**Plenary Talk** PV I Mon 9:00 RW 1

**Femtosecond Technology: From Timing of X-ray Free-Electron Lasers to Attosecond Science and Fusion Lasers** — •Franz Kärtner — Deutsches Elektronen-Synchrotron DESY, Center for Free-Electron Laser Science CFEL, Hamburg, Germany — Universität Hamburg

X-ray Free-Electron Laser (XFEL) facilities are combined accelerator and ultrafast laser laboratories that have triggered the development of many advanced ultrafast laser technologies. Here, we review the pulsed optical timing and synchronization of large-scale XFELs based on the low jitter of femtosecond lasers. This technology has been commercialized and is used to time ESA's Deep Space satellite tracking network. Tight synchronization and phase measurement devices have been developed to generate sub-cycle optical waveforms from power-scalable parametric waveform synthesizers. This system has been used to identify optimized waveforms for efficiently generating isolated attosecond pulses in the water window range of up to 450 eV. Direct waveform measurements and simulations reveal that this enhancement arises from sub-femtosecond shaping of the dominant optical cycle. This shaping maximizes phase-matched single-atom emissions and mitigates plasma-induced dephasing. To power scale such parametric waveform synthesizers and generate high-energy terahertz radiation, we developed highly efficient cryogenic Yb:YLF laser technology. It turns out that this technology can be scaled to hundreds of joules of energy at a repetition rate of 10-20 Hz, making it a potential candidate for inertial confinement fusion lasers.

**Plenary Talk** PV II Mon 10:30 RW 1

**Universal scaling laws in the coherence decay of polariton Bose Einstein condensates** — •Jacqueline Bloch — Center for Nanoscience and Nanotechnology, Paris-Saclay University/CNRS, 10 bd Thomas Gobert, 91120 Palaiseau, France

Cavity polaritons, hybrid light-matter quasiparticles emerging from the strong coupling between photons confined in cavities and excitonic excitations [1] provide a powerful platform to explore the *physics of Bose Einstein condensation in a driven dissipative context.* In 2015, it was discovered that under certain excitation conditions, the phase dynamics of a polariton condensates is governed by the celebrated Kardar Parisi Zhang (KPZ) equation [2-6]. This means that the spatio-temporal coherence decay should reveal universal KPZ scaling laws. The full phase diagram of these out of equilibrium condensates was then explored theoretically both in 1D [7] and 2D [8] and the very existence of a KPZ phase in 2D is a highly debated topic.

In the present talk, after a general introduction about polariton condensates, I will review experimental investigations of their coherence properties. I will describe our experimental demonstration of KPZ universal behavior in 1D [9] and then discuss our recent interferometry experiments realized in 2D. Depending on the strength of the non-linearity in the system (that can be varied changing the detuning between the exciton resonance and the cavity mode), different scaling laws in the spatio-temporal decay of the coherence are revealed. Our results hints toward a cross over between a diffusive Edward Wilkinson regime and a superdiffusive KPZ regime.

This work highlights the profound difference between driven-dissipative out of equilibrium condensates and their equilibrium counterparts.

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[2] M. Kardar, G. Parisi, Y. C. Zhang, Phys. Rev. Lett. 56, 889 (1986)
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[7] F. Vercesi et al., Phys. Rev. Research 5, 043062 (2023)
[8] F. Helluin et al., Phys. Rev. Research 7, 033103 (2025)
[9] Q. Fontaine et al, Nature 608, 687 (2022)

**Lunch Talk** PV III Mon 13:15 RW 1

**Why Diversity Makes Better Physics** — •Ulrike Boehm[1] and •Karoline Irschara[2] — [1]Carl Zeiss AG, Oberkochen, Germany — [2]Institute for Quantum Optics and Quantum Information, Innsbruck, Austria

Studies have repeatedly demonstrated that diverse teams lead to increased creativity, productivity and innovation - a phenomenon that can be observed in both academic and industrial settings. However, substantial gender imbalances persist in physics: Although the number of women studying physics in Central Europe has grown steadily over the last years, they remain underrepresented at senior levels. In Germany, for example, women hold only 12% of physics professorships, which is clearly too low a proportion to constitute a critical mass.

