Eröffnungsvortrag

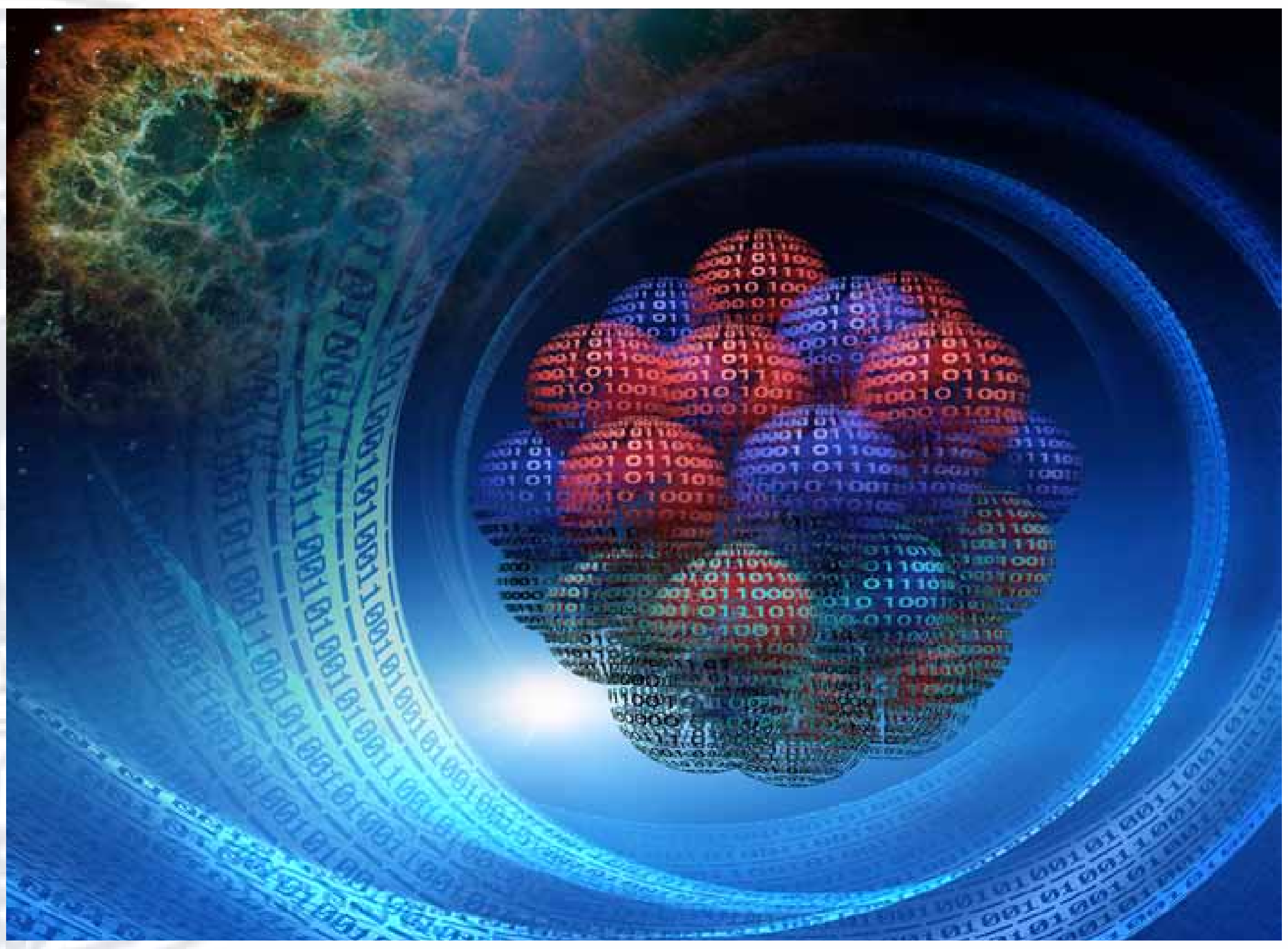
Großes Physikalisches Kolloquium an der Universität zu Köln

