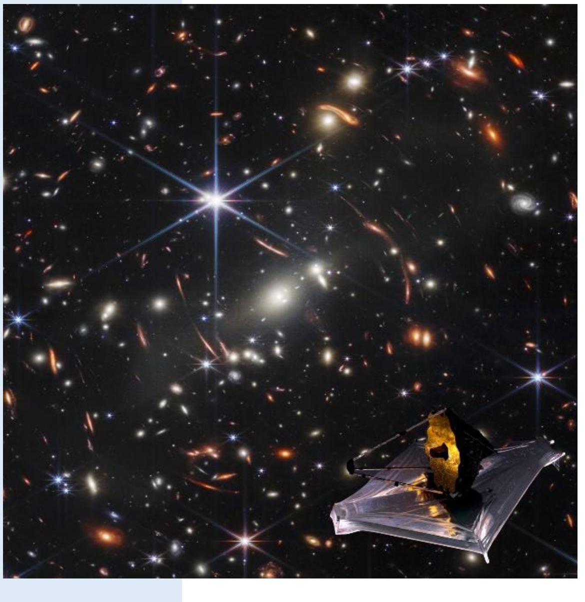
Großes Physikalisches Kolloquium an der Universität zu Köln

Prof. Dr. Pascal Oesch
Observatoire de Genève,
University of Geneva

On the Search of the First Galaxies with the JWST

25.04.2023
16^{30} Uhr
HS III

The first deep images with the James Webb Space Telescope (JWST) have transformed our view of the Universe. With its unparalleled imaging and spectroscopic capabilities, JWST finally provides deep restframe optical observations to z=10 -- a huge leap from the current z=3. Additionally, JWST immediately extended our cosmic horizon into uncharted territory, with galaxy candidates now identified out to z~14-16, only ~250-300 Myr after the Big Bang. We are thus at the brink of finding the first galaxies that ended the cosmic Dark Ages and started the reionization of the Universe.



In this talk, I will show how far we have come in understanding early galaxy build-up over the last years. I will start with the state of knowledge from three decades of Hubble and Spitzer Space Telescope datasets before JWST, and will then present an overview of our current understanding of early galaxies based on early results from the first JWST images that have become available since last summer.

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Prof. Dr. Gudrun Wolfschmidt
Hamburg Observatory
Universität Hamburg

From Classical Astronomy to Theoretical Astrophysics

02.05.2023
16^{30} Uhr
HS III

Until the 19th century, classical astronomical research was based on measuring stellar and planetary positions for compiling star catalogues, in addition, since Newton's gravitational theory also celestial mechanics, and astronomers were mathematicians. Around 1860, astronomy underwent a revolution. Instead of only studying the direction of star light, the quantity and quality of radiation were studied for the first time. This was the beginning of modern (observational) "astrophysics". The astrophysicists began to investigate the properties of the celestial bodies with physical and chemical methods. The new topics were photometry, photography, spectroscopy/spectralanalysis, and solar physics.

The next step was the introduction of theoretical astrophysics around 1900. Karl Schwarzschild (1873-1916), born 150 years ago, started with observational astrophysics by introducing photographic photometry. With his pioneering research as director of Göttingen and Potsdam observatories, he introduced new theoretical topics like solar physics, theory of stellar atmospheres, stellar structure, and Einstein's General Theory of Relativity. He achieved the breakthrough of the Hertzsprung-Russell-Diagram (HRD), developed independently by Ejnar Hertzsprung (1873-1967) in 1905, and Henry Norris Russell (1877-1957) in 1910/12. The HRD is essential for the discussion of stellar evolution. Modern theoretical astrophysics began through the inclusion of the important new physics in astronomy.

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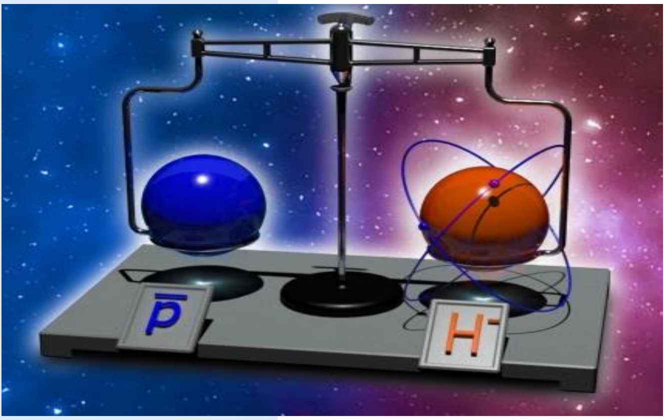
Prof. Dr. Klaus Blaum
Max-Planck-Institut für Kernphysik,
Heidelberg, Germany

9.05.2023
16^{30} Uhr
HS III

Precision Tests of Fundamental Interactions and Their Symmetries using Exotic Ions in Penning Traps

The four fundamental interactions and their symmetries, the fundamental constants as well as the properties of elementary particles like masses and moments, determine the basic structure of the universe and are the basis for our so well tested Standard Model (SM) of physics. Performing stringent tests on these interactions and symmetries in extreme conditions at lowest energies and with highest precision by comparing e.g. the properties of particles and their counterpart, the antiparticles, will allow us to search for physics beyond the SM. Any improvement of these tests beyond their present limits requires novel experimental techniques.