This keynote will present recent data on gender representation in physics, examine the factors driving these disparities and explain why diversity is essential for the scientific community and beyond. We will showcase best practices and introduce atom*innen, a new interactive platform designed to support and connect women and gender minorities in quantum physics. We will conclude by outlining concrete measures to strengthen inclusion and equal opportunities throughout the physics community.

**Discussion** PV IV Mon 13:15 P 1

**Why publish – and where? DPG's and IOP's own journal, its authors, and its role** — •Carol Clark[1], •Frieder Lindel[2], •Berthold-Georg Englert[3], •Dieter Weiss[4], and •Andreas Buchleitner[5] — [1]IOPP, Bristol — [2]ETH Zürich — [3]Beijing Institute of Technology — [4]Universität Regensburg — [5]Albert-Ludwigs-Universität Freiburg

The scientific publishing landscape experiences rapid changes and serious challenges – induced and posed by running science as a competitive market, by the multiplication of scientific journals and alternative communication channels, and, most recently, by the advent of continuously improving tools provided by artificial intelligence. The New Journal of Physics (NJP), as a joint endeavor of the Deutsche Physikalische Gesellschaft (DPG) and the Institute of Physics (IOP), has to navigate these rather troubled waters, and can successfully do so only with the commitment of both societies' active scientists.

After a short introduction, we want to engage into a debate on the above challenges, on the future of scientific publishing, and, in particular, on the authors' motivation(s), frustrations, and expectations. An interactive fishbowl format will involve diverse perspectives, initially from the stage, then from the audience, contemplate the role of scientists at different stages of their career, and the constructive role which NJP, backed by IOP's and DPG's leader- and membership, can fulfill.

**Plenary Talk** PV V Tue 9:00 RW 1

**From reactors to stars: Decoding nuclear histories from tiny grains of matter** — •Michael Savina — Lawrence Livermore National Laboratory, Livermore CA, USA

Nuclear reactors, whether in terrestrial facilities or the cores of stars, induce profound changes in the isotopic and elemental composition of matter. The high specific activity of spent fuel from nuclear reactors makes handling macroscopic quantities problematic, while in the case of stars only microscopic stardust grains have survived the journey to Earth and are available for study. Therefore in both cases one is trying to reconstruct the irradiation history of the material from a handful of tiny particles. This places a premium on extracting maximum information from minimal material.

Over the past 30 years, my international colleagues and I have advanced a form of laser-based mass spectrometry known as resonance ionization mass spectrometry (RIMS) to tackle these so-called "atom-limited" analyses, in which one cannot purify or isolate the elements of interest. These unique instruments have given us insights into the conditions inside nuclear reactors, as well as the creation of elements in stars. I will briefly discuss the basic science behind the technique, highlight the important knowledge gained from these tiny and often precious samples, and describe how the knowledge gained over the years has enabled us to embark on the design and construction of a new generation of instruments designed to move RIMS from boutique to routine. LLNL-ABS-2015057

**Plenary Talk** PV VI Tue 9:45 RW 1

**Identifying old ice and water with single-atom counting** — •Zheng-Tian Lu — University of Science and Technology of China, Hefei, China

The long-lived noble-gas isotope $^{81}$Kr is the ideal tracer for old water and ice with ages of 0.1 - 1 million years, a range beyond the reach of $^{14}$C. $^{81}$Kr-dating, a concept pursued over the past six decades, is now available to the earth science community at large. This is made possible by the development of the Atom Trap Trace Analysis (ATTA) method, in which individual atoms of the desired isotope are captured and detected. ATTA possesses superior selectivity, and is thus far used to analyze the environmental radioactive isotopes $^{85}$Kr, $^{39}$Ar, $^{41}$Ca, and $^{81}$Kr. These isotopes have extremely low isotopic abundances in the range of $10^{-17}$ to $10^{-11}$, and cover a wide range of ages and applications. In collaboration with earth scientists, we are dating groundwater and mapping its flow in major aquifers around the world, and dating old ice from the deep ice cores of Antarctica, Greenland, and the Tibetan Plateau. For an update on this worldwide effort, please google "ATTA Primer".