Prof. Dr. Achim Schwenk
Technische Universität Darmstadt

25.10.2016
16^{45} Uhr / HS III

From nuclear forces to neutron stars

The strong interaction described by quantum chromodynamics is responsible for binding neutrons and protons into nuclei and for the many facets of nuclei and dense matter in astrophysics. Combined with the electroweak interaction, it determines the properties of all nuclei in the nuclear chart in a similar way as quantum electrodynamics shapes the periodic table of elements. While the latter is well understood, it is still unclear how the nuclear chart emerges from the underlying forces. During the last decades, nuclear structure theory has made great progress on many fronts and evolved into a field with a systematic theoretical foundation, with nuclear forces based on the underlying interactions and advanced methods to solve the nuclear many-body problem with controlled uncertainties. Effective field theories have played a guiding role in this process, as they reduce the complexity of the underlying theory to the relevant degrees of freedom in a systematic way. We will discuss the advances and challenges in understanding and predicting nuclei and neutron stars based on effective field theories of the strong interaction, focusing on the special role of extreme neutron-rich systems.



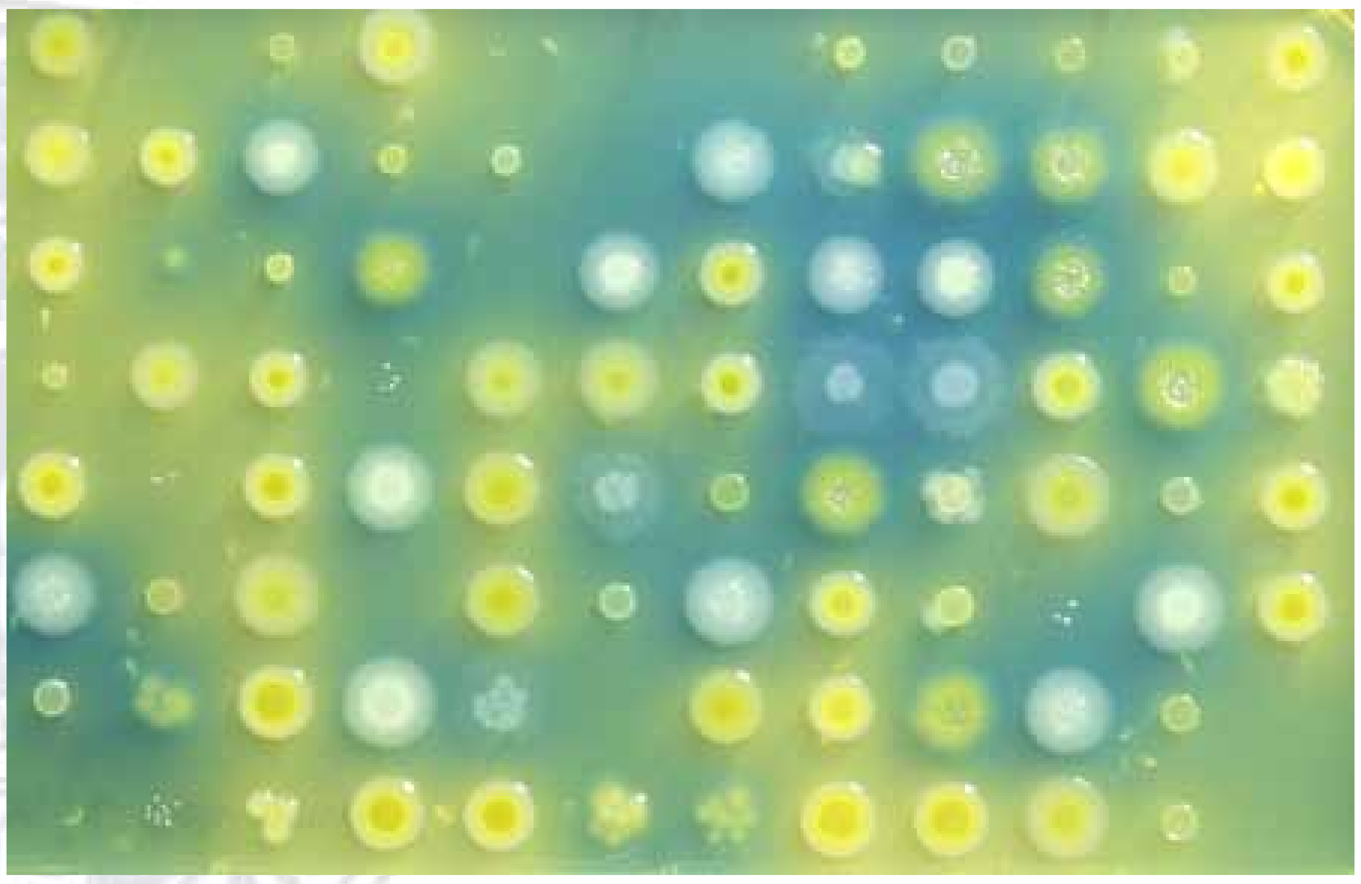
Großes Physikalisches Kolloquium an der Universität zu Köln