An overview is given on recent mass and *g*-factor measurements with extreme precision on single or few cooled ions stored in Penning traps. On the one hand, mass measurements provide crucial information for atomic, nuclear and neutrino physics as well as for testing fundamental interactions and their symmetries. On the other hand, *g*-factor measurements of the bound electron in highly charged hydrogen-like ions allow for the determination of fundamental constants and for constraining Quantum Electrodynamics. For example, the most stringent test of CPT symmetry in the baryonic sector could be performed by mass comparison of the antiproton with the H^- ion and the knowledge of the electron atomic mass could be improved by a factor of 13. Our latest results on precision measurements with exotic ions in Penning traps will be presented.



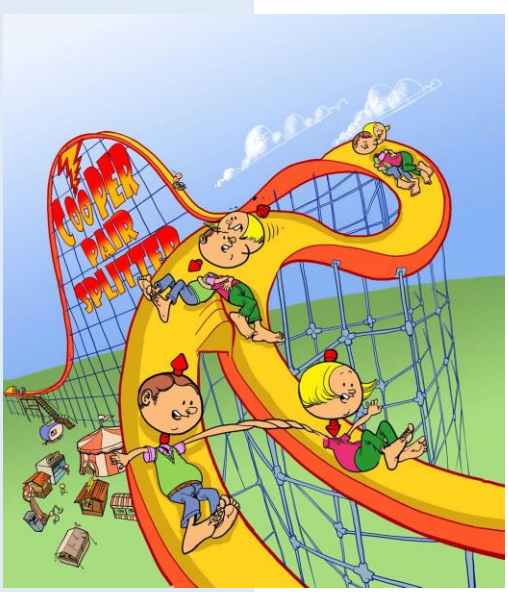
Großes Physikalisches Kolloquium an der Universität zu Köln

Prof. Dr. Christian Schönenberger
Department of Physics
Swiss Nanoscience Institute
University of Basel

16.05.2023
16^{30} Uhr
HS III

Cooper pairs are nice, but split ones are even nicer! Why it is important to "unpair" a Cooper pair

An elegant concept for the creation of entangled electrons in a solid-state device is to split Cooper pairs by coupling a superconductor to two parallel quantum dots in a Y-junction geometry. Cooper pair splitting (CPS) was investigated in recent years in devices based on semiconducting nanowires and carbon nanotubes. I will first review these experiments and demonstrate that high splitting efficiencies > 90% can be achieved.



A high CPS efficiency is a prerequisite for Bell state measurements, a clear way of proving that Cooper pairs can be extracted coherently, leading to spatially separated entangled electron pairs. My aim is to present a journey in research that started around 12 years ago in my lab. It shows how scientific research evolves, where one often takes detours and where one constantly must reflect the finding in the lab based on either physical intuition (simple minded models) or, if available, good theory.

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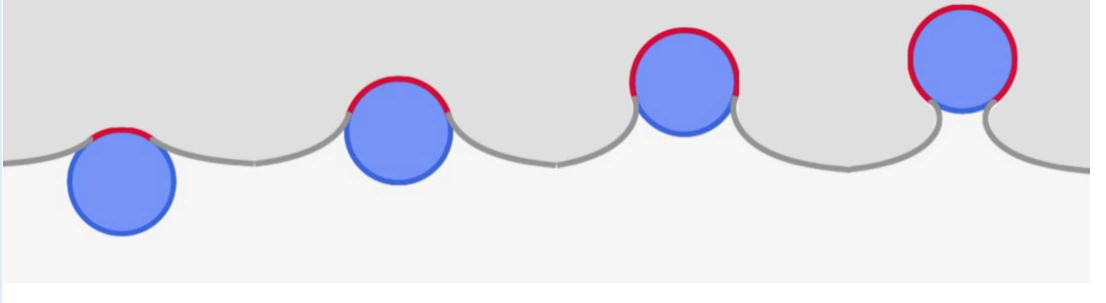
Prof. Dr. Ulrich Schwarz
Heidelberg University

Physics of viruses

6.06.2023
16^{30} Uhr
HS III

Physical law imposes important constraints for virus structure, replication and spread. Here we discuss how it can help to better understand the different stages of the viral life cycle. Most viruses use a spherical protein shell to protect their genome; its assembly has to avoid kinetic trapping and malformed structures, a process that can be analyzed with statistical models for self-assembly. Many viruses, including SARS-CoV-2, influenza A and Ebola, are in addition wrapped by a membrane which anchors the glycoproteins attaching them to the host cells. Continuum models can be used to identify the physical limits of the entry process, including the minimal size and typical time required for entry. For enveloped viruses, the most critical step in the life cycle is the opening of a fusion pore, to release the genome into the host cell. Continuum models can be used to calculate the corresponding free energy landscape and to identify strategies to prevent this last step of the infection.



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Prof. Dr. Dima Abanin
University of Geneva
Google Quantum AI

Non-equilibrium matter through the prism of quantum entanglement

4.07.2023
16[30] Uhr
HS III

Remarkable experimental progress in quantum simulation enabled studies of non-equilibrium phenomena in interacting quantum systems. Bringing quantum matter out-of-equilibrium is a tool to engineer desired properties, but theoretically poses a major challenge, due to the exponential growth of computational complexity. I will overview theoretical progress in describing non-equilibrium quantum matter, based on quantum entanglement. In particular, I will describe mechanisms to avoid thermalisation, which lead to coherence protection and enable non-equilibrium phenomena not envisioned within statistical mechanics. Understanding spatial and temporal entanglement out-of-equilibrium suggests new efficient computational methods and provides a unifying principle for classification of non-equilibrium phases.