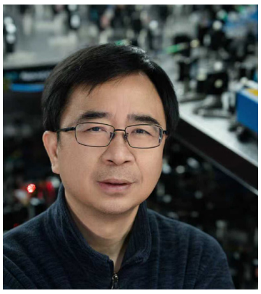
Plenary Speakers

(Arranged in the Order of Presentation Time)

Speaker 1



Jian-Wei Pan

University of Science and Technology of China

Presentation Title：Dream or Reality: Quantum Information Processing the Past, Present and Beyond

Abstract: Quantum information science and technology are emerging and fascinating technologies formed by combining coherent manipulating of individual quantum systems and information technology, which enables secure quantum cryptography (quantum communication), super-fast quantum computing (quantum computation), and improving measurement precision (quantum metrology) etc., to beat classical limits. It is foreseen to establish a large-scale quantum network, or quantum internet, to provide secure communication via quantum key distribution, and to connect quantum computers via quantum teleportation, and achieving ultra-high resolution via quantum sensor.

Based on state-of-the-art fiber technology and rich fiber resources, we have managed to achieve prevailing quantum communication with realistic devices in real-life situation. This constitutes demonstrations by developing decoy state scheme over 100km firer, extending its employment in the metropolitan area network, as well as maintaining Measurement Device Independent QKD (MDI-QKD). At the meantime, we are also developing practically useful quantum repeaters that combine entanglement swapping, entanglement purification, efficient and long-lived quantum memory for the

ultra-long distance quantum communication. Another complementing route is to attain global quantum communication based on satellite. We have spent the past decade in performing systematic ground tests for satellite-based quantum communications.

Along with quantum communication, many technologies of coherently manipulating photons have been developed, such as high precision quantum interference of independent photons, phase stabilization, single-photon detection, and frequency dissemination, enabling optical quantum information processing including optical quantum computation.

Future Prospects include building a global quantum communication infrastructure with satellite and fiber networks, enormous spatial resolution and global precise timing information sharing networks with applications for the global quantum communication network, ultra-precise optical clocks in outer space to detect gravitational wave signal with lower frequency. In the field of quantum computation and simulation, our next 5 year plan is to realize coherent manipulation of a few hundreds to thousand qubits to realize quantum simulation by which one can study the mechanism of high-temperature superconducting, quantum hall effect and so on. In next 10-15 years, it might be possible to extend up to millions of qubits to lay the foundation for universal quantum computation with help of quantum error correction.

Speaker 2

Masahito Ueda

Tokyo University

Presentation Title：Beyond Hermitian Quantum Physics

Abstract: Isolated quantum systems are described by Hermitian Hamiltonians. However, when they are open to surrounding environments or subject to quantum measurements, one should go beyond the Hermitian framework. Beyond-Hermitian physics has recently attracted a great deal of attention due to remarkable advances in experimental techniques and theoretical methods in AMO, condensed matter and nonequilibrium statistical physics. Complete knowledge about quantum jumps allows a description of quantum dynamics at the single-trajectory level. A subclass thereof without quantum jumps can be described by a non-Hermitian Hamiltonian. Here, symmetry, topology and many-body effects are fundamentally altered from Hermitian physics. In this talk, I will discuss what new potentials can be liberated once we go beyond the Hermitian framework. I will illustrate them in the context of the quantum speed limit, intermediate-state engineering, continuous quantum phase transitions and non-Hermitian topological phases. I will also discuss applications of beyond-Hermitian quantum physics to statistical physics and condensed matter physics, such as Yang-Lee zeros, nonunitary critical phenomena and non-Hermitian BCS superconductivity.

Speaker 3

Kevin Insik Hahn

IBS, Korea

Presentation Title: First Experiments Using the RAON Accelerator Facility and Research Activities at CENS

Abstract: The low-energy accelerator section of the radioactive ion (RI) beam facility RAON in Korea has been completed. RAON successfully delivered a stable 40Ar beam to domestic users last year and is expected to provide additional stable and RI beams in the near future. Among its experimental facilities, KoBRA is expected to perform nuclear structure and nuclear astrophysics experiments during the early operation phase of RAON. The Center for Exotic Nuclear Studies (CENS) at the Institute for Basic Science (IBS) was established six years ago to conduct both experimental and theoretical research aimed at understanding fundamental properties of exotic nuclei and the origin of heavy elements in the Universe. Most experiments so far have been performed using existing accelerator facilities around the world. Various detector systems and experimental devices are currently being developed by CENS. Recent research activities at CENS and some of the first experiments conducted at RAON will be presented.