Prof. Dr. Tobias Bollenbach
Universität zu Köln

08.11.2016
16⁴⁵ Uhr / HS III

Quantitative approaches to antibiotic resistance evolution

The evolution of antibiotic resistance is an increasingly serious concern. At the same time, this phenomenon provides a rare opportunity to observe evolution in real time in the laboratory. The most challenging open questions in this field include how key aspects of drug resistance evolution can be predicted and how this worrying process can be slowed down or perhaps even entirely circumvented. In this talk, I will give an overview of basic research aimed at elucidating and controlling the evolutionary dynamics underlying drug resistance. Physicists have recently played a central role in tackling this problem by developing new quantitative experimental techniques and theoretical concepts. In this context, I will present recent results from my group that revealed quantitative determinants enabling partial predictions of resistance evolution. I will further discuss how drug interactions that occur when multiple antibiotics are combined can be exploited to counteract resistance. We have shown that such drug interactions obey simple scaling laws that facilitate the design of optimized multi-drug combinations. I will also discuss open challenges and how we will tackle them.



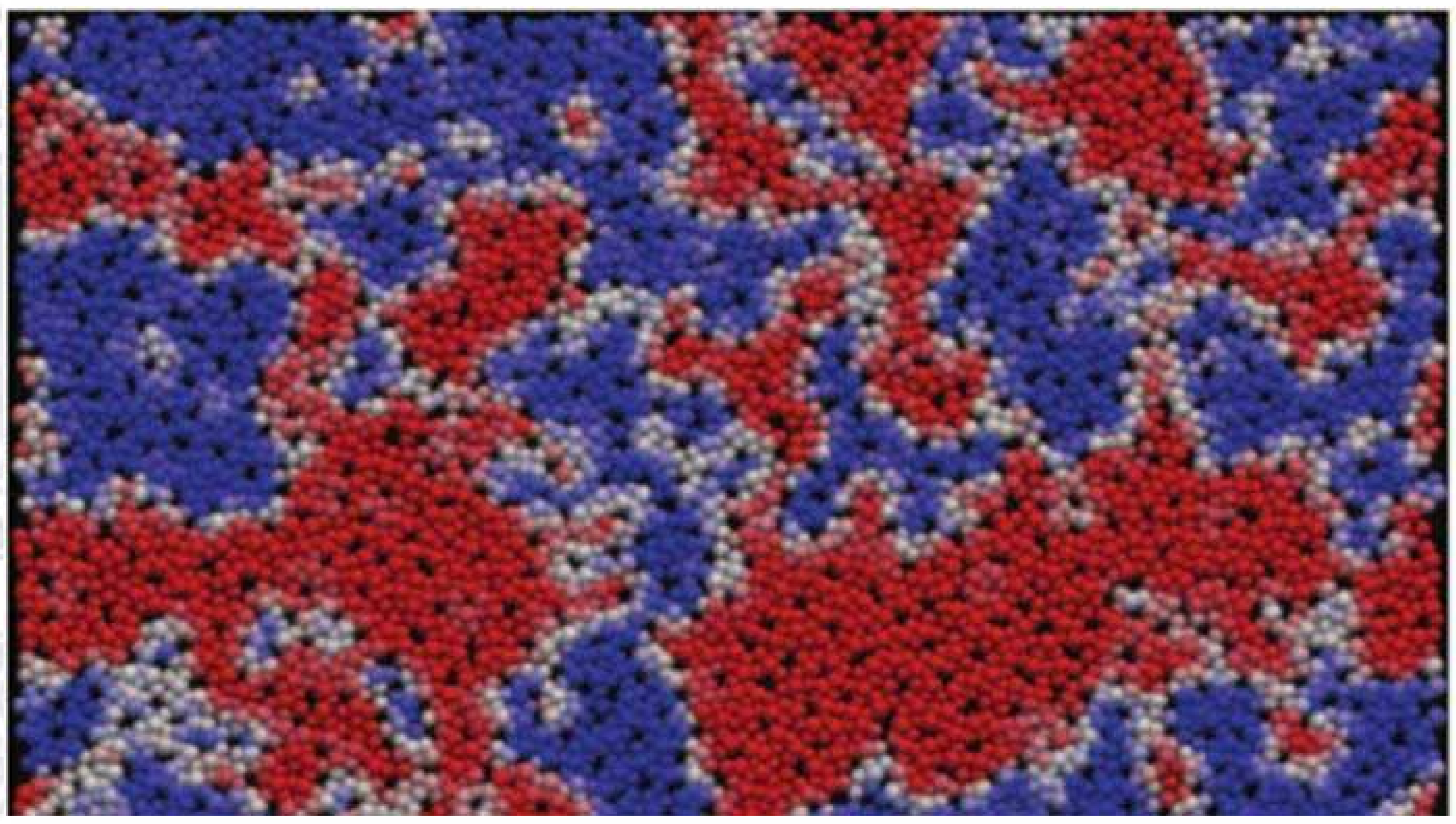
Großes Physikalisches Kolloquium an der Universität zu Köln

Prof. Dr. Giulio Biroli
Institut de Physique Théorique, CEA Saclay

22.11.2016
16^{45} Uhr / HS III

Non-Linear Responses, Soft-Modes and the True Nature of Glasses

Amorphous glassy matter is ubiquitous. It intervenes as well in everyday life as in cutting edge science: not only a lot of materials are glassy (glasses, foams, plastic) but also several systems in mathematics, computer science and biology display glassy behavior. In recent years, research has been boosted by new theoretical and experimental advances ; unifying concepts and theoretical frameworks have emerged. After a general introduction, I will present two recent results obtained studying non-linear responses. I shall show that high order non-linear susceptibilities of super-cooled liquids provide definite results on the critical behavior of the glass transition and reveal its non-standard nature. In the amorphous solid phase, the emergence of a marginally stable glass phase at low temperature leads to the breakdown of standard elasticity and diverging fluctuations of all non-linear elastic modulii.