### Prize Talk PV VII Tue 14:00 RW 1

**Assembling quantum matter one atom at a time: Many-body physics with arrays of Rydberg atoms** — •Antoine Browaeys — Institut d'Optique, CNRS, 2 avenue A. Fresnel, 91120 Palaiseau, France — Laureate of the Herbert-Walther-Prize 2026

Over the last twenty years, physicists have learned to manipulate individual quantum objects: atoms, ions, molecules, quantum circuits, electronic spins... It is now possible to build "atom by atom" a synthetic quantum matter. By controlling the interactions between atoms, one can study the properties of these elementary many-body systems: quantum magnetism, transport of excitations, superconductivity... and thus understand more deeply the N-body problem. More recently, it was realized that these quantum systems may find applications in the industry, such as finding the solution of combinatorial optimization problems.

This talk will present an example of a synthetic quantum system, based on laser-cooled ensembles of individual atoms trapped in microscopic optical tweezer arrays. By exciting the atoms into Rydberg states, we make them interact, even at distances of more than ten micrometers. In this way, we study the magnetic properties of an ensemble of more than a hundred interacting 1/2 spins, in a regime in which simulations by usual numerical methods are already very challenging. Some aspects of this research led to the creation of a company, Pasqal.

### Prize Talk PV VIII Tue 14:50 RW 1

**Complex scattering systems: from non-Hermitian topology to neuromorphic computing** — •Clara Wanjura — Max Planck Institute for the Science of Light, Staudtstraße 2, 91058 Erlangen — Laureate of the Gustav-Hertz-Prize 2026

Recent experimental advances allow us to realise complex optical systems that can be explored for quantum science and technological applications, ranging from sensors based on optomechanical systems harnessing the interaction between light and mechanical vibrations to analogue computing systems based on nanophotonics. In my talk, I will discuss two different kinds of complex scattering systems enabled by these advances.

In the first part, I will discuss a notion of topology only arising in systems exhibiting gain and loss and how these systems can be harnessed to devise quantum devices such as quantum-limited directional amplifiers and sensors, e.g., based on cavity optomechanics. Specifically, we have shown that this notion of non-Hermitian topology corresponds one-to-one with the phenomenon of directional amplification, which is highly sought-after for applications including quantum information processing. Non-Hermitian topology is also a resource for sensing as we recently demonstrated in an optomechanical system.

In the second part, I will discuss our work on neuromorphic computing systems based on optical scattering. Neuromorphic computing is born out of the demand for more energy-efficient hardware for machine learning and artificial intelligence. As such, neuromorphic computing aims to replace or complement our digital hardware with analogue physical neural networks. In particular, I will show how one can perform fully non-linear neuromorphic computing with a purely linear scattering system. This approach greatly simplifies the experimental requirements on neuromorphic hardware platforms and can be widely applied in existing state-of-the-art scalable platforms, such as optics, microwave and electrical circuits.

### Plenary Talk PV IX Tue 15:35 RW 1

**The Activities of the WE-Heraeus Foundation for Early Career Researchers** — •Jürgen Mlynek[1] and •Klaus Richter[2] — [1]Chairman of the Board of the WE-Heraeus Foundation — [2]President of the DPG

Jürgen Mlynek, Chairman of the Board of the WE-Heraeus Foundation, and Klaus Richter, President of the DPG, present activities to support young scientists – some jointly like Leading for Tomorrow, others by the foundation alone like the Research Fellowships or the Parliament Fellowships. The basis for the long-standing and fruitful cooperation between the foundation and the DPG, and thus ultimately also for these activities was laid by long-standing Chairman Dieter Röss, who recently passed away and whose important role for the foundation and beyond will be remembered.

