

The quantum vacuum in strong electromagnetic fields constitutes a highly topical subject of research.

For instance, it exhibits properties of a birefringent medium and even allows for the scattering of light by light.

In this talk, I will provide you with a thorough but at the same time easily comprehensible explanation of the theoretical concepts giving rise to these phenomena.

Moreover, I will explain and highlight how these effects -- which have not yet been observed -- could soon be verified experimentally for the first time, using state-of-the-art technology.

27.04.2016 **Dr. Gergely Endrödi,** Institut für theoretische Physik, Goethe Universität, Frankfurt

Magnetized quarks and gluons on the lattice

In the extreme environment produced in heavy-ion collisions, strongly interacting matter undergoes a transition, where protons and neutrons melt and the so-called quark-gluon plasma phase is formed. Such collisions also witness the strongest magnetic fields ever produced on the face of the Earth. Besides heavy-ion experiments, strong magnetic fields also play a relevant role in the evolution of the early universe and for a class of neutron stars.

In this talk, I will introduce the basic concepts of lattice field theory and explain how this approach can be used to determine the properties of strongly interacting matter. In particular I will concentrate on how background magnetic fields affect the thermodynamics of quarks and gluons.

04.05.2016 **Prof. Dr. Eva K. Grebel**, Astronomisches Rechen-Institut, Zentrum für Astronomie der Universität Heidelberg Heidelberg

Archaeology with Galactic Building Blocks

How galaxies form and evolve are key questions of modern astrophysics. We can either attempt to observe the different phases of galaxy evolution by focusing on the distant, early universe where only the brightest (proto-)galaxies are accessible to us at low resolution. Or we can explore these questions by focusing on the stellar fossils of past epochs in the nearby universe, where we can achieve a unique level of detail. In recent years significant breakthroughs have been achieved with both of these complementary methods, providing an unprecedentedly detailed picture of galactic assembly histories.

11.05.2016 **Prof. Dr. Rainer Müller,** Physikdidaktik, TU Braunschweig

Die Wesenszüge der Quantenphysik unterrichten

Die Quantenphysik hat das Weltbild der modernen Physik wie kaum eine andere Theorie geprägt. Seit ihrer Begründung wird sie von begrifflichen Diskussionen begleitet. Sie weist viele unanschauliche Züge auf, die den klassischen Vorstellungen hochgradig widersprechen.

Im Vortrag wird das Lehrkonzept "milq" vorgestellt, in dem die begrifflichen Aspekte der Quantenphysik im Mittelpunkt stehen. Die Konzentration auf die "Merkwürdigkeiten" der Quantenphysik sind im Einklang mit der veränderten Sichtweise auf die Quantenphysik, die sich in den letzten 10--20 Jahren entwickelt hat. Die "`Paradoxien"', die früher in Gedankenexperimenten diskutiert wurden, sind inzwischen in das Stadium ihrer technologischen Anwendung gekommen (z. B. in der Quanteninformation). Hier besteht noch ein großes Entwicklungspotential für die Lehre in Universität und Schule.

18.05.2016 **Prof. Luciano Rezzolla,** Institute for Theoretical Physics, Goethe University-Frankfurt

Kolloquium zum 100. Todestag von Karl Schwarzschild

Black holes, neutron stars and gravitational waves: exploring Einstein's Universe with supercomputers

Einstein's theory of general relativity predicts the existence of compact objects such as black holes and neutron stars, whose properties are the most extreme known in physics and that can release enourmous amounts of gravitational radiation through some the most catastrophic events in the universe. I will present a virtual journey into black holes and neutron stars and explain how, with the aid of modern supercomputers, we are now able to explore the physics and astrophysics of these objects and predict the gravitational waves that they are expected to emit.

25.05.2016 **Prof. Joachim Weickert,** Fakultät für Mathematik und Informatik, Universität des Saarlandes, Saarbrücken

Image Processing and Computer Graphics with Models from Physics

Most processes in physics can be described by relatively simple laws, follow certain optimality principles, and enjoy a number of invariances. Since these properties are also desirable for most visual computing applications, it is not surprising that physics has provided fascinating inspirations for many algorithms. In this talk we will explore three applications that have been developed in our group and that rely heavily on models from physics: We use simple principles from electrostatics to designwellperforming halftoning algorithms, and we show how heat conduction can inspire novel methods for data compression. Finally we generalise concepts from drift-diffusion processes to design powerful methods for image editing. All these algorithms are highly flexible and belong qualitatively to the leading methods in their class.

01.06.2016 **Prof. Wolfgang Bauer,** Michigan State University

The Physics of Global Warming and Renewable Energies

Approximately 85% of the world power consumption of 16 TW are generated from burning fossil fuels. This results in an annual addition of 16 billion tons of carbon dioxide to our atmosphere, which in turn causes a rise in the surface temperature of Earth. We explore the physics of the radiation processes that lead to this result. In the second part we will explore how much renewable power sources can contribute to the mitigation of global warming, and at what cost.

