Prize Talk PV I Mon 10:30 AudiMax

Exotic atoms: from fundamental tests of strong field quantum electrodynamics to nuclear and astrophysical applications — •Paul Indelicato — Laboratoire Kastler Brossel, Sorbonne Université, Campus P. et M. Curie, 4 Place Jussieu, Paris, France — Laureate of the Gentner-Kastler-Prize 2026

Atoms where an electron is replaced by a heavier particle like the muon or an antinucleus like antiprotons are called exotic atoms. Because of the large mass of the particle, they allow to test bound state quantum electrodynamics (BSQED) in very strong fields. One can then study transitions between circular Rydberg states of such atoms to test BSQED without influence from the nucleus. Lower levels allow to do nuclear physics or strong interaction physics. A new kind of detectors, microcalorimeters have resolutions ≈ 200 times better than the Ge detectors used in the past, which allows for high precision x-ray energy measurements. They have been used on muonic atoms to test BSQED and to measure light nuclei charge radius. Test of BSQED in antiprotonic atoms are performed at the ELENA ring at CERN. It may be possible in the future that antideuterium atoms may also be observed at ELENA. Atoms with heavier antinuclei could be present in cosmic rays, following decay of dark matter. Their x-rays could be detected using detectors flying on balloons in the atmosphere like GAPS (General AntiParticle Spectrometer).

In my talk I will present results of advanced calculation, using all-order vacuum polarization for several kind of exotic atoms and exact finite size corrected self-energy for muonic atoms. I will then compare to recent measurements and possible future observations.

Plenary Talk PV II Mon 11:00 AudiMax

Why the Invention of the World Wide Web was no Coincidence: Scientific Culture and Technological Innovation at CERN, 1972-1991 — •Barbara Hof — Université de Lausanne, Switzerland

How does the development of the Web look when examined through the lens of the history of physics? What factors contributed to this computing invention, which became a public success only in the 1990s, and to what extent can its development be attributed to international collaboration and existing technical infrastructures? My talk explores why CERN's unique blend of international data exchange, a culture of open science, and cutting-edge accelerator research made it the ideal breeding ground for a universal information system. I argue that, long before the creation of the Web application, CERN had already established a robust infrastructure of networked computers and the corresponding expertise. These conditions, born out of the necessity of exchanging experimental physics data both within CERN and across institutional and national borders, were crucial to the Web's development. Drawing on original archival materials, I will trace the evolution of networking at CERN from the early 1970s to the creation of the Web two decades later. The history of the Web also prompts reflection on the broader role of developing applications in and for physical research, as well as the pursuit of practical solutions. These factors are relevant to physics and its history far beyond the invention of the Web.

Plenary Talk PV III Mon 11:45 AudiMax

Copernicus Revisited: is the Earth special? — •Laura Kreidberg — Max Planck Institute for Astronomy, Heidelberg, Germany

Nearly 500 years ago, Nicolas Copernicus published his disruptive theory that Earth is not the center of the universe. This "Copernican demotion" has held fast over the centuries, as astronomers have learned that there is nothing particularly remarkable about Earth or even the Milky Way. In the last two decades, however, a new test of the Copernican Principle has emerged – the discovery of an abundance of planets orbiting other stars. These discoveries allow us to put Earth in context and evaluate whether the formation, architecture, and present-day characteristics of our Solar System are in fact typical. Thanks to the revolutionary capabilities of the James Webb Space Telescope (JWST), we are finally able to study other Earth-size planets in detail, and in particular search for and characterize their atmospheres. In this talk, I will give a status report on JWST observations of rocky planets. I will cover the latest results for the iconic TRAPPIST-1 system, the study of the surface of the airless planet LHS 3844b, the search for atmospheres on lava worlds, and observations of planets in the radius valley at the boundary of rocky and gaseous worlds. Taken together, these results provide a first picture of the building blocks available for the origin of life on terrestrial planets beyond the Solar System, providing essential context for how special Earth really is.