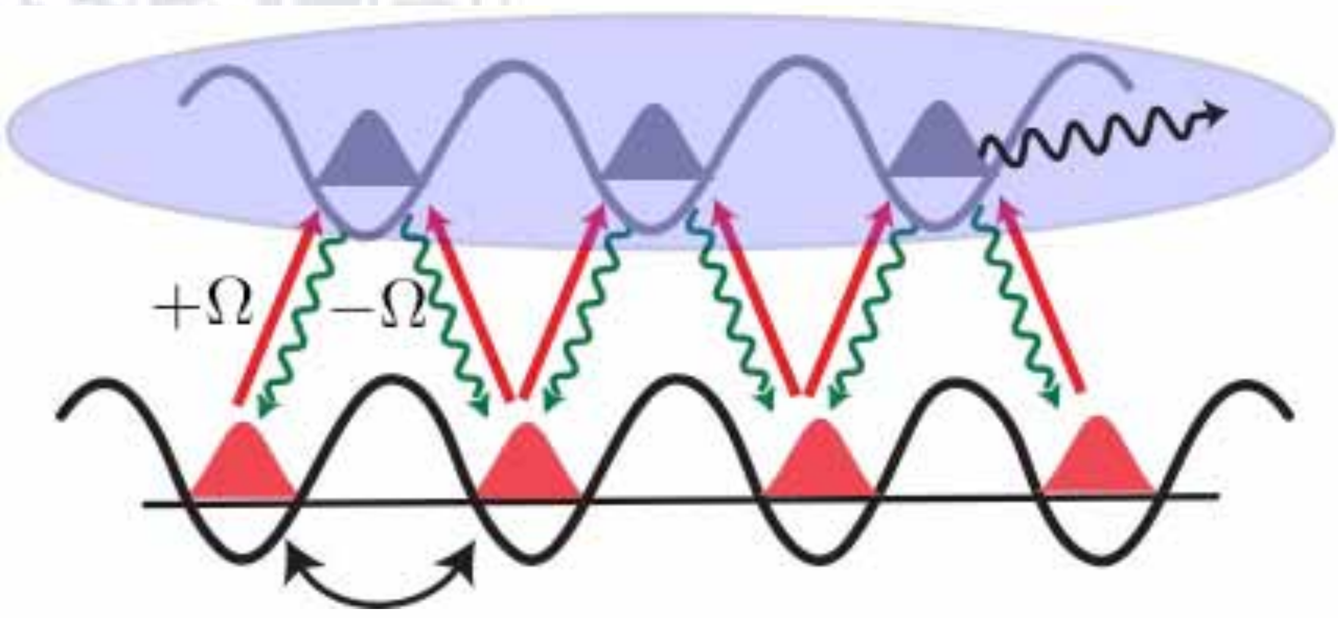
Großes Physikalisches Kolloquium an der Universität zu Köln

Prof. Dr. Sebastian Diehl
Universität zu Köln

06.12.2016
16^{45} Uhr / HS III

Driven Open Quantum Systems: From Micro- to Macrophysics

Recent developments in diverse areas - ranging from cold atomic gases over light-driven semiconductors to microcavity arrays - move systems into the focus, which are located on the interface of quantum optics, many-body physics and statistical mechanics. They share in common that coherent and driven-dissipative quantum dynamics occur on an equal footing, placing these systems far away from thermodynamic equilibrium. Harnessing the control and manipulation tools of ultracold atoms, it is possible to design controlled driven dissipative dynamics. This allows for counter-intuitive effects such as dissipatively induced long-range phase coherence. We sketch a microscopic implementation scheme, and show how this concept may open up an arena for many-body physics, realizing novel types of phase transitions resulting from competing Hamiltonian and dissipative dynamics, or dissipatively induced topological order. We then address aspects of many-body physics and statistical mechanics of driven open quantum systems, where light is strongly coupled to matter, such as realized in exciton-polariton condensates. In particular, we argue that two dimensional driven systems cannot support superfluidity and quasi-long range order, in stark contrast to thermodynamic equilibrium. Furthermore, we show that driven Bose criticality lies beyond the equilibrium classification of dynamical critical phenomena, in particular highlighting that the microscopic drive conditions bear observable though fully universal consequences even at the largest scales.



