

Abstract

International Conference on Ultrafast Science
and Quantum Sensing (USQS)



Name: Jian-Wei Pan

Organization: University of Science and Technology of China

Biography:

Jian-Wei Pan, was born in Dongyang China on 11 March, 1970. He is currently a Distinguished Chair Professor of quantum optics and quantum information at the University of Science and Technology of China. He was elected as an academician of the Chinese Academy of Sciences in 2011 and as a foreign member of the Royal Society (London) in 2024.

Prof. Pan is a pioneer in multi-photon interferometry and quantum experiments in space. He closed the major loopholes for secure quantum communication associated with imperfect devices. He developed the quantum satellite Micius, demonstrated for the first time the feasibility of intercontinental quantum communication via satellite. These pioneering efforts have transitioned quantum communication from a purely theoretical concept to reality. Based on multi-photon interferometry, he demonstrated quantum computational advantage, validating the feasibility of quantum computing systems to outperform classical machines in solving certain specific problems, thereby refuting the Extended Church-Turing Thesis. Due to his contributions to quantum information technology, he was selected as the “Ten people who mattered this year” by Nature in 2017, and was selected for the TIME 2018 list of the 100 most influential people in the world.

Title:

Quantum Entanglement 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.



Name: Jiangfeng Du
Organization: Zhejiang University

Biography:

Prof. Jiangfeng Du, fellow of the Chinese Academy of Sciences, serves as President of Zhejiang University. He is also an alternate member of the 20th Central Committee of the Communist Party of China.

As a physicist, Prof. Du specializes in experimental research on quantum physics and its applications. Through the independent development of a series of high-performance magnetic resonance experimental equipment, his groundbreaking work has elevated the sensitivity and resolution of magnetic resonance detection to world-leading status and has led to innovative advancements in quantum physics experimental techniques, particularly in the areas of spin quantum control and dynamic decoupling. Notably, his research has yielded remarkable progress in the application of quantum physics to precision measurement science and information science.

Title:

Single-Spin Quantum Sensing and Frontier Applications

Abstract:

Spin is a fundamental property of particles in nature and has significant applications in modern technologies such as magnetic resonance imaging and magnetic storage. Over the past three decades, with tremendous advancements in experimental techniques, the control of spin has reached new heights, enabling high-precision control and measurement of single spins at the microscale. This brings significant opportunities for developing novel spin applications. Quantum sensing based on single spins is one of the representative quantum technologies in this area. It may offer unique comprehensive advantages such as high sensitivity, high resolution, and relaxed applicable conditions for measuring various physical quantities, which has broad applications in various fields. This report presents the recent research progress of our team in this direction, including the preparation of single-spin quantum sensors, the development of quantum sensing technologies, and advancements in applications within fundamental physics and life sciences.



Name: Sheng-Cai Shi

Organization: University of Science and Technology of China

Biography:

Prof. Sheng-Cai Shi received his B.S. degree in 1985 from Southeast University (China), M.S. degree in 1988 from Purple Mountain Observatory (PMO, China), and Ph.D. degree in 1996 from the Graduate University for Advanced Studies (Japan). From 1992 to 1998, he was with Nobeyama Radio Observatory, National Astronomical Observatory of Japan (NAOJ). He has been a Professor and the Head of Mm- & Submm-Wave Lab at PMO since 1998 and is currently serving as the Chair of the Advisory Committee of PMO. His current research interests include the physics of superconducting devices, THz mixers and detectors, and THz applications. He is a recipient of HLHL Award in 2019 and was elected as an Academician of CAS in 2021.

Title:

Superconducting Detectors for Applications from Astronomy to Quantum Science

Abstract:

With sensitivity approaching the quantum limit and the background limit in coherent and incoherent detection, respectively, superconducting detectors are playing a pivotal role in astronomy such as the first image of a black hole ever taken in human history. The superconducting detectors developed originally for astronomy have also been applied to other fields ranging from quantum science to dark matter detection. This talk will introduce the latest development of four major types of superconducting detectors and some typical applications. The roadmap and development of China's terahertz astronomy will be presented at last.



