Fachbereich Physik

GOETHE UNIVERSITÄT FRANKFURT AM MAIN

Vorträge im Physikalischen Kolloquium

Sommersemester 2023

Mittwochs 16 Uhr c.t., Hörsaal _0.111 (EG), Max-von-Laue-Str. 1

03.05.2023 **Prof. Dr. Claudius Gros** (Institut für Theoretische Physik, Goethe-Universität Frankfurt)

Attention, transformer & Chat-GPT: The second galilean revolution in the making? What the hype is about.

The introduction of the attention mechanism 2014/17 initiated an AI revolution. Instead of classical deep neural networks, large language models are based nowadays on 'transformer' architectures implementing the "attention is all you need" paradigm. In this lecture an overview of state-of-the-art machine learning concepts is presented. The aim is an understanding of 'Generative Pretrained Transformers', the basis of ChatGPT. The possible functional similarity of active information routing in foundation models and in the brain is discussed. How likely is the advent of the second Galilean revolution, in this view, namely that the human brain will lose its hitherto unique position?

local host: Prof. Dr. Reinhard Dörner | doerner@atom.uni-frankfurt.de

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10.05.2023 **Prof. Dr. Malte Göttsche** (RWTH Aachen)

Physics and Nuclear Disarmament

With the Ukraine War, the threat of nuclear weapons use has re-emerged in the public debate. Today, there exist over 12,000 nuclear weapons globally, and large fissile material stocks allowing the production of many more. While the war and the political climate will not allow disarmament initiatives in the foreseeable future, the public debate has triggered a new sense of urgency. Physicists have an important role: To enable international agreements on warhead and fissile material reductions, strong verification protocols are essential to monitor compliance. New concepts and techniques will be required and must be available should a political window of opportunity open in the longer term. As they can take many years to develop, continuing this work remains crucial today. In this presentation, three elements of a possible verification toolbox will be presented. First, radiation detection techniques suited to establish the authenticity of nuclear warheads to be dismantled must be developed. Second, new concepts are required to estimate the amount of produced weapons-usable fissile materials. This is the purpose of nuclear archaeology, which attempts to reconstruct the past fissile

material production using forensic measurements in shut-down nuclear facilities and extensive simulations. Third, we discuss the detection of antineutrinos from nuclear waste as part of nuclear archaeology.

local host: Fachschaft Physik | kontakt@fachschaft.physik-uni-frankfurt.de

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17.05.2023 **Dr. Cora Uhlemann** (Newcastle University)

The Skeleton of our Universe

Cosmology has evolved from a speculative field into a precision science using large sky surveys as a laboratory for fundamental physics. From this year, the Euclid satellite and Rubin Observatory will map the distribution of galaxies across most of the sky and 10 billion years of cosmic history. They will identify billions of galaxies, estimate their distances and determine their shapes to test physics on the largest scales.

In this talk, I will take you on a journey through our Universe across the largest scales and the longest times. We will discover the large-scale skeleton of matter behind the cosmic web of structure observed in galaxy surveys. I will explain how our Universe evolved from a nearly uniform initial state into today's cosmos with rich structure from stars to galaxies and beyond. We will see how the tug of war between the gravity of dark matter and the expansion by dark energy is recorded in the cosmic large-scale structure. I will describe how we can squeeze out more information from the largest galaxy surveys by probing cosmic structures beyond the average of standard forward models and statistical analyses. This will enable us to put our physical model of the Universe and its ingredients to the ultimate test.

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

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31.05.2023 **Dr. Harald Lück** (Leibniz Universität Hannover)

The next generation of ground based gravitational wave observatories

The current "advanced" generation of gravitational wave detectors has completed an impressive series of observational runs in recent years, and will have started another data run by the time of the talk. However, the sensitivity of today's detectors, impressive as it is, only allows us to eavesdrop on sources in our cosmic neighbourhood, and not yet with sufficient precision to study the underlying physical processes in detail.

With the Einstein telescope and the Cosmic Explorer, the next generation of gravitational wave detectors is being planned. These detectors will be an order of magnitude more sensitive and extend to lower frequencies, opening up new areas and looking back to the early times after the Big Bang. This talk will give an overview of the possibilities, the plans and the difficulties to achieve this.

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

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07.06.2023 **Prof. Dr. Christoph Kulgemeyer** (Universität Bremen)

Physik erklären - was zeichnet gutes Erklären aus?

Erklären zu können, wird häufig von Schülerinnen und Schülern als zentrale Eigenschaft guter Physiklehrkräfte genannt. Aber was bedeutet es eigentlich, gut erklären zu können? Was macht also eine Erklärung mehr oder weniger verständlich? Dürfen Lehrkräfte in einem zeitgemäßen Physikunterricht überhaupt erklären oder ist es lernwirksamer, wenn sich Schülerinnen und Schüler die Physik selbst erarbeiten, z.B. anhand von Schülerexperimenten? Wie lernwirksam können dann Erklärvideos, z.B. bei YouTube, sein? Welche Fähigkeiten muss jemand haben, um gut erklären zu können - und wie fördert man die im Lehramtsstudium? Im Vortrag werden mehrere zusammenhängende empirische Studien diskutiert, die auf diese Fragen eingehen.