Plenary Talk PV IV Tue 9:00 AudiMax

Basics of plasma technologies: examples for applications and diagnostics — •Holger Kersten — Kiel University, IEAP, 24098 Kiel

Gas discharges involving surface phenomena have been studied for more than 250 years (1). Classification of discharge modes was initially based on their visual appearance and later by their current-voltage characteristics. Oscillating or pulsing of power supplied, involvement of magnetic fields, effects of electrode material and geometry etc. make the situation more complicated (2). Effects like secondary electron emission, thermionic emission, drifts in magnetic fields, gas heating, flow pattern and collision processes affect the discharge mechanisms which are important for various plasma-based applications in thin film deposition or plasma etching as well as in plasma fusion or electric space propulsion.

In order to optimize the related processes suitable diagnostics for the plasma bulk as well as for the sheath in front of solid surfaces are necessary. Among them, methods for flux measurement of charged and neutral species toward plasma-facing surfaces by probes are of special interest. In addition to well-established conventional probe diagnostics also the principles of non-conventional diagnostics as calorimetric probes (CPs) and force probes (FPs) will be discussed (3).

(1) J. Cipo, H. Kersten, ViP 30(2018), 34-42.
(2) A. Anders, Appl. Phys. Rev. 11(2024), 031310.
(3) J. Benedikt, H. Kersten, A. Piel, PSST 30(2021), 033001.

Plenary Talk PV V Tue 9:45 AudiMax

Invariants of Topological Order: An Operator-Algebraic Approach — •Yoshiko Ogata — Research Institute for Mathematical Sciences, Kyoto University, Kyoto 606-8502 JAPAN

Recently, topological phases of matter have attracted significant attention in physics and mathematics. In this talk, I will explain the operator-algebraic approach to this subject. This approach allows us to treat infinite systems directly. A key benefit of considering infinite systems is that it provides a stable theory. In particular, this framework enables us to describe quasi-particle excitations, known as anyons, as invariants in the classification of topological order, in a mathematically rigorous way. I will also present recent developments within this framework.

Ceremonial Talk PV VI Tue 14:00 AudiMax

The Higgs boson - Deciphering its nature at present and future colliders — •Karl Jakobs — Physikalisches Institut, University of Freiburg

After the discovery of the Higgs boson at the Large Hadron Collider (LHC) at CERN, particle physics has entered a new era. With the successful data taking at the LHC over the past decade, many properties of this particle have been measured and found to be in agreement with expectations from the Standard Model. Despite this, important questions of particle physics, such as the nature of dark matter and the origin of the matter-antimatter asymmetry in the universe, remain open and call for experimental exploration. The Higgs field itself is linked to deep structural questions of the Standard Model such as flavour, naturalness and the stability of the vacuum. Probed with highest precision at the quantum level, the Higgs boson may hold the key to shed light on some of these questions and to build a bridge between particle physics and cosmology.

In this talk, the role of the Higgs boson in the Standard Model and our present understanding of its properties are discussed. The largely increased accuracy expected to be reached at the High-Luminosity LHC and at the proposed next-generation Future Circular Collider at CERN will turn the Higgs boson into a precision tool. Measuring its self-interaction, rare decays, and couplings with unprecedented accuracy provides high sensitivity to physics beyond the Standard Model and may provide a giant leap forward in the understanding of nature.