### Ceremonial Talk PV X Tue 15:50 RW 1

**How one, two and many atoms scatter light** — •Wolfgang Ketterle — Massachusetts Institute of Technology

Scattering of light is one of the most elementary processes for atoms and is discussed in many textbooks. We have performed several light scattering experiments which reveal fundamental quantum aspects. At ultralow temperatures, light scattering is suppressed or enhanced by Pauli blocking and bosonic stimulation, respectively. Light scattering can distinguish a superfluid from a Mott insulator. We have experimentally investigated whether light is coherent and incoherent when scattered by single atoms. For two atoms confined to less than 50 nm, we have observed a novel stimulated dipole-dipole interaction, and large momentum transfers exceeding ten photon recoil when single photons are emitted.

### Plenary Talk PV XI Wed 9:00 RW 1

**Quantum Processors and Quantum Networks Atom-by-Atom** — •Hannes Bernien — University of Innsbruck and IQOQI, Innsbruck, Austria

Reconfigurable arrays of neutral atoms have emerged as a leading platform for quantum science. Their excellent coherence properties combined with programmable Rydberg interactions have led to intriguing observations such as quantum phase transitions, the discovery of quantum many-body scars, and novel quantum computing architectures.

Here, I will look forward to what is next for atom arrays. In particular, I am going to introduce a dual-species Rydberg array, that naturally lends itself for measurement-based protocols such as quantum error correction, long-range entangled state preparation, and measurement-altered many-body dynamics. The second atomic species is used as an auxiliary qubit to measure and control the primary species. In a first demonstration of this architecture, we use an array of cesium qubits to correct correlated phase errors on an array of rubidium data qubits. Rydberg interactions between the two species then lead to novel regimes, including greatly enhanced resonant dipole interactions, that we use to demonstrate a two-qubit gate and quantum non-demolition readout. Finally, we realize quantum cellular automaton dynamics with only global control.

An important step for atom arrays will be the scaling beyond a single processing module. I will describe a modular quantum network architecture and will present a node that combines large atom arrays with arrays of photonic interfaces at telecom wavelength.

### Plenary Talk PV XII Wed 9:45 RW 1

**Passive 300 Attosecond Pulses and the Breakdown of the Single Active Electron Approximation** — •Paul Corkum[1], Dong Hyuk Ko[1], and Graham Gardiner Brown[2] — [1]Joint Attosecond Science Laboratory, University of Ottawa and National Research Council Canada, 25 Templeton Street, Ottawa, Ontario, Canada K1N 6N5 — [2]Max Born Institute, Max-Born Straße 2A, D-12489 Berlin, Germany

When one irradiates a system with intense infrared light, an electron can tunnel. Usually, but not always, the hole stays in place. If the hole is static, only one electron is involved, but, in xenon, we create a superposition of states in the ion. Any coherent superposition of states describes a hole wave packet that moves through the atomic core. Any imbalance in the superposition also creates a static hole.

Using the perturbed trajectory measurement method we observe the spin-orbit motion in the emitted radiation. Surprisingly, we find that even the very high frequency light (that gains cross section from the 4D giant plasmon resonance) shows spin-orbit wave packet dynamics. The timing is shifted from the timing of radiation where there is no hole motion, but only by a small amount.

The most important observation is that the ion contributes substantially to the photon energy of these 90 eV photons. The ion contribution can even exceed the recollision electron's kinetic energy at the moment of recollision.

### Discussion PV XIII Wed 20:00 RW 1

**Quantum Fundamentals and Technologies – what comes next?** — •John Doyle[1], •Wolfgang Ketterle[2], •Ferdinand Schmidt-Kahler[3], •Andreas Buchleitner[4], •Immanuel Bloch[5], •Jürgen Mlynek[6], •Gereon Niedner-Schatteburg[7], and •Dieter Meschede[8] — [1]Harvard — [2]MIT — [3]Johannes Gutenberg-Universität Mainz — [4]Albert-Ludwigs-Universität Freiburg — [5]Max Planck Institut für Quantenoptik, München/Garching — [6]Chairman of the Board of the WE-Heraeus Foundation, Berlin — [7]RPTU Kaiserslautern-Landau — [8]Universität Bonn

Quantum technologies have received substantial public recognition as a candidate for transforming science, technology and ultimately societies with new opportunities ranging from sensing to secure communication to quantum computing. While in the past driven mostly by academic institutions the expectation of an economic impact has prompted large companies to heavily invest into this field. In this discussion round we will address questions including: Where do we expect the first big impact? What are the most serious obstacles to be overcome? Where is the role of future academic research? And more.