Name: Heping Zeng
Organization: East China Normal University

Biography:

Heping Zeng is a professor at the State Key Laboratory of Precision Spectroscopy Science and Technology, East China Normal University. He is a recipient of the National Science Fund for Distinguished Young Scholars of China, a Changjiang Scholar Distinguished Professor, a national-level candidate for the “New Century Talent Project”, a Shanghai Leading Talent, and the leader of an Innovative Research Group supported by the National Natural Science Foundation of China. His primary research interests focus on precision spectroscopy and quantum control. In recognition of his “significant contributions to elucidating ultrafast processes in strong-field molecular dynamics and sustained technical development in high-power fiber ultrafast lasers and infrared single-photon detection,” he was elected as an OSA Fellow in 2016. In 2020, he was selected for the Chongqing Talent Program as an Outstanding Scientist. He also received the 2020-2021 China Physical Society’s “Sa Bendong Award for Applied Physics”, was named a model of “Exemplary Teacher and Scholar in Shanghai” in 2021, and was recognized as the Lead Expert of the Chongqing “Chief Expert Studio” in 2022. He is an adjunct professor at Laval University in Canada, a topical editor for the journal Optics Letters, a guest editor for Nanomaterials, and an editorial board member for European Physical Journal D, Scientific Reports, Modern Applied Physics, and Acta Optica Sinica.

Title:

Optical Frequency Comb Control & Mid-Infrared Single-Photon Detection

Abstract:

Optical frequency comb technology has revolutionized precision metrology, spectroscopy, and high-capacity communication systems by providing a coherent and equally spaced spectrum of laser frequencies. Its ability to bridge the optical and radio frequency domains with exceptional precision has driven breakthroughs in areas such as atomic clocks, molecular fingerprinting, and astrophysics. Machine learning further enhances this technology by enabling advanced control strategies to improve comb stability through intelligent control and noise reduction, while also accelerating the development of novel designs and operational regimes. Applied in mid-infrared (MIR) single-photon detection, optical frequency combs have advanced the exploration of the molecular fingerprint region, enabling high-sensitivity environmental sensing and biomedical diagnostics. This talk will present our latest advancements in this field, covering topics including the role of dynamics and machine learning in driving new frequency comb designs and stability improvements, the development and applications of high-sensitivity, low-noise dual-comb techniques, and progress in ultrafast MIR detection and imaging technologies.



Name: Lin Li

Organization: Ningbo Institute of Materials Technology & Engineering, CAS

Biography:

Professor Lin Li obtained a PhD degree in Laser Engineering from Imperial College London in 1989 and was appointed as a chair professor and founded the Laser Processing Research Centre as its Director at University of Manchester Institute of Science and Technology (UMIST), UK in 2000. He received the Sir Frank Whittle Medal from the Royal Academy of Engineering in 2013 for his achievements in engineering innovations in manufacturing, The Royal Society Wolfson Research Merit Award for laser nano-fabrication and nano-imaging, Arthur L. Schawlow award from Laser Institute of America for advancing the science, technology and applications of laser-based manufacturing and Donald Julius Groen Prize from Institution of Mechanical Engineers for contributions in laser based additive manufacturing. Professor Li is an elected Fellow of Royal Academy of Engineering, and has served as President of Laser Institute of America, President of Association of Laser Users (AILU) and President of International Academy of Photonics and Laser Engineering.

Title:

Ultrafast Laser Processing of Engineering Materials at Nano/Micro/Macro Scales

Abstract:

This presentation summarises the author's research in the area of picosecond laser and femtosecond laser processing of engineering materials including metals, glass, ceramic, semiconductors and composites. The research covers nano-materials synthesis, direct writing of nano-structures and micro-structures, cutting, grooving, drilling and milling. In addition, light field modulation and process measurements are discussed.