Prize Talk PV VII Tue 15:00 AudiMax

Between fascination and abstraction. Is it possible to teach modern physics at high-schools? — •Matthias Bartelmann — Institute for Theoretical Physics, Heidelberg University — Laureate of the Robert-Wichard-Pohl-Prize 2026

Since this talk is related to the Robert Wichard Pohl Prize, which is awarded also for the conveyance of physics, let me take the opportunity to speak about some sore points in physics education and a possible approach to a solution. Undeniably, high-school teachers are decisive for instilling fascination for, or raising disgust against physics

in formative years. If we want to pass our fascination for physics on to further generations, teaching teachers must be among our most important objectives. But modern physics is necessarily developing towards higher degrees of abstraction whose mathematical expression is more and more remote from the mathematics available at high-schools. Consequently, the fascination for modern physics is often lost at high-schools, physics is mistaken for an application of formulae appearing out of the blue, and essential ideas characteristic for physics do not appear. But is it possible to teach the most fascinating aspects of modern physics without having its mathematical foundation available? In this talk, I intend to argue that this is indeed possible. For this purpose, I will describe and discuss a lecture series recently introduced and tested at Heidelberg University. The lecture consists of three parts, one experimental, one theoretical, and one on timely applications. I will focus on the theoretical part, which is arguably the most difficult, and describe its motivation, ideas, structure, and summarize part of its contents.

Evening Talk PV VIII Tue 19:00 AudiMax
Zu Wasser, zu Eis und in der Luft: Astroteilchenphysik mit Gammastrahlung und Neutrinos — •Claudio Kopper und •Christopher van Eldik — Naturwissenschaftliche Fakultät, Friedrich-Alexander-Universität Erlangen-Nürnberg, Erlangen, Germany

1.000.000.000.000.000 Elektronenvolt: Diese unvorstellbar hohe Energie erreichen geladene Teilchen in den „kosmischen Beschleunigern“ unserer Milchstraße - eine weit höhere Energie, als der zur Zeit größte durch Menschen gebaute Teilchenbeschleuniger LHC ermöglicht. Welche Himmelsobjekte sind für dieses Phänomen verantwortlich? Wie funktionieren diese Beschleuniger?

Mit speziellen Gammastrahlung-Teleskopen in Namibia und Chile und Neutrino-Observatorien im Mittelmeer und dem antarktischen Eis gehen Erlanger Forscher diesen Fragen auf den Grund. Sie finden dabei ein Universum vor, das völlig anders aussieht, als die Betrachtung des Sternenhimmels mit dem bloßen Auge vermuten lässt.

Plenary Talk PV IX Wed 9:00 AudiMax
Status and perspectives for science at FAIR (Facility for Antiproton and Ion Research) — •Thomas Nilsson — GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany

The international FAIR project is currently rapidly developing from the construction phase towards the delivery of cutting-edge science. The installations within the scope of the FAIR2028 stage will soon serve a large international community in nuclear, hadron, atomic and plasma physics, as well as material science and biophysics, offering new, world-unique opportunities. With our accelerators and lasers, we will recreate and study some of the most extreme conditions found in Nature - the Universe in the lab.

The scientific groundwork has been laid through the intermediate FAIR Phase-0 programme at the existing GSI infrastructure, where new and upgraded instrumentation and beams for FAIR have been utilized for science. Thus, the international collaborations are poised for the imminent exploitation of the new facility.

The status of the FAIR project will be reported, focusing on the path towards and beyond the first scientific experiments, underpinned by selected results from the FAIR Phase-0 programme. Furthermore, an outlook on the next phases of science at FAIR will be presented.

Plenary Talk PV X Wed 9:45 AudiMax
Precision at the Energy Frontier: What the LHC is revealing about Fundamental Particle Physics — •Ludovica Aperio Bella — DESY, Hamburg, Germany

The Large Hadron Collider (LHC), the most powerful particle accelerator ever built, has opened an unprecedented window onto the fundamental laws of nature. Across the vast set of results published by its major experiments (ATLAS, CMS, LHCb and ALICE), the Standard Model (SM) remains the most successful framework for describing the elementary constituents of matter and their interactions. Historically, precise relations among SM parameters enabled the prediction of the top-quark mass and placed stringent constraints on the Higgs boson long before their discoveries.

Today, thanks to the extraordinary volume and quality of LHC data, precision measurements of key SM parameters have become central to the LHC physics program. These measurements provide some of the most sensitive tests of the internal consistency of the SM and offer unique opportunities to uncover deviations that could signal new physics.

