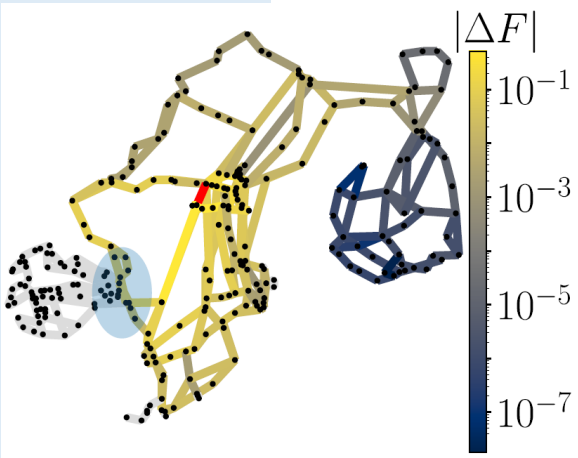
Großes Physikalisches Kolloquium an der Universität zu Köln

Prof. Dr. Dirk Witthaut
Institut für Energie- und Klimaforschung,
Forschungszentrum Jülich
Institut für Theoretische Physik, Universität zu Köln

Statistical Physics for Sustainable and Secure Energy Systems

15.11.2022
16^{30} Uhr
HS III

The mitigation of climate change requires a comprehensive transformation of our energy system. Power plants based on fossil fuel must be replaced by renewable energy sources, which challenges the operation and stability of the electric power system. In my talk, I will review the key challenges and discuss how methods and ideas from theoretical physics can contribute to their solution.



I will focus on two topics: (i) Renewable power fluctuates on many time scales, making it increasingly difficult to balance generation and load. Methods from stochastic time series analysis are essential to quantify these fluctuations and to understand their impact on power system operation. (ii) Damages of transmission and generation infrastructures are the biggest threat for system stability. Network science helps to understand how failures spread and enables the design of resilient grid structures.

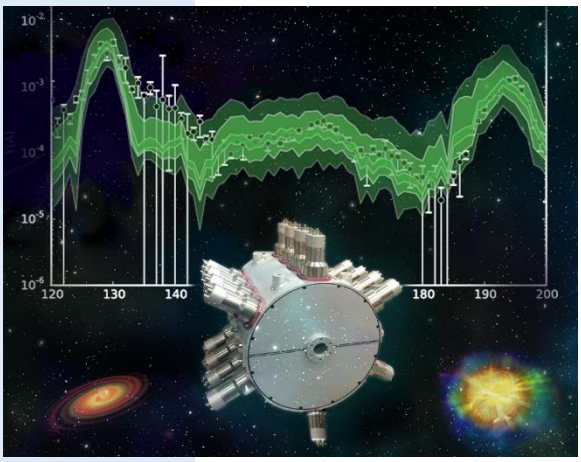
Großes Physikalisches Kolloquium an der Universität zu Köln

Prof. Dr. Artemis Spyrou
Michigan State University

The synthesis of heavy elements in stellar explosions

29.11.2022
16^{30} Uhr
HS III

Since its birth roughly 60 years ago, the field of Nuclear Astrophysics strives to provide a comprehensive description of element synthesis in the Universe. While parts of stellar nucleosynthesis are well understood, others remain elusive to this day. Especially, the production of elements heavier than iron has been one of the major open questions in the field. Multiple processes and stellar sites contribute to the complex puzzle of heavy element production. Interpreting the astronomical observations requires the understanding of the nuclear processes that drive stellar explosions. This colloquium will focus on the critical nuclear properties needed to explain heavy element nucleosynthesis.



I will discuss recent experimental results, as well as new initiatives and future plans at the next generation rare isotope facility, the Facility for Rare Isotope Beams (FRIB) at Michigan State University.

Ernst-Ising prize colloquium & Großes Physikalisches Kolloquium an der Universität zu Köln

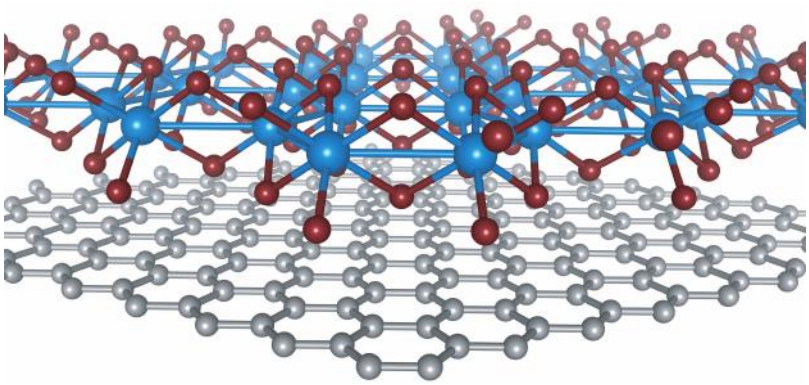
Prof. Dr. Roser Valentí
Institut für Theoretische Physik
Goethe-Universität Frankfurt am Main