Name: Zhanshan Wang
Organization: Tongji University

Biography:

Zhanshan Wang, Professor at the School of Physics Science and Engineering, Tongji University, PhD supervisor, recipient of the National Science Fund for Distinguished Young Scholars of China, the high-level talent of the Ministry of Education of China, the first batch of Shanghai Outstanding Talents, leader of the National Natural Science Foundation of China (NSFC) Innovative Research Group, SPIE Fellow, and Fellow of the Chinese Optical Society. He was awarded the Second Prize of the State Technological Innovation Award and the First Prize of the Technological Innovation Award of the Ministry of Education, among others. His main research areas include high-damage-threshold laser coatings, precision optical imaging systems, and extreme ultraviolet (EUV) and X-ray coatings. He has published over 300 papers and is a program committee member for several international conferences abroad. He is currently the Executive Editor of Acta Optica Sinica (Online) and serves on the editorial boards of Optics and Precision Engineering, Acta Optica Sinica, and Acta Photonica Sinica.

Title:

Nonlinear Optical Effects of Multilayer Microstructure under Ultrafast Laser Irradiation

Abstract:

With the continuous improvement of ultrafast laser power, the nonlinear optical effects of optical components have gradually become a research hotspot. This report initially explores the nonlinear effects of multilayer-film gratings utilized in laser pulse compression. Through electric field optimization and material manipulation, the nonlinear effects of the films are effectively suppressed. In terms of enhancing nonlinear effects, by introducing metasurface on the surface of multilayer films and regulating the electric field, the third-harmonic generation effect of the components has been enhanced by nearly one order of magnitude.



Name: Hongbo Sun
Organization: Tsinghua University

Biography:

Hong-Bo Sun, received the B.S. and the Ph.D degrees in electronics from Jilin University, Changchun, China, in 1992 and 1996, respectively. He worked as a postdoctoral researcher in Satellite Venture Business Laboratory, the University of Tokushima, Japan, from 1996 to 2000, and then as an assistant professor in Department of Applied Physics, Osaka University, Japan. In 2004, he was promoted as a full professor (Changjiang Scholar) in Jilin University, and since 2017 he has been working in Tsinghua University, China. His research interests have been focused on laser precision manufacturing. He has published over 500 papers, which have been cited for over 35000 times, and H factor is 101, according to ISI search report. He is currently the executive editor-in-chief (EEIC) of Light: Science and Applications and editor-in-chief of Photonix (Both from Nature Publishing Group). He is IEEE, OSA and SPIE fellow.

Title:

Optical Manufacturing with Far-Field Nano Super Resolution

Abstract:

Femtosecond laser nanofabrication provides a new technical avenue towards micro-nanodevices. Comparing with the currently available nanofabrication approaches including photolithography, nanoimprinting, focus ion beam, it is unique in the three-dimensional (3D) processing capability and applicability to hard-processing materials. These make the new concept, stereo-integrated photonics circuits possible. The talk will introduce our recent research progress along these lines, from light-matter interaction physics to intelligent micro-nanorobots and quantum photonic chips.



Name: Minghui Hong
Organization: Xiamen University

Biography:

Prof. Hong Minghui is the Tan Kah Kee Chair Professor, Xiamen University, Fujian, China. He is also the Engineering Technology Division Chairman and Dean of Pen-Tung Sah Institute of Micro-Nano Science and Technology of Xiamen University. Prof. Hong specializes in laser microprocessing & nanofabrication. He has co-authored 15 book chapters, 42 patents granted, and ~ 600 scientific papers and 100+ plenary/keynote/invited talks in international conferences. He is a member of organizing committees for Laser Precision Micromachining International Conference (2001~2024), International Symposium of Functional Materials (2005, 2007 and 2014), Chair of International Workshop of Plasmonics and Applications in Nanotechnologies (2006), Chair of Conference on Laser Ablation (2009) and Chair of Asia-Pacific Near-field Optics Conference (2013 and 2019). Prof. Hong is invited to serve as an Editor of Light: Science and Applications, Engineering, Science China G, Laser Micro/nanoengineering, and Executive Editor-in-chief of Opto-Electronic Advances and Opto-Electronic Science. Prof. Hong is Fellow of Academy of Engineering, Singapore (FSEng), Fellow of Optical Society of America (OPTICA), Fellow of International Society for Optics and Photonics (SPIE), Fellow of International Academy of Photonics and Laser Engineering (IAPLE) and Fellow of Institution of Engineers, Singapore (IES). As an active tech entrepreneur, he is also the leading founder of Phaos Technology Pte. Ltd., Opto Science Pte. Ltd. and Xiamen Light Technology Integration Pte. Ltd.