This talk will present recent high-impact results from the LHC collaborations, highlighting landmark measurements that have achieved unprecedented precision and discussing their implications for the structure of the SM and the broader physics landscape. Prospects for the High-Luminosity LHC era will also be outlined, where an order-of-magnitude increase in data will enable even more stringent tests.

Evening Talk PV XI Wed 19:00 AudiMax
Lise-Meitner-Lecture: Gravitational wave astronomy – quo vadis? — •Michèle Heurs — Leibniz Universität Hannover, Hannover, Germany — Deutsches Zentrum für Astrophysik (DZA), Görlitz, Germany — Deutsches Elektronen-Synchrotron DESY, Zeuthen, Germany

Since the first direct detection of gravitational waves (GWs) in 2015, we have opened an entirely new observation window into the Universe (complementary to the electromagnetic spectrum, neutrinos, and cosmic rays), heralding the era of multi-messenger astronomy with GWs. A wealth of scientific insights has already been gained – but so much more is yet to be discovered!

The sensitivity of current GW detectors is so incredible that the quantum noise of the employed ultra-stable laser light would be limiting. This necessitates the use of non-classical (“squeezed”) light, which is already routinely employed in the current (second) generation of detectors, e.g., aLIGO and AdVirgo. Many additional noise sources, such as seismic and thermal noise, pose further challenges for future (third-generation) detectors, e.g., the Einstein Telescope, a planned underground GW observatory in Europe.

To learn more about our Universe, we must achieve ever-higher detection rates for meaningful GW astronomy, which requires ever-greater detection sensitivity and larger detection bandwidth. In my talk, I will introduce the principle of interferometric GW detection, highlight some of the advanced technologies (employed and under development), and shed light on the plans for future interferometric GW observatories.

Plenary Talk PV XII Thu 9:00 AudiMax
AI in the context of medical images — •Stefan Wesarg — Fraunhofer Institute for Computer Graphics Research IGD, Darmstadt, Germany

AI is transforming how medical image data is used for diagnosis and therapy of diseases. Most prominently, it can help in uncovering complex patterns in radiology that exceed human perception or speed up the analysis of such data. Current machine learning approaches will be covered by focussing on their applications to medical image data. This includes diagnosis, disease monitoring, and early detection. Key themes include methods for organ and lesion segmentation, analysis of multimodal imaging data, and integrating image-based features with clinical information to create robust decision-support systems. The abstract also addresses AI-driven prosthetics development based on image data. Finally, we will outline challenges such as generalization and implementation in real-world workflows.

Plenary Talk PV XIII Thu 9:45 AudiMax
LISA: The first space-based gravitational-wave observatory — •Guido Mueller — Max Planck Institute for Gravitational Physics (Albert Einstein Institut), Hannover, Germany — Leibniz Universität Hannover, Germany — University of Florida, Gainesville, FL USA

Since their first detection, gravitational waves (GWs) have become a central pillar of current and future efforts to study the Universe. Ground-based observatories have opened a new observational window, allowing us to detect GWs from mergers of neutron stars and black holes with masses up to a few hundred solar masses.

The first space-based gravitational-wave observatory, the Laser Interferometer Space Antenna (LISA), will extend these observations to the millihertz band, the natural frequency range of sources involving massive black holes with masses of millions of solar masses. In 2024, LISA was adopted by ESA as its next L-class mission, with a launch anticipated in the mid-2030s. The mission is currently progressing through its preliminary design reviews, consolidating the overall design and paving the way toward full implementation.

In this plenary talk, I will discuss the science case for LISA, introduce the mission concept, highlight the key technological challenges, and outline the roadmap from engineering models to flight hardware.

Evening Talk PV XIV Thu 20:00 AudiMax
Max-von-Laue-Lecture: My journey in Nuclear Physics –

Quantum Chromodynamics and the threat of nuclear annihilation — •David Gross — University of California, Santa Barbara