Speaker 4

Rajdeep Singh Rawat

Nanyang Technological University

Presentation Title: Non-Conventional Application of Pulsed High Energy Density Plasma for Novel Material Synthesis

Abstract: In most industrial applications, plasma-based processes typically rely on low-temperature non-equilibrium plasmas for material synthesis and processing, though there is a growing adoption of higher-density thermal plasmas in specific sectors. The science and engineering behind low-temperature plasmas (LTPs), which operate at temperatures on the order of few eVs and densities ranging from 106 to 1016 cm-3, are well-established, making them a standard choice for precise material modification and fabrication. For instance, LTP-based plasma-enhanced chemical vapor deposition (PECVD) is essential for depositing thin films and coatings in microelectronics and semiconductor production, while LTP-driven plasma etching enables the precise patterning of silicon wafers for chip manufacturing. Additionally, LTPs are utilized to enhance textile surfaces, improving properties like adhesion, dye absorption, and water resistance without affecting the material's bulk integrity, and they are also employed in sterilizing medical equipment by disrupting microbial cell structures and DNA. On the other hand, higher-density thermal plasmas, operating

continuously, find applications in plasma arc welding and cutting, thermal barrier coatings in aerospace via plasma spraying, and high-temperature metallurgical processes in plasma furnaces. Meanwhile, pulsed high-energy-density plasma sources, such as the dense plasma focus (DPF), a Z-pinch, device generating plasmas with keV-level temperatures and densities of 1019-20 cm-3 are emerging as promising tools for advanced material processing and nanoscale synthesis. However, DPF systems, being pulsed devices, often face skepticism regarding their controllability and reproducibility in material synthesis. In this plenary talk, I will explore the distinctive characteristics of the dense plasma focus as an innovative high-density, high-temperature pulsed plasma source and illustrate its potential for controlled, reproducible nanomaterial fabrication. I will present various strategies that we have developed and the results achieved, demonstrating that the DPF can serve as an effective, versatile, and dependable high-energy plasma tool for advanced material processing and synthesis.

Speaker 5

Xin-gao Gong

Fudan University

Presentation Title: AI Physics and Materials Design

Abstract: Artificial intelligence has profoundly altered the development of the economy and society and revolutionized the paradigms of scientific research. In this talk, I will explore the impact of artificial intelligence on contemporary physics by discussing the main bottlenecks of computational physics. Based on our own research, I will introduce the latest progress in molecular dynamics methods and first-principles electronic structure calculations, especially the successfully constructed universal Kohn-Sham Hamitonian, and demonstrate how AI is changing the landscape of computational physics. Several examples will be presented to illustrate the efficiency and effectiveness of AI-based algorithms, especially in the field of material design.

Speaker 6

Shuyun Zhou

Tsinghua University

Presentation Title: Floquet Engineering of Quantum Materials

Abstract: Time-periodic light-field can dress the electronic states of quantum materials, providing a fascinating controlling knob for transient modifications of the electronic structure with light-induced emergent phenomena. In this talk, I will present our recent experimental progress on the Floquet engineering of quantum materials using time- and angle-resolved photoemission spectroscopy (TrARPES). In particular, experimental progress on the Floquet engineering of black phosphorus and topological insulator will be presented. I will also provide some experimental insights on Floquet engineering and light-matter interactions in quantum materials.

References:

[1] Nat. Rev. Phys. 4, 33 (2022)

[2] Nature 614, 75 (2023)

[3] Phys. Rev. Lett. 131, 116401 (2023)

[4] Nat. Commun. 15, 10533 (2024)

[5] ACS Nano 18, 32038 (2024)

[6] Phys. Rev. Lett. 134, 146401 (2025)

Speaker 7

Tadashi Takayangi

YITP, Kyoto

Presentation Title: Holographic Spacetime from Quantum Information

Abstract: The idea of holographic duality in string theory provides a simple geometric computation of entanglement entropy. This generalizes the celebrated Bekenstein-Hawking formula of black hole entropy and strongly suggests that a gravitational spacetime consists of many qubits with quantum entanglement. Recently, a new extension of entanglement entropy, called pseudo entropy, which depends on both an initial and a final state, was introduced. This quantity turned out to have a clear geometric dual via the holography and also plays a role of a new order parameter of quantum phases. In this talk, after reviewing the above mentioned developments, we would like to point out that pseudo entropy becomes a useful probe in traversable wormhole geometries and de Sitter spacetime, where non-hermitian density matrices naturally appear in their CFT duals.

Speaker 8

Yew San Hor

Missouri University of Science and Technology

Presentation Title: Rethinking the Foundations of Quantum Mechanics through the Interconnectedness of Fields.

