Fachbereich Physik

GOETHE UNIVERSITÄT FRANKFURT AM MAIN

Vorträge im Physikalischen Kolloquium

Wintersemester 2022/2023

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

19.10.2022 Abschiedskolloquium für Prof. Dr. Ratzinger

Prof. Dr. Thomas Haberer (Heidelberger Ionenstrahl-Therapiezentrum (HIT))

Tumortherapie an Teilchenbeschleunigern: Aus dem Labor in die klinische Routine

local host: Prof. Dr. Holger Podlech | h.podlech@iap.uni-frankfurt.de

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02.11.2022 Prof. Dr. Kurt Wagemann (Dechema Gesellschaft für Chemische Technik und Biotechnologie)

Die Rolle des Wasserstoffs für ein klimaneutrales Deutschland im Jahr 2045

In den Medien, in der Politik, aber auch in der Wissenschaft existieren zwei Denkrichtungen:

- Wasserstoff wird in großem Stil in den unterschiedlichsten Anwendungsbereichen dazu dienen, auf fossile Rohstoffe zu verzichten – Wasserstoff als Enabler der Defossilisierung.
- Für Wasserstoff bleiben am Ende nur Nischenanwendungen übrig, da aus Effizienzgründen überwiegend direkt elektrifiziert wird – the all electric world.

Die Wirklichkeit des Jahres 2045 wird aller Wahrscheinlichkeit nach durch keines dieser beiden Zukunftsbilder beschrieben werden.

Der Vortrag versucht, eine neutrale Darstellung zu geben.

Ausgehend von den verschiedenen Wegen der Herstellung von klimaneutralem Wasserstoff und dessen Einsatzes in den Sektoren Verkehr, Raum- und Prozesswärme sowie Stahl und Chemie werden verschiedene Aspekte des Hochlaufes einer Wasserstoffwirtschaft dargestellt.

local host: Prof. Dr. Horst Schmidt-Böcking | schmidtb@atom.uni-frankfurt.de

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16.11.2022 **Prof. Dr. Jens Bredenbeck** (Institut für Biophysik, Goethe-Universität Frankfurt)

Molecular Vibrations - Silent Observers and Active Players

Vibrations are sensitive probes of molecular structure and dynamics. Interrogated by ultrafast infrared pulse sequences, local vibrations provide information on structure changes of molecules from the size of a few atoms to large proteins and from femtoseconds to milliseconds, which we demonstrate for the case of photoreceptor proteins.

But vibrations are also important active players in (bio-)molecular dynamics. Using a two-dimensional infrared correlation spectroscopy, we detected underdamped, THz motion of proteins proposed to enhance enzyme catalysis. Vibrations are also involved in energy transfer processes in proteins. We developed genetically encoded vibrational energy injectors and sensors to track energy transfer in proteins on the picosecond time scale on the level of single amino acids.

Excitation of vibrations can be used to manipulate molecular systems. In our VIPER (vibrationally promoted electronic resonance) 2D-IR spectroscopy, we exploit vibronic couplings to change the UV/VIS spectrum of molecular systems by mid-IR pulses. Applications are discussed from controlling chemical reactions over optoelectronics to photobiology.

local host: Dr. Benesh Joseph | joseph@biophysik.uni-frankfurt.de

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30.11.2022 **Prof. Dr. Falko Pientka** (Institut für Theoretische Physik, Goethe-Universität Frankfurt)

Particle physics in the solid state

The collective behavior of many interacting particles in solids gives rise to a wealth of fascinating phenomena. While a full theory of many particles is typically out of reach, there are usually only a few parameters relevant for the description of the low-energy material properties. It is often convenient to introduce effective quasiparticles, whose properties govern the response of the solid at low energies and which may or may not have counterparts as elementary particles in nature.

A key feature of a quasiparticle is that it cannot exist on its own, but it is intimately linked to its environment, with which it interacts. Hence, probing their properties can yield insight into the complex many-body state of the system. Moreover, as the properties of quasiparticles can be very exotic and potentially tunable, they provide excellent building blocks for novel devices.

In this talk I will discuss several examples of the sometimes surprising behavior of elementary excitations occuring in different states of matter ranging from ordinary Fermi liquids over excitons in semiconductors to topological superconductors and spin liquids. I will highlight how the peculiarities of quasiparticles can teach us about the entire system and potentially lead to new applications.

local host: Prof. Dr. Roser Valenti | valenti@itp.uni-frankfurt.de

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14.12.2022 **Prof. Dr. Sanjay Reddy** (University of Washington, USA)

Neutron Stars as Laboratories for Nuclear and Particle Physics

I will discuss efforts to interpret recent gravitational wave and x-ray observations of neutron stars. These studies have provided new insights into the sound speed in dense matter and low-temperature properties, such as its specific heat and neutrino emissivity. Neutron stars can also be excellent sites to look for dark matter. I will address how one can harness neutron star observations to constrain or discover dark matter candidates with sub-GeV masses. I will conclude by highlighting the need for next-generation gravitational wave observatories such as Cosmic Explorer and Einstein Telescope and outline their discovery potential.

local host: Prof. Dr. Jürgen Schaffner-Bielich | schaffner@astro.uni-frankfurt.de

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21.12.2022 **Festkolloquium zu Ehren von Prof. Dr. Dr. h.c. Horst Stöcker anlässig seines 70. Geburtstages**