Großes Physikalisches Kolloquium an der Universität zu Köln

Prof. Dr. Andreas Burkert
Ludwig-Maximilians-Universität München

10.01.2017
16^{45} Uhr / HS III

The origin and dynamics of high-redshift disk galaxies

The redshift two Universe ist one of the most interesting epochs of galaxy evolution. It is the era with the peak of the cosmic star formation rate. Between redshift 3 and 1 the total stellar mass density in galaxies increased from 15% to 70%. It is also the time of rapid galaxy assembly and the epoch where galaxy morphology was determined. I will summarize recent observations of the SINS survey, a Spectroscopic Imaging survey of z=2 galaxies in the near infrared with SINFONI. This survey has opened a fascinating window into early galaxy evolution. The SINS data show a diversity of galactic systems at redshift 2 with physical properties that are unparalleled in the z=0 Universe. Gas-rich, extended, fast rotating and highly turbulent disks have been found with star formation rates that are a factor of 10 to 100 larger than in present-day Milky-Way type galaxies. Kpc-sized, massive gas clumps dominate the appearance of these galaxies. These giant clumps are considered to represent the progenitors of present-day globular clusters. They could provide the seeds for supermassive black holes and they might lead to the formation of young bulges in the centers of their galaxies. These fascinating and puzzling observations will be confronted with theoretical ideas and numerical simulations of gas-rich galactic disk evolution (Behrendt et al. 15, 16). I will argue that the high-redshift galaxies, like present-day disks, are in a self-organized equilibrium state with their observed extreme properties emerging naturally from self-regulated galactic evolution, controlled by gas inflow from the cosmic web.

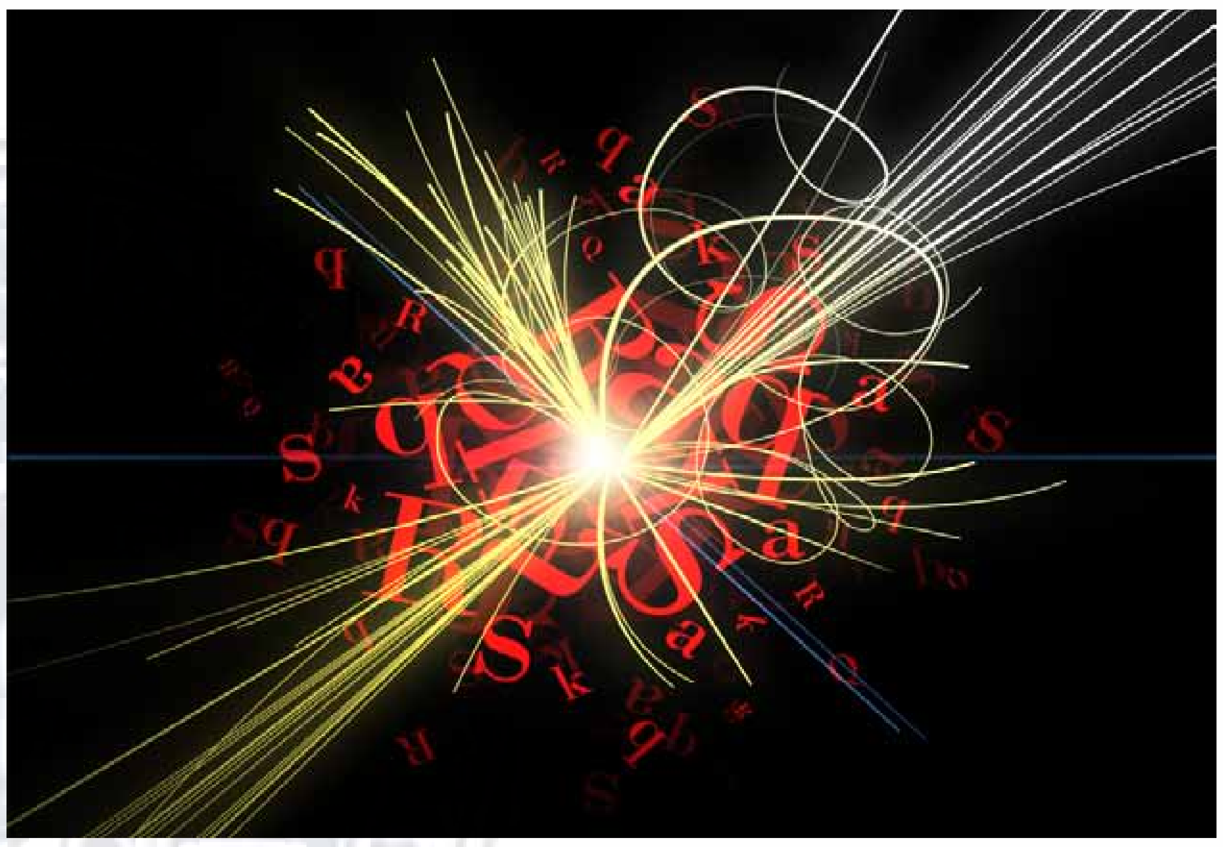
Großes Physikalisches Kolloquium an der Universität zu Köln