Abstract: Over a century after the birth of quantum mechanics, its principles underpin transformative technologies such as quantum computing. Yet, foundational questions remain unresolved. Despite numerous interpretations, ranging from pilot-wave theory to the many-worlds interpretation, core concepts like superposition, wavefunction collapse, and quantum entanglement remain philosophically and physically ambiguous. Richard Feynman once observed that anyone who thinks they fully understand quantum mechanics does not truly understand it. Recent surveys confirm that even among experts, there is no consensus on the meaning of the quantum wavefunction or the nature of measurement [1]. In this talk, I propose a new perspective, the interconnectedness of fields, which suggests that all matter in the universe is fundamentally linked through continuous fields, particularly the electromagnetic field. Building on Gauss’s law and field-theoretic principles, this approach reframes particles not as isolated entities, but as localized manifestations of interacting fields. This framework offers new explanations for classic quantum phenomena. In the double-slit experiment, whether light exhibits wave-like or particle-like behavior depends not on observation itself, but on the field configuration imposed by the experimental setup. More generally, this principle suggests that the outcome of any quantum measurement is predetermined by the field configuration established

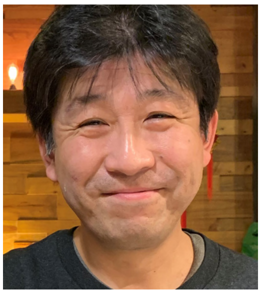
by the apparatus, rather than by an observer-induced collapse. This reinterpretation aligns with recent advances in quantum optics showing that classical interference can be understood through bright and dark collective photon states [2] and that scattering processes can reveal the interplay of coherence, incoherence, and which-way information in atom–photon entanglement [3]. To test this idea, I show an experiment where microwaves are detected as particles, allowing us to measure the photon’s size and shape. Such a result challenges conventional assumptions and supports the notion that what we observe depends on how fields are shaped and constrained. This theory may not only resolve longstanding quantum puzzles but also inform new directions in quantum technology and field unification.

[1] Nature 643 1176 (2025).

[2] Physical Review Letters 134 133603 (2025).

[3] Physical Review Letters 135 043601 (2025).

Speaker 9



Satoki Matsushita

ASIAA

Presentation Title：Imaging Black Hole Shadows

Abstract: In 2019, the Event Horizon Telescope (EHT) Collaboration released the first image of the black hole shadow in human history toward M87*, the supermassive black hole at the center of the giant elliptical galaxy M87 (EHT Collaboration et al. 2019). This huge success owes to the usage of the Very Long Baseline Interferometry (VLBI) technique at the millimeter/submillimeter wavelengths. In 2021, polarized light image of the black hole shadow (EHT Collaboration et al. 2021), and in 2022, the second image of the black hole shadow of Sgr A*, the supermassive black hole at the center of our Galaxy, have been released (EHT Collaboration et al. 2022). In 2023, we published the first results from the Greenland Telescope (GLT; Inoue et al. 2014, Chen et al. 2023) with joining the Global Millimeter Very Long Baseline Interferometric Array (GMVA), showing the ring + jet features for the first time at the vicinity of M87* (Lu et al. 2023). GLT is located at the northern-most place in the array, which provides the highest imaging resolution on the ground. In 2024 and in 2025, the new M87* images taken in 2018 and 2021 have been published (EHT Collaboration et al. 2024, 2025) to show the time difference in the black hole shadow images. Now the new research field of studying black holes, general relativity, and various activities at the vicinity of black holes with imaging black hole shadows has been started. In this talk, I will present how these images were taken, and what physics has been derived from the data and the images so far. I will also mention the future prospects of this field.

Speaker 10

Hyoung Joon Choi

Yonsei University

Presentation Title：Materials Properties from First Principles

Abstract: First-principles methods based on density functional theory (DFT) have been systematically developed over a long period of time through tremendous efforts of many researchers. In this presentation, I will highlight their applications to superconductivity, electronic transport in nanostructures, and magnetic properties. For conventional superconductivity, the first-principles approach involves calculating electronic states, phonon states, and their coupling within the framework of DFT, followed by the evaluation of superconducting properties using Eliashberg theory. This approach has been highly successful in explaining multigap superconductivity and in predicting near-room-temperature superconductivity in high-pressure hydrides. In the study of electronic transport in nanostructures, the first-principles method enables quantum-mechanical simulations of electron propagation while fully incorporating the atomistic details of the systems. Regarding magnetic properties, DFT with both collinear and non-collinear spin densities provides fundamental insights into various magnetic orderings and magnetic excitations. To date, calculating materials properties from first principles has been firmly established as one of the main pillars of physics research, and it will continue to advance in the future.