Großes Physikalisches Kolloquium an der Universität zu Köln

Prof. Dr. Laura Kreidberg
Max Planck Institute for Astronomy
Heidelberg

Planets are Places: Exoplanet Atmosphere Characterisation in the JWST Era

21.11.2023
16^{30} Uhr
HS III

The past 25 years have revealed a diversity of exoplanets far beyond what was imagined from the limited sample in the Solar System. With new and upcoming observing facilities and a rapidly growing number of nearby planets, we are beginning to bring this diversity into focus, with detailed follow-up characterization of the planets’ atmospheres. In this talk, I will focus on two key questions in exoplanet atmosphere studies: (1) what can we learn about giant planets' origins from their present-day atmospheres? And (2) what can we learn about habitability from “Earth cousins”, planets that are a little bigger or a little hotter than the Earth? I will provide some historical context on these two questions, share a few preliminary results from the first JWST observations of transiting planets, and conclude with a long-term perspective on exoplanet atmosphere characterization through the 2040s, including the search for biosignatures in the atmospheres of potentially inhabited planets.

Großes Physikalisches Kolloquium an der Universität zu Köln

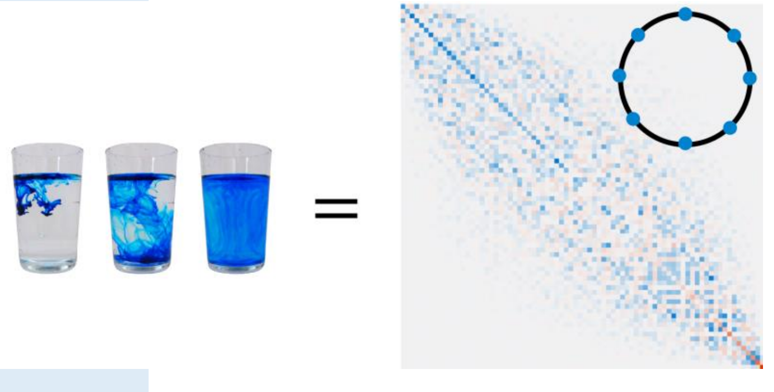
Prof. Dr. Silvia Pappalardi
Insitut für Theoretische Physik
Universität zu Köln

05.12.2023
16^{30} Uhr
HS III

Quantum Systems out-of-equilibrium: the Eigenstate Thermalization Hypothesis and Beyond

Understanding how thermal equilibrium and irreversibility arise from unitary quantum evolution is a theme as old as quantum mechanics. This question has recently been the focus of great attention due to the great experimental progress in quantum simulations, which now allow us to probe dynamics at unprecedented time scales in condensed matter physics. The current framework for understanding quantum dynamics is given by the Eigenstate-Thermalization Hypothesis (ETH). This is a simple assumption on the structure of local observables in the energy eigenbasis, that has proved to be extremely successful in describing some dynamical properties of physical Hamiltonian systems.

In this colloquium, I will discuss the recent developments in the field going beyond the standard framework. First, if one is interested in correlations of multiple times (relevant beyond linear response or to account for chaos), it becomes clear that ETH as was known is incomplete. I will introduce the full version of ETH and the emergence of Free Probability as the right tool to describe it. Secondly, I will describe the different mechanisms leading to violations of ETH and I will present long-range inter-acting systems as a remar-kable example.



Großes Physikalisches Kolloquium an der Universität zu Köln

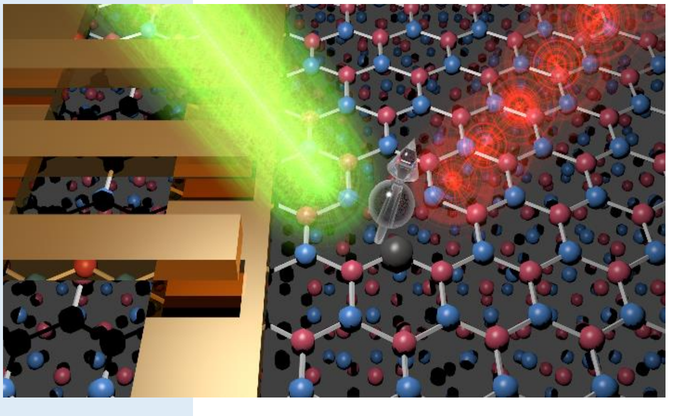
Prof. Dr. Annika Kurzmann
II. Physikalisches Institut
Universität zu Köln