**Plenary Talk** PV XIV Thu 9:00 RW 1

**Optical Coherence Tomography: From First Experiments to Clinical Impact** — •Wolfgang Drexler — Zentrum für Medizinische Physik und Biomedizinische Technik, Medizinische Universität Wien, Währnger Gürtel 18-20 / 4L

Since its first experimental demonstrations, Optical Coherence Tomography (OCT) has evolved into one of the most powerful imaging modalities in medicine. This talk traces the technological and translational journey of OCT over more than three decades, highlighting the dramatic advances in axial and lateral resolution, imaging speed, and tissue penetration that have transformed the technique from a laboratory curiosity into a clinical cornerstone. Progress in light sources, detection schemes, and system engineering has enabled real-time, micrometer-scale visualization of tissue microstructure in vivo. Beyond structural imaging, functional extensions such as Doppler OCT, OCT angiography (OCTA) and dynamic contrast OCT as well as transverse resolution enhancing adaptive optics (AO) OCT have opened new windows into blood flow, microvasculature, cellular-scale morphology, and tissue dynamics. Integration with multimodal microscopy and multimodal endoscopy has further expanded the reach of OCT across organ systems and clinical applications. Most notably, OCT has become the gold standard for ophthalmic diagnosis, fundamentally changing clinical practice and largely replacing ultrasound for retinal and anterior segment imaging. The OCT story exemplifies how sustained innovation and close interaction between physics, engineering, and medicine can lead to profound and lasting clinical impact.

**Plenary Talk** PV XV Thu 9:45 RW 1

**Ultracold polyatomic molecules for quantum science** — •John Doyle — Harvard University, Cambridge, USA

Nineteenth century physics and chemistry, in particular spectroscopy, laid the groundwork for the development of quantum mechanics. The richness of molecular spectra was at the same time beautiful and bedeviling, leading to models of wave resonances and vortices in molecules. Today, detailed spectroscopy has given us full quantum control over small molecules. We can now hold single polyatomic (CaOH) molecules in optical tweezer arrays and have developed new qubits. This approach embodies one of the themes in the continuing development of quantum research in this century - the taming of increasingly complex quantum objects and the assembly of fully controllable engineered quantum systems. I will also describe our work in Metrology-based Particle Physics, where we are using cold and ultracold molecules to search for new CP-violating physics beyond the Standard Model, in the mass range >10 TeV, and to search for ultralight Dark Matter.

**Lunch Talk** PV XVI Thu 13:15 RW 1

**Perspectives on the use and abuse of power in academia** — •Jutta Stahl — University of Cologne, Germany

Abuse of power in academia is currently the focus of intense public and academic debate. Several media reports on specific cases have raised serious concerns. While some observers frame these incidents as unfortunate individual exceptions, others argue that they reflect broader, systemic problems. Empirical work documents various forms of misconduct linked to power abuse, systemic weaknesses and the often severe consequences for those affected.

This talk discusses both individual and systemic causes of power abuse especially from a psychological perspective. A central systemic factor is the steep hierarchical structure of academia and the multiple dependencies it creates, for example through fixed term contracts, grading authority, and information asymmetries. However, comprehensive systemic analyses show that these problems are embedded in an even more complex interplay of several factors. Against this backdrop, the talk outlines measures at different levels - individual, institutional, and structural - that are needed to reduce these risks and to foster a productive, respectful, and physically and mentally healthy academic work environment. The presentation and subsequent discussion will address concrete options for prevention, intervention, and cultural change in academic institutions.