Prof. Dr. Klaus Mecke
Universität Erlangen-Nürnberg

24.01.2017
16^{45} Uhr / HS III

Kosmo-Poetik: Was haben Physik und Literatur sich zu erzählen?

Warum und zu welchem Ende ist es lohnenswert, sich mit den Beziehungen zwischen Physik und Literatur zu beschäftigen? Das soll im Vortrag anhand von historischen Beispiele und systematischen Analysen skizziert werden. So ist z.B. zur Zeit Johannes Keplers die Synthese wissenschaftlicher und literarischer Schreibweisen in einem Text noch denkbar: Kepler entwirft 1609 in seinem Somnium eine fiktive Mondreise, die den Kampf zwischen den miteinander konfligierenden Weltbildern inszeniert und durch allegorische, optische, narrative und wissenschaftliche Schreibverfahren der neuen astronomischen Auffassung zur Verbreitung verhilft. Mit Kepler als Vorbild reflektieren auch heute literarische Texte den Beitrag der Physik zur Kultur des 20. und 21. Jahrhunderts, so z.B. Thomas Lehrs Roman ‚42' und Raoul Schrotts Epos ‚Erste Erde'. Das Erlanger Zentrum für Literatur und Naturwissenschaft (ELINAS) widmet sich diesem interdisziplinären Austausch durch Tandemprojekte: dieses zusammen mit der Literaturwissenschaftlerin Aura Heydenreich.



Großes Physikalisches Kolloquium an der Universität zu Köln

PD Dr. Peter Thirolf
Ludwig-Maximilians-Universität München

31.01.2017
16^{45} Uhr / HS III

Direct Detection of the Elusive 229Thorium Isomer: Milestone Towards a Nuclear Clock

Today's most precise time and frequency measurements are performed with optical atomic clocks. However, it has been proposed that they could potentially be outperformed by a nuclear clock, which employs a nuclear transition instead of an atomic shell transition. There is only one known nuclear state that could serve as a nuclear clock using currently available technology, namely, the isomeric first excited state of 229Th. Since 40 years nuclear physicists have targeted the identification and characterization of the elusive isomeric ground state transition of 229mTh. Evidence for its existence until recentlz could only be inferred from indirect measurements, suggesting an excitation energy of 7.8(5) eV. Thus the first excited state in 229Th represents the lowest nuclear excitation so far reported in the whole landscape of known isotopes. Recently, the first direct detection of this nuclear state could be realized via its internal conversion decay branch, which confirms the isomer's existence and lays the foundation for precise studies of its decay parameters, in particular its half-life and excitation energy. This would pave the way towards an all-optical control and thus the development of an ultra-precise nuclear frequency standard. Moreover, a nuclear clock promises intriguing applications in applied as well as fundamental physics, ranging from geodesy and seismology to the investigation of possible time variations of fundamental constants.