Title:

Femtosecond Laser Microprocessing and Nanofabrication: Progress and Challenges

Abstract:

In this talk, dynamic laser interactions with materials will be reviewed. Technical challenges on laser precision engineering from microns down to nanometers will be analyzed. How to achieve a small heat-affected zone (HAZ) is the first key challenge for high-quality micro/nanostructures' fabrication. Ultrafast femtosecond laser induced photo-thermal and photo-chemical effects are the effective means to solve this issue. How to achieve high speed laser processing is the second key challenge for industrial applications. Parallel femtosecond laser beam processing is a versatile solution for high-resolution and high-speed precision engineering at the same time. The third challenge is how to carry out the femtosecond laser nano-structuring in far field. Though the femtosecond laser nanofabrication in near field, combined with AFM, NSOM and microspheres, can achieve 25 nm resolution, it requires the optics working close to sample surfaces, which limits the laser nanofabrication only suitable for super-smooth surface samples. Our recent research shows that with double femtosecond laser beams irradiation, the feature size can be reduced to ~15 nm on silicon surfaces in far field and in ambient air. Further fine-tuning of the experimental setup and laser processing parameters is highly possible to bring the femtosecond laser precision engineering resolution down to 10 nm and beyond.



Name: Yuxin Leng

Organization: Shanghai Institute of Optics and Fine
Mechanics, CAS

Biography:

Yuxin Leng, Ph.D. he is a professor in State Key Laboratory of High Field Laser Physics at SIOM. He is currently investigating development and application of high field ultrafast laser, including optical parametric chirped pulse amplification (OPCPA); the ultra-intense and ultra-short laser based on Ti:sapphire chirped pulse amplifier; and carrier-envelope phase (CEP) stabilized tunable high intense ultra-short infrared coherent radiation source; new laser source and its applications.

Title:

High-power Ultrafast Lasers: From VUV to MIR

Abstract:

High-power ultrafast lasers, ranging from vacuum ultraviolet (VUV) to mid-infrared (MIR), can provide novel ultrafast detection methods for atomic and molecular physics, condensed matter physics, and ultrafast chemistry. At first, we have proposed a method for generating octave-spectral-wide ultraviolet pulses in capillary fibers by coupling dispersive-wave radiation with soliton-splitting dynamics, this method can generate microjoule, high-coherence, tunable ultraviolet wide spectrum (200-400 nm) pulses, supporting a near-single cycle with a Fourier transform limit pulse width of about 1 fs. Also, we have independently developed near-infrared high-power femto-second driven lasers based on Yb doping crystals, realizing high-performance millijoule femtosecond laser outputs of over 10 W [2,3], and the highest output power can exceed 100 W with pulse width of less than 200 fs. About the mid infrared ultrafast lasers, we have achieved high-power ultrafast laser output with full coverage tuning from visible to long-wave infrared based on optical parametric amplification [4]. And at 1.5 μm and 4 μm , we have achieved ultra-intense ultra-short laser of hundreds of GW through chirped pulse amplification [5], and we are further improving it to the hundreds of millijoules and TW range. We believe that these high-power ultrafast laser sources covering VUV to MIR can provide brand new experimental methods and become essential tools for promoting breakthrough development in emerging application fields.



Name: Yunquan Liu
Organization: Peking University

Biography:

Yunquan Liu, Boyuan Distinguished Professor at Peking University. He received his Ph.D. from the Institute of Physics, Chinese Academy of Sciences in 2006. From 2006 to 2008, he conducted postdoctoral research at the Max Planck Institute for Nuclear Physics. In 2009, he joined Peking University as a researcher under the "Hundred Talents Program." In 2011, he was awarded the National Science Fund for Distinguished Young Scholars. In 2012, he received the Wang Xuan Young Scholar Award, Wang Daheng Young Scientist Optics Award in 2013, Rao Yutai Award from the Chinese Physical Society (2014-2015). In 2014, he was appointed as a Changjiang Distinguished Professor and was selected the Young and Middle-aged Science and Technology Innovation Talent Program (2013-2014). His research focuses on strong-field attosecond optics, quantum optics of free electrons, and ultrahigh spatiotemporal resolution technologies and their applications.