**Evening Talk** PV XVII Thu 20:00 RW 1

**Quantentechnologien für Klima und Umwelt: Unsere Ozeane, unser Eis, unser Trinkwasser – wenige Atome verraten Alter** — •Markus Oberthaler — Kirchhoff-Institut für Physik, Universität Heidelberg

Quantentechnologien gelten als Schlüsseltechnologien der Zukunft, da sie revolutionäre Fortschritte in den Bereichen Kommunikation, Sensorik und Informationsverarbeitung versprechen. Bislang gibt es nur wenige Beispiele, in denen Quantentechnologien bereits heute wissenschaftliche Fragen beantworten. In diesem Vortrag geht es um ein solches Beispiel: eine Quantentechnologie, mit der sich die Frage beantworten lässt, wie alt das Wasser ist, das wir trinken, wie alt das Gletschereis ist, auf dem wir stehen, und wie viel anthropogenes $CO_2$ bereits im Ozean gespeichert ist.

Um die „Uhr“ von Wasser und Eis zu lesen, wird die Methode der radiometrischen Datierung verwendet. Dafür muss jedoch auf extrem seltene Isotope wie 39Ar zurückgegriffen werden – nur ein Atom unter $10^{15}$ Argon-Atomen. Das erfordert Konzentrationsbestimmungen auf dem Niveau einzelner Atome. Genau hier setzt die quantentechnologische Methode der Atom Trap Trace Analysis (ATTA) an. Mit Methoden der modernen Atomoptik werden einzelne Atome in magnetooptischen Fallen eingefangen und nachgewiesen. Dadurch wird es möglich, das Alter der Probe bereits mit etwa zehn Litern Wasser oder Eis zu bestimmen.

Der Vortrag zeichnet die komplette Kette nach – von der Probennahme in der Natur über die Aufbereitung der Proben bis hin zum Nachweis der einzelnen Atome. Anhand konkreter Beispiele aus den Bereichen Trinkwasserversorgung, Ozeanzirkulation und Gletscherdynamik wird gezeigt, wie diese Methode völlig neue Zeitfenster in Umweltsystemen eröffnet und somit zu einem besseren Verständnis von Klima und Umwelt beiträgt.

**Plenary Talk** PV XVIII Fri 9:00 RW 1

**Chaos in the quantum world** — •Andreas Buchleitner — Physikalisches Institut, Albert-Ludwigs-Universität Freiburg

Chaos in the classical world is the antithesis of order and predictability. It is associated with noise and the loss of control, but also with chance and change. In its elementary form it emerges from deterministic equations, and gives rise to - often ephemeral - “complex” dynamical structures. These represent an essential ingredient for the diversity, variability and (transient) robustness of patterns we witness in the classical world around us. Yet, their control is not trivial a task.

After accomplishing the isolation and control of individual quantum objects, it remains a challenge for contemporary quantum physics to maintain control when many of these elementary building blocks are assembled together. Since this often results in the strong coupling of multiple degrees of freedom, it is not surprising that “chaos” and “complexity” are lurking also in the microscopic world of few to many quantum objects - and jeopardize controllability.

Thus, which insights can we gain from our understanding of classical chaotic systems to decipher and, perhaps, control “chaotic” and/or “complex” quantum systems? And how do quantum mechanical uncertainty and complementarity mould the fingerprint of classically chaotic dynamics in the quantum realm? We will try to elucidate these questions with concrete examples within the context of modern atomic, molecular and optical physics, will seek to discriminate single against many-body “quantum chaos”, and discuss a corollary for the emergence of thermodynamic behaviour.

**Plenary Talk** PV XIX Fri 9:45 RW 1

**Quantum Photonics for Quantum Computing and Machine Learning** — •Philip Walther — University of Vienna, Faculty of Physics, Vienna Center for Quantum Science and Technology (VCQ), Vienna, Austria

After providing a brief overview of recent advancements in the generation and processing of multi-photon states, I will show the potential of photonic quantum machine learning. After presenting a quantum-enhanced reinforcement learning using a tunable integrated processor, I will discuss our development of a so-called quantum memristor for single photons. These devices, which can mimic the behavior of neurons and synapses, hold great promise for the realization of quantum neural networks. I will also present how photonic processors can implementing quantum-enhanced kernels for machine learning tasks. At the end I will change topic by briefly discussing the flexibility of photonic systems for tasks that require non-standard quantum computer architectures; and potentially update about our ongoing experimental research aiming to explore the interface between quantum mechanics and general relativity by performing high-precision experiments using entangled photon states as probe.