Grußworte
Prof. Dr. Roger Erb, Dekan des Fachbereichs Physik
Prof. Dr. Michael Huth, Vizepräsident Goethe-Universität Frankfurt
Prof. Dr. Dr. h.c. Volker Mosbrugger, Stiftungsratvorsitzender des FIAS

Interludium
36 Jahre mit Horst (Reminiszenzen)

Festvortrag
Prof. Dr. John Harris (Yale University)

Umtrunk und Imbiss im FIZ
Max-von-Laue Straße, 60438 Frankfurt
(Zur Planung bitten wir um Rückantwort bis zum 25.11.2022)

local host: Prof. Dr. Dirk Rischke | drischke@itp.uni-frankfurt.de

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11.01.2023 **Prof. Dr. Camilla Juul Hansen** (Institut für Angewandte Physik, Goethe-Universität Frankfurt) - Antrittsvorlesung

Tracing the origin of the Elements using ancient stars

Chemical abundances derived from stellar spectra can be used to understand a number of physical quantities in the Universe. The origin of the elements formed after the Big Bang, heavy element nucleosynthesis, the enrichment from the First Stars, and chemical evolution of the Galaxy - these are some of the many aspects that stellar spectroscopy of old stars can help us understand. Metal-poor, old, unevolved stars are excellent

tracers as they preserve the abundance pattern of the gas they were born from. I will show how we can trace and constrain the physics of early rapid neutron-capture process events, and how we can trace the r-process observationally both directly and indirectly. Moreover, I will show how low-mass stars can help us map the nature of the long-gone First Stars and place constraints on, e.g., their mass. The low-mass stars we are analysing with world-class facilities, like the Very Large Telescope in Chile, allow us to chemically tag the early Universe at a redshift corresponding to z~7. In this quest, we have recently discovered a special carbon-rich group of stars that carry insight into the nature of the First stars.

local host: Prof. Dr. René Reifarth | reifarth@physik.uni-frankfurt.de

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25.01.2023 **PD Dr. Chuan Zhang** (GSI Helmholtz-Zentrum für Schwerionenforschung) - Habilitations-Antrittsvorlesung

Behind Efficient & Brilliant Radio-Frequency Quadrupole Accelerators

High power linear accelerators have been developed as essential tools for modern scientific research. Increasing the beam intensity, often leads to challenges from space charge effects, which are most pronounced in the RFQ (Radio-Frequency Quadrupole) accelerators due to the low beam velocity. This inaugural lecture will introduce the basic principle of RFQ accelerators and novel design approaches using dedicated emittance transfers along the RFQ.

These approaches can achieve not only efficient machines but also brilliant beams. Using examples of real RFQs developed for some recent projects, the beam physics behind these two new approaches as well as two well-known methods will be discussed.

local host: Prof. Dr. Holger Podlech | h.podlech@iap.uni-frankfurt.de

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01.02.2023 **Prof. Dr. Laura Sagunski** (Institut für Theoretische Physik, Goethe-Universität Frankfurt)

Gravitational Waves from the Dark Side of the Universe

The first ever direct detections of gravitational waves from merging black holes and neutron stars by the Laser Interferometer Gravitational-Wave Observatory (LIGO) and the Virgo detector have opened a fundamentally new window into the Universe. Gravitational waves from binary mergers are high-precision tests of orbital dynamics and provide an unprecedented tool to probe fundamental physics. Not only do they allow to test gravity under extreme conditions, but also to address the very fundamental open questions in the evolution of our Universe, namely the mysteries of dark matter and dark energy (or possible modifications of general relativity). In my talk, I will show how we can turn binary mergers into cosmic labs where we can test the very foundations of general relativity and explore the existence of new interactions and particles, like axions, which could be the dark matter.

local host: Prof. Dr. Luciano Rezzolla | rezzolla@itp.uni-frankfurt.de

08.02.2023 **Prof. Dr. Stefan Heusler** (Universität Münster)

High Tech – Low Cost: Innovative Experimente für den Physikunterricht in der Oberstufe

In der Sekundarstufe I ist Physikunterricht dadurch geprägt, dass die Lernenden die Experimente selbst durchführen. Auch in der Sekundarstufe II spielen Experimente eine wichtige Rolle - aufgrund der komplexeren und meist auch teureren experimentellen Aufbauten werden allerdings oftmals Demonstrationsexperimente bzw. Animationen, Simulationen und Videos anstelle von Schülerexperimenten gezeigt. Für die Lernenden geht so aber ein Teil der Erfahrungen verloren, die in einem selbst durchgeführten Experiment gesammelt werden können. Im Vortrag stellen wir ein Low-Cost-Experimentierset aus dem 3D-Drucker vor, welches vor allem auf Modularität, Benutzbarkeit und auf erzielbare Ergebnisqualität im Schülerversuch fokussiert. So können wichtige Experimente aus dem Bereichen Wellenoptik als Schülerexperimente angeboten werden, weiterführende Experimente zur spinabhängige Lichtemission in NVZentren, aber auch Analogieexperimente zu Quantenkryptographie, und vieles mehr. Der konkrete Einsatz dieser Experimente in der Schule wird ebenso diskutiert wie Möglichkeiten und Grenzen bezüglich verschiedener Facetten des Kompetenzerwerbs.

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