Title:

Controlling of Ultrafast Strong Light Fields and Applications

Abstract:

The interaction of ultrashort, ultra-intense lasers with matter represents an extreme nonlinear process, with the core scientific question centering on electron dynamics. In the talk, I will discuss recent advances of strong-field physics with ultrafast light field manipulation. By controlling of various parameters of ultrafast laser fields, such as amplitude, phase, polarization, orbital angular momentum, spin angular momentum and quantum statistics, we show the electrons in matters can be studied. Applications of light field manipulation in ultrafast studies of strong-field phenomena, such as above-threshold ionization, tunneling ionization, and high-order harmonic generation, will be discussed.



Name: Sotir Chervenkov

Organization: University of California San Diego

Title:

Attosecond Science Meets Quantum Optics: Novel Regimes of Coherent X-ray Generation for Attosecond Spectroscopies of Electron Correlations and Rabi Oscillation

Abstract:

Ultrafast imaging and spectroscopies using coherent EUV - X-ray light based on the nonlinear process of high harmonic generation are already addressing grand challenges in complex molecular systems, plasmas, and advanced nanomaterials. The exquisite quantum control of the attosecond dynamics of the rescattering electrons in this extreme frequency upconversion makes it possible to sculpt the classical and quantum properties of the light with unprecedented tunability of the spectral, spatial, temporal shape, and spin and orbital angular momentum state. The superb coherence of this unique light allows for multi-dimensional imaging at the space-time extreme with 4D resolution of nanometers and femtoseconds, including access to an effective 5th dimension – the periodic table of elements – due to the X-ray absorption fingerprinting with elemental and chemical specificity.

In this talk, I will present two novel quantum regimes of coherent X-ray generation where the design of the light properties is dominated by the dynamics of the entangled electrons in a simple He atomic system. Interestingly, the physics of these regimes extends beyond the well-established three-step high harmonic model.

In the first regime, using strong UV laser fields, the entangled electron dynamics yield a characteristic plateau in the X-ray spectral region, extending well beyond the conventional cutoff [1]. This is due to simultaneous double electron recombination where a single high-energy X-ray photon is emitted only in atomic systems with strongly correlated electrons. This low probability phenomenon paves a way to a sensitive attosecond spectroscopy as a probe of highly correlated interactions. Similar physics of high harmonics from solids might be able to characterize electron correlations in phase transition materials and nanosystems of relevance to quantum computing and superconductivity.

In the second extreme regime, using intense EUV driving fields tuned to a resonance frequency of He can result in very bright harmonic emission in the X-ray regime [2]. Favorable quantum dynamics of the electron wavepackets, and phase and group velocity matching of the light fields enhance the X-ray yield. Furthermore, record-fast attosecond Rabi oscillations are predicted to suppress the depletion of the ground state, which otherwise terminates the emission of X-ray photons. The physical description of this novel high harmonic process is not possible within the scope of the conventional three step model since two different pathways coexist: first, a two-level coupling, and second, a bound-continuum coupling.

These new advances in quantum control over the coherent X-ray emission enable new insights into complex entangled electron dynamics and applications in nanoscience and quantum technology.



Name: Xuehua Wang

Organization: Sun Yat-sen University

Biography:

Dr. Xue-Hua Wang is a Professor in Optics, School of Physics and Engineering, Sun Yat-Sen (Zhongshan) University, China. He got his PhD degree in 1995 at Shanghai Jiaotong University, China. He has long conducted researches on nano photonics, quantum optics and solid quantum chips, especially on controlling interaction between light and matter. He has made some significant achievements in these fields, including the universal position-dependent theoretical model for quantum light emission in nano structures, fabrication of highly-efficient on-demand controllable quantum light sources, highly-efficient realization of the room-temperature quantum state based upon strong coupling, and highly-efficient propagation and information storage of nano photons. He has published more than 140 peer-reviewed papers on famous international journals, such as Nat. Nanotech., Nat. Photon., Phys. Rev. Lett., Light: Sci.& Appl., Nat. Commun., Sci. Adv., etc.