12.12.2023
16^{30} Uhr
HS III

Two-dimensional materials for quantum networks

One of the major challenges for future quantum information technology is to establish a global quantum network, where different quantum systems are coupled via fiber-based single-photon channels. In such a quantum network, the analog of a bit in a classical computer, the quantum bit, has to be transferred to its optical counterpart, which is a single photon. In my talk, I will describe the main components and interfaces before discussing two-dimensional (2D) materials as a promising material platform for a quantum network.

I will discuss different promising two-dimensional (2D) materials: (i) Bilayer graphene has a high potential as a host material for so-called spin or valley qubits. In this direction, we realized the first few-electron quantum dots based on bilayer graphene, where we observed important requirements for a qubit, such as spin and valley blockade. (ii) Hexagonal boron nitride or transition metal dichalcogenides can be used as platforms for single photon emitters, promising highly coherent and indistinguishable photons, as previously shown for self-assembled quantum dots.



Großes Physikalisches Kolloquium an der Universität zu Köln

Prof. Dr. Alexandre Obertelli
Technische Universität Darmstadt

09.01.2024
16^{30} Uhr
HS III

Neutron excess in atomic nuclei

Neutron excess in atomic nuclei have challenged our understanding of nuclear structure and the properties of nuclear matter for decades: the existence of neutron droplets have been looked for 60 years, the discovery of neutron halos in neutron drip line nuclei have impulsed radioactive beam physics, nucleus with neutron excess show a shell structure different from the one of stable nuclei, while the spatial distribution of the neutron excess directly connects to the nuclear equation of state at saturation density. Rare isotope facilities have given access to the neutron-rich side of the nuclear landscape. This colloquium will focus on few of the most recent experiment results in the field: the first observation of an interacting free four-neutron system, the discovery of the 28O unbound system (8 protons, 20 neutrons), as well as the description of the new experiment PUMA (antiproton Unstable Matter Annihilation) at CERN aiming at using antimatter to investigate neutron skins at the nuclear surface.

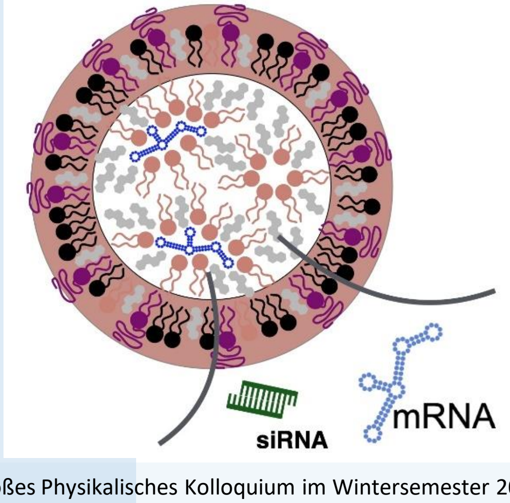
Großes Physikalisches Kolloquium an der Universität zu Köln

Prof. Dr. Joachim O. Rädler
Faculty of Physics and Center for NanoScience, Ludwig-Maximilians-Universität München

23.01.2024
16^{30} Uhr
HS III

Lipid nanoparticles (LNPs) - a soft matter perspective on programmable nucleic acid carriers

Lipid Nanoparticles (LNPs) represent the most advanced technology for delivery of nucleic acid. The particles exhibit a well-designed core-shell structure containing ordered lipid mesophases that encapsulate nucleic acid. We discuss distinct pH dependent structural transitions in bulk phases of cationic ionizable lipids (CILs) and their role in nucleic acid transfer. Using high resolution small angle X-ray scattering we elucidate the distinct role of a pH-driven transitions from inverse cubic Fd3m to inverse hexagonal HII phases.



These structural transitions are related to gene delivery activity. Gene expression time courses, taken by live cell imaging on single cell arrays (LISCA), yield delivery delay times, mRNA translation efficiency and mRNA stability. We show that understanding the content and release kinetics of lipid nanoparticles that contain multiple nucleic acid species, allows for the design of regulatory motives, e.g. feed forward loops, resulting in tailored expression kinetics.