10.01.2023
16^{30} Uhr
HS III

Strategies to design quantum materials with exotic properties

Unconventional superconductivity with high critical temperatures, topologically non-trivial phases, frustrated magnetism, spin-liquids or the intensively discussed Kitaev phases are a few examples of exotic states in quantum materials. One of the big challenges in quantum physics is the microscopic description of such systems. Moreover, being able to understand them implies the possibility of predicting compounds with desirable properties.

In this talk, I will present and discuss strategies for designing quantum materials from first principles and by using statistical methods, and will motivate their possible use for present technological applications.



Großes Physikalisches Kolloquium an der Universität zu Köln

Prof. Dr. Dennis Mücher
Institut für Kernphysik,
Universität zu Köln

Nucleosynthesis: The Origin of the Chemical Elements

17.01.2023
16^{30} Uhr
HS III

We are all made from nuclear matter, with carbon, nitrogen and oxygen being among the most essential to form all life on earth. Although Earth's complex organic life is dictated by the rules of biology and organic chemistry, the fact that these elements are available in large quantities is a direct consequence of their nuclear properties. Nuclear astrophysicists have a detailed understanding about how lighter elements are formed by nuclear fusion reactions in dying stars. Thus, Carl Sagan was correct when he famously said, "*We are made of starstuff.*" Fusion reactions are however not able to explain the creation of heavier elements, whose exact origin is a complex puzzle with many open questions.
In this presentation I will provide an overview about current experimental efforts in the field of explosive nucleosynthesis.

I will discuss the origin of the rare ^{60}Fe isotope detected via Accelerated Mass Spectrometry at the University of Cologne, as well as our efforts to enhance the sensitivity for detection of this key isotope in the future. I will also show recent results from Radioactive Ion Beam facilities which enable us to study neutron-rich nuclear matter, playing a pivotal role in neutron star merger events.

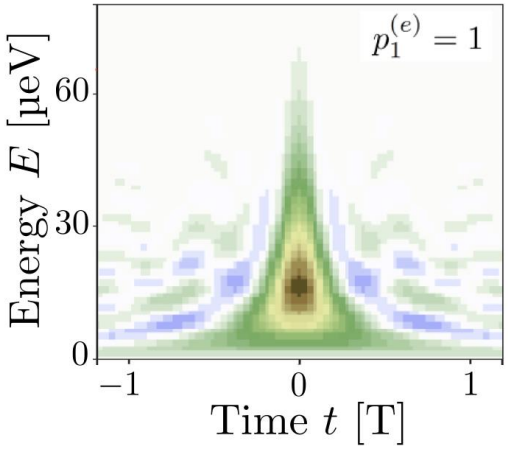
Großes Physikalisches Kolloquium an der Universität zu Köln

Prof. Dr. Erwann Bocquillon
II. Physikalisches Institut
Universität zu Köln

Topological one-dimensional conductors

24.01.2023
16^{30} Uhr
HS III

In solid-state matter, topological properties of the band structure can enforce the appearance of conducting one-dimensional edge states at the boundaries of the material, while the bulk remains insulating. These states are a fascinating playground to study the physics of one-dimensional quantum coherent conductors. They also provide a support system for 'topological quantum bits', robust against local perturbations, and envisioned to solve decoherence problems in the realization of quantum computers.
I will discuss how one can utilize GHz excitations and current correlations to generate, manipulate and study excitations in these systems down to the elementary level of single electrons.



Experimental measurement of the wavefunction of a single electron.

Großes Physikalisches Kolloquium an der Universität zu Köln

Prof. Dr. Rosalind Allen
Friedrich-Schiller Universität Jena

Statistical physics approaches to understanding how antibiotics kill bacteria

31.01.2023
16^{30} Uhr
HS III

Antibiotics are a mainstay of modern medicine, but there is huge global concern about the emergence of antibiotic resistant infections. Despite their importance, we understand surprisingly little about how antibiotics actually inhibit bacterial infections. This is a complex problem because of the interplay between antibiotic action and bacterial growth, which connects with physics via nonlinear dynamics, mechanics and stochasticity. I will discuss, with examples, how bacteria grow in different scenarios. I will further discuss how statistical physics approaches can provide new understanding of how antibiotics work in the context of growing bacteria, with implications for antibiotic resistance evolution.