Title:

Artificial Room-Temperature Quantum States

Abstract:

Room-temperature (RT) quantum state is the key foundation for the development of high-performance micro-nano quantum optoelectronic devices, quantum computation and solid-state quantum chips. However, it is extremely difficult for the quantum states to survive at the RT due to the huge dissipation. The potential solution is to constructing artificial RT quantum states by strong coupling between emitters and photons. Over the past more than two decades, the only method of achieving the RT strong coupling quantum state is to greatly improve the exciton-photon coupling strength for overcoming the huge dissipation. The plasmonic microcavities has been applied for this purpose¹⁻³. I will firstly introduce the critical criteria and diversity of the RT strong coupling^{4,5}. Then, I will present how to realize the RT single qubit formed by the strong coupling of a single exciton with a single metal nanoparticle⁶. However, the RT strong coupling achieved by enhancing the coupling strength is accidental events with very low probability of less than 1% due to harsh critical conditions. To overcome this challenge, we present a highly-efficient approach for achieving the room-temperature strong coupling by reducing the critical coupling strength at the exceptional point based upon the damping inhibition and matching of the coupled systems⁷. In contrast to the method of enhancing the exciton-photon coupling strength, our strategy can dramatically relax the harsh critical conditions and significantly improves the experimental success rate of the RT strong coupling from about 1% to 80%, which will boost advance in the RT strong coupling quantum states and the quantum devices.



Name: Hong Guo
Organization: Peking University

Biography:

Hong Guo, Boya Distinguished Professor of Peking University. His research covers quantum sensing and devices such as optical pumped magnetometer (OPM), quantum key distribution (QKD) and quantum random number generations (QRNG), generation of quantum frequency standards and their transfer via optical fiber links, and quantum open systems. In OPM and its applications in magnetic anomaly detections (MAD) and imaging in biomedical sciences, he realized the first OPM-based recording of brain in unshielded earth field environment, and the first OPM-based movable unshielded magnetocardiography system. His OPM research also extends to many applications, encompassing participating as a joint member station in the Global Network of Optical Magnetometer for Exotic physics (GNOME) for the search of the dark matter/energy and other exotic physics beyond the standard model, and the applications in the studies of archaeology and other areas. In time-frequency related fields, he demonstrated a high-precision time-frequency transfer over thousands of kilometers of fiber with the ability to download multi-frequencies simultaneously in different nodes, and achieved femtosecond-level measurements of both time interval of electrical signals and optical fiber delays, which further develops precision measurement technologies. He also achieved the security proof of digital signal processing and the longest-distance transmission in commercial fiber link of continuous-variable QKD, which expands the application scenarios of quantum security.

Title:

Quantum Technologies: from Sensing to Perception

Abstract:

In recent years, quantum technology has become a hotspot in numerous related areas of science and technology, encompassing quantum supremacy, quantum revolution, etc. This talk explores key aspects of quantum technologies related to information perception and acquisition, the maintenance of the related information security, and information processing. Specifically, I will delve into quantum sensing, with a focus on magnetic anomaly detection using optically pumped magnetometers in unshielded earth environments, and quantum precision measurement, with a focus on the secure transfer of time-frequency signals in optical fiber links. Moreover, I would like to mention some potential evolution of quantum technologies over the next decades -- the transition from fundamental quantum sensing technologies to more sophisticated quantum information perception (physics + mathematics, hardware + software, and AI-oriented).



Name: Jing Zhang
Organization: Shanxi University

Biography:

Zhang Jing, Director of the Institute of Optoelectronics and the State Key Laboratory of Quantum Optics and Optical Quantum Devices, Shanxi University. He is National Science Fund for Distinguished Young Scholars, Yangtze River Scholars Distinguished Professor, Optical Society of America (OSA) Fellow, American Physical Society (APS) Fellow. He has made a series of important research works in the field of continuous variable quantum information and quantum gases, especially in the spin-orbit coupled degenerate Fermi gases and twisted bilayer optical lattice. The works about quantum simulation based on ultra-cold Fermi gas won the second prize of the National Natural Science Award in 2020. He was selected for the Xplorer prize by Tencent, National Innovation Excellence Award.