08.06.2016 **Prof. Thomas Klinger,** Max-Planck-Institut für Plasmaphysik and Ernst-Moritz-Arndt University, Greifswald

The long way to steady state fusion plasmas - the superconducting stellarator device Wendelstein 7-X

The stable generation of high temperature Hydrogen plasmas (ion and electron temperature in the range 10-20 keV) is the basis for the use of nuclear fusion to generate heat and thereby electric power. The most promising path is to use strong, toroidal, twisted magnetic fields to confine the electrically charged plasma particles in order to avoid heat losses to the cold, solid wall elements. Two magnetic confinement concepts have been proven to be most suitable: (a) the tokamak and (b) the stellarator. The stellarator creates the magnetic field by external coils only, the tokamak by combining the externally created field with the magnetic field generated by a strong current in the plasma. “Wendelstein 7-X” is the name of a large superconducting stellarator that goes into operation after 15 years of construction. With 30 m3 plasma volume, 3 T magnetic field on axis, and 10 MW micro wave heating power, Hydrogen plasmas are generated that allow one to establish a scientific basis for the extrapolation to a future fusion power plant. It is a unique feature of Wendelstein 7-X to be able to operate high-power Hydrogen plasmas under steady-state conditions, more specifically for 1800 s (note that the world standard is now in the 10 s ballpark). This talk provides a review of the principles of nuclear fusion and discusses the key physics subjects of optimized stellarators. The sometimes adventurous undertaking to construct such a first-of-a-kind device is summarized as well. We finish with an outlook towards the fusion power station and address the most important remaining issues to be addressed in the framework of the world-wide fusion research endeavor.

15.06.2016 **Prof. Marcel Merk,** Nikhef (National Institute for Subatomic Physics), Amsterdam, NL

Flavour Physics with Beauty Particles in the LHCb Experiment

Why does nature include three generations of fundamental particles and antiparticles? Is it related to the absence of antimatter in the universe? Although the standard model of particle physics contains an asymmetry between matter and antimatter, the existence of particles or forces beyond the standard model is required to explain the cosmic absence of antimatter.

LHCb is a precision experiment searching for new physics in decays of unstable particles containing beauty quarks. These so-called flavour changing decays are a sensitive probe for possible quantum effects of new, heavy particles. After a general introduction of flavour physics and the LHCb experiment, I will present recent findings of LHCb on the topic of Charge Parity violation as well as on rare processes.

22.06.2016 **Prof. Dr. Harald Giessen,** 4. Physikalisches Institut, Universität Stuttgart

Merging micro- and nano-optics: new directions in photonics

Microoptics has a plethora of applications, ranging from miniature endoscopes in hospitals to beam shaping or imaging. 3D printing with a femtosecond laser and two-photon polymerization allows for manufacturing optical elements directly after their design with an optical CAD program on a computer, with a resolution better than 100 nm and a high accuracy and reproducibility.

The talk is showing first experimental results and discusses the different possibilities and perspectives. Triplett microscope objectives of only 100 µm diameter with excellent imaging properties, fitting into the inside of a syringe, are becoming available with this technology and can be useful for medical applications as well as for novel sensors or inspection methods.

We are going to show how these concepts can be combined with plasmonic nanoantennas and ultrathin metal films for generation of deep subwavelength nanofoci down to 60 nm.

29.06.2016 **Prof. Dr. Achilleas Frangakis**, Institute of Biophysics, Goethe-University Frankfurt

ZIP ME UP! Zooming into wound healing

In order to prevent death by bleeding or infection, every wound (skin opening) must close at some point. The events leading to skin closure had been unclear for many years.

In my talk I will elaborate on our newest technical developments in light and electron microscopy, which lead to the understanding of the molecular mechanism of this process.

We used fruit fly embryos as a model system, which similarly to humans, at some point in their development have a large opening in the skin on their back that must fuse. This process is called zipping, because two sides of the skin are fastened in a way that resembles a zipper that joins two sides of a jacket. To visualize this orchestra of healing, a very high-resolution picture of the process is needed. For this purpose we have recorded an enormous amount of data that surpasses all previous studies of this kind. We can see how cells find their opposing partner by “sniffing” each other out. As a next step, they develop adherens junctions, which act like a molecular Velcro. This way they become strongly attached to their opposing partner cell. The biggest revelation of this study was that small tubes in the cell, called microtubules, attach to this molecular Velcro and then deploy a self-catastrophe, which results in the skin being pulled towards the opening, as if one pulls a blanket over. Unexpectedly, a somehow conserved mechanism in nature.

06.07.2016 **Prof. Dr. Paolo Giubellino,** ALICE (A Large Ion Collider Experiment) CERN, Switzerland

Results and prospects of the ALICE experiment

The ALICE experiment has been designed to study strong interactions at the unprecedented energies provided by the world's most powerful accelerator: the Large Hadron Collider at CERN. ALICE has generated a wealth of results addressing soft and semi-hard QCD questions in proton-proton collisions. Yet, the most relevant results have been obtained with Heavy-Ions, the core Physics program of the experiment. The ALICE results are shedding new light on the remarkable properties of strongly interacting matter at extreme densities and temperatures, the highest ever studied experimentally. Very intriguing results have also been published also from the run with proton against lead. First results are now also coming from the new run at 13 TeV. The experiment has also a very exciting long term future: based on what has been learnt so far, a major upgrade of the experiment has been proposed, which will allow a detailed quantitative study of the properties of the Quark Gluon Plasma at the LHC: thanks to the upgrade, ALICE will be able to analyse, with much improved detail, one thousand times the amount of data collected so far. The Upgrade program progresses in parallel with data taking and analysis, making this a particularly rich moment in the life of the experiment.

13.07.2016 **Prof. Dr. Cecilia Jarlskog,** Lund University, Lund, Sweden

How does one get a Nobel Prize in Physics?

After giving some background information, I will give some examples of those who were awarded the Prize, among them Albert Einstein and Marie Curie. I will also briefly look into the future of the Prize.