local host: Prof. Dr. Thomas Wilhelm | wilhelm@physik.uni-frankfurt.de

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14.06.2023 **PD Dr. Markus Röllig** (Physikalischer Verein) – Antrittsvorlesung

Disentangling star formation conditions in the era of JWST

The evolution of galaxies is driven by massive stars due to their enormous energy output during their short lifetime. Massive stars provide stellar feedback in the form of (ionising) radiation, the associated radiation pressure on dust and gas, stellar winds, and type II supernova (SN) explosions. To resolve the local impact and leakage of these feedback processes out to the galactic-scale environment, the study of local templates at high spectral and spatial resolution is required. Commonly, the regions where the radiative feedback from a massive star most strongly interacts with the surrounding gas are called photodissociation regions or photon-dominated regions (PDRs), which mark the interstellar medium (ISM) phase transition between the ionised and neutral or molecular ambient medium. Modern instruments allow a detailed study of this interface region. In combination with complex numerical models of PDRs we can disentangle the interplay between UV radiative transfer, astrochemistry and local micro-physics in the ISM.

local host: Prof. Dr. Roger Erb | roger.erb@physik.uni-frankfurt.de

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21.06.2023 **Dr. Dirk Eidemüller** (Science journalist, editor "Physik in unserer Zeit" Berlin)

Nuclear Energy - Promises and Problems

The peaceful use of nuclear power has been a promise of physicists to society since the 1950s. But since its beginnings, nuclear power has also come under serious criticism, especially after major reactor disasters like Chernobyl or Fukushima. Other aspects like uranium mining, proliferation and nuclear waste also call for a thorough examination. Using material presented in several books on these subjects I will present an overview of this highly controversial technology.

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

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28.06.2023 **Sonderkolloquium Prof. Dr. Herbert Ströbele** (anlässlich des 80. Geburtstags)

14:30 Uhr: Begrüßung, Prof. Dr. R. Erb, Dekan

Prof. R. Stock - 4 Pi-Detektoren von der Blasenkammer zur TPC

Erinnerungen und Glückwünsche

16:15 Uhr: **Prof. Dr. Claudia Höhne** (Justus Liebig Universität Gießen)

Das QCD-Phasendiagramm im Lichte von NA49, HADES und CBM

Die experimentelle Untersuchung des QCD Phasendiagramms mit Hilfe von Schwerionenkollisionen wird spätestens seit den 80er Jahren intensiv vorangetrieben. Experimente untersuchen dabei stark wechselwirkende Materie unter extremen Bedingungen bzgl. Temperatur und Dichte. Dabei lassen sich grundlegende Fragen wie die nach QCD (de)confinement, der Brechung der chiralen Symmetrie oder der Eigen-schaften von Hadronen in Materie beantworten. In diesem Vortrag beleuchten wir Ergebnisse bei moderaten Temperaturen und hohen Dichten im Lichte der Experimente NA49 und HADES sowie mit einem Ausblick in die Zukunft bei CBM.

local host: Prof. Dr. Henner Büsching | buschin@ikf.uni-frankfurt.de

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05.07.2023 **Prof. Dr. Christian Fischer** (Justus-Liebig-Universität Gießen)

Quarks & co: dynamical mass generation and restoration at finite temperature and density

The physics of the strong interaction (QCD) of quarks and gluons has profound implications for the world we live in. Almost all the mass of visible matter is generated dynamically be the strong interaction and the loss of this mechanism at large temperatures and densities is important for the physics of the early universe and dense stellar objects such as neutron stars.

In this colloquium talk we discuss the interplay of dynamical mass generation from the strong and electroweak interactions and explore the consequences for phase transitions of the strong interaction at finite temperature and chemical potential. Using a functional approach to QCD we illustrate the search for a critical end point and outline possible strategies to explore the cold and dense region of the QCD phase diagram.

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12.07.2023 **Prof. Dr. Mathias Kläui** (Universität Mainz)

Antiferromagnetic Spintronics: Spintronics without magnetic fields and Moving Electrons

While known for a long time, antiferromagnetically ordered systems have previously been considered, as “interesting but useless”. However, since antiferromagnets potentially promises faster operation, enhanced stability and higher integration densities, they could potentially become a game changer for new spintronic

devices. Here I will show how antiferromagnets can be used as active spintronics devices by demonstrating the key operations of “reading” [1], “writing” [2], and “transporting information” [3] in antiferromagnets. Beyond typical bulk and thin film systems, recently also antiferromagnetic van der Waals materials have been discovered [4], which bode particularly well for manipulation by efficient interface effects.

[1] S. Bodnar et al., Nature Commun. 9, 348 (2018); L. Baldrati et al., Phys. Rev. Lett. 125, 077201 (2020)

[2] L. Baldrati et al., Phys. Rev. Lett. 123, 177201 (2019); H. Meer et al., Nano Lett. 21, 114 (2020); S. P. Bommanaboyena et al., Nature Commun. 12, 6539 (2021);

[3] R. Lebrun et al., Nature 561, 222 (2018). R. Lebrun et al., Nature Commun. 11, 6332 (2020). S. Das et al., Nature Commun. 13, 6140 (2022).

[4] R. Wu et al., Phys. Rev. Appl. 17, 064038 (2022).

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