Title:

Observation of Quantized Vortex in An Atomic Bose-Einstein Condensate at Dirac point

Abstract:

When two or more energy bands become degenerate at a singular point in the momentum space, such singularity, or “Dirac points”, gives rise to intriguing quantum phenomena as well as unusual material properties. Systems at the Dirac points can possess topological charges and their unique properties can be probed by various methods, such as transport measurement, interferometry and momentum spectroscopy. While the topology of Dirac point in the momentum space is well studied theoretically, observation of topological defects in a many-body quantum systems at Dirac point remain an elusive goal. Based on atomic Bose-Einstein condensate in a graphene-like optical honeycomb lattice, we directly observe emergence of quantized vortices at the Dirac point. The phase diagram of lattice bosons at the Dirac point is revealed. Our work provides a new way of generating vortices in a quantum gas, and the method is generic and can be applied to different types of optical lattices with topological singularity, especially topological flat band near Dirac point for twisted bilayer optical lattices



Name: Xinhua Peng

Organization: University of Science and Technology of China

Biography:

Xinhua Peng is a Professor from University of Science and Technology of China. She received her Ph.D degree in Wuhan Institute of Physics and Mathematics, Chinese Academy of Sciences (CAS) in 2003. Subsequently she arrived at University of Dortmund, Germany, as an Alexander von Humboldt Fellow. In 2008, she joined in Department of Modern Physics, University of Science and Technology of China under the CAS "Hundred Talents Program". Her research interests mainly focus on spin-based quantum information processing, encompassing quantum algorithms, quantum simulation, quantum control, and quantum sensing. She has published around 130 peer-reviewed papers on Nat. Phys, PNAS, Sci. Adv., Phys. Rev. X/Lett. et al. She was awarded including Distinguished Young Scholars of NSFC, Young Yangtze River Scholars Award of the Ministry of Education, the 12th Chinese Young Women Scientist Award and Xplorer Prize.

Title:

Spin-Based Quantum Information Processing

Abstract:

Spin plays a pivotal role in quantum information science, including quantum computation, quantum sensing and quantum communication. This talk will explore recent advancements in manipulating and controlling spin qubits, focusing on nuclear spins in gaseous, liquid, and solid-state systems. We'll discuss novel techniques for achieving high sensitivity in ultra-weak magnetic field measurements, critical quantum metrology with Heisenberg scaling, and universality in many-body non-equilibrium dynamics. Additionally, we'll cover breakthroughs in fT-level sensitivity and spin quantum control, along with progress in spin-based systems for dark-matter detection and practical quantum simulations. These developments not only expand the boundaries of quantum information science but also pave the way for innovative quantum technology applications. Finally, we'll explore current challenges and future directions in the field.



Name: Weiping Zhang

Organization: Shanghai Jiao Tong University

Biography:

Professor Weiping Zhang is Chair Professor in School of Physics and Astronomy, Shanghai Jiao Tong University. His research involves the field of atomic, molecular and optical physics, including quantum optics, atom optics and quantum metrology. He won the Yutai Rao Prize in Physics from Chinese Physical Society, the First Prize of Shanghai Natural Science Award, and Outstanding Referee Award from American Physics Society (APS). He is the Fellow of American Physical Society (APS Fellow), Fellow of Optical Society of America (Optica Fellow), Fellow of Chinese Optical Society (COS Fellow), and was the Divisional Associate Editor of the APS Journal of Physical Review Letters. He published over 200 papers, including near 40 ones of Physical Review Letters, and 3 of Science Advances and Nature communications. He is also the Chair of Division for Optical Quantum Science and Technology of Chinese Optical Society.

Title:

Quantum Enhanced Metrology Based on Strongly Correlated Atom-light Quantum Manipulation

Abstract:

Research on quantum optics and atom optics is pushing the fundamental understanding of atom-photon interaction toward the developments in quantum metrology. In this talk, a number of recent progresses in both experiments and theories from our group will be introduced in the direction, including photon-correlated interferometer based on photon four-wave mixing in atomic vapors, atom-light hybrid interferometer with magnon-photon interference in Raman coupling, and the new development of quantum atomic magnetometry using entangled light beams.



Name: Guilu Long

Organization: Tsinghua University

Biography:

Long Guilu, a professor at Tsinghua University and vice dean of the Beijing Academy of Quantum Information Sciences. He is a recipient of the National Science Fund for Distinguished Young Scholars, a fellow of the Institute of Physics (UK) and the American Physical Society, the director of the Quantum Communication Committee of the China Institute of Communications, the council member of the China Cryptology Society and the deputy director of the Quantum Cryptography Commission, a member of the Quantum Science and Technology Working Group of the International Union of Pure and Applied Physics (IUPAP). He has been engaged in research on quantum computing and communication for a long time, having published more than 400 papers, which have been cited more than 29,000 times on Google Scholar. He has won many honors, including the Second Prize of the National Natural Science Award, the IBM Global Faculty Award, and the First Prize of the Science and Technology Award of the Chinese Institute of Electronics.

Title:

Prospect of Factorization Using Current Generation Quantum Hardware

Abstract:

The Shor's algorithm can break the RSA encryption, but the required hardware will take at least 10 years to be realized, so the threat is still far away. In 2022, Chinese scholars proposed the large integer factorization algorithm integrating quantum and classical computers [1]. It can challenge the RSA encryption with near-term quantum hardware, which has attracted widespread attention and had a significant impact. This report will introduce the recent progress and discuss the prospect



Name: Qiongyi He
Organization: Peking University

Biography:

Qiongyi He, Peking University Boya Distinguished Professor. Her main research field is quantum optics and quantum information, including the detection, classification, quantification of various types of quantum correlations, as well as their applications in quantum information processing. To date, she has published over 100 journal papers, including Nature Physics, Nature Communications, Physical Review Letters, Science Bulletin. She has been awarded funding from National Science Fund for Distinguished Young Scholars, the Wang Daheng Optical Award, and the China Young Female Scientists Award.

Title:

Testing Non-Gaussian Entanglement and Its Applications

Abstract:

Quantum entanglement is a distinctive feature of quantum physics and is key resource in many quantum information tasks. Entanglement in continuous-variable non-Gaussian states are of particular interest in quantum technology due to their potential applications in quantum computing and quantum metrology. However, how to create such states and detect its non-Gaussian entanglement remain a challenge since the sheer amount of information in such states grows exponentially and makes a full characterization impossible. Here, I would introduce our recent progress for creating non-Gaussian states and experimentally feasible approach to detect non-Gaussian entanglement.



Name: Wei Lu

Organization: Shanghai Institute of Technical Physics

Biography:

Prof. Lu Wei graduated from the Department of Physics at Fudan University in 1983. He obtained his Ph.D. from the Shanghai Institute of Technical Physics (SITP), Chinese Academy of Sciences (CAS), in 1988. From 1989 to 1991, he served as a Humboldt Scholar at the Technical University of Braunschweig in Germany. Since 1988, he has been working at SITP, where he previously held positions as Director of the State Key Laboratory of Infrared Physics and as Director of SITP. In 2019, he became the Executive Dean of the School of Physical Science and Technology at ShanghaiTech University.

Prof. Lu has long been engaged in the research of semiconductor optoelectronics, with a focus on developing advanced infrared optoelectronic devices urgently needed by China's science and technology satellites. Building on his fundamental research in quantum-structured materials and subwavelength optoelectronic modulation, he proposed novel mechanisms that led to the development of various new types of space-borne optoelectronic devices. These devices have been applied in China's Practice Satellite series, Ocean Satellite series, and Meteorological Satellite series, among others.

Prof. Lu has received numerous honors, including the Second Prize of the National Natural Science Award in 2014 (ranked first), the Second Prize of the National Technological Invention Award in 2011 (ranked first), and one China Patent Excellence Award (ranked first). He has published more than 290 SCI papers, which have been cited over 10,000 times, and he has authored two monographs. In addition, he holds over 80 authorized invention patents.

Title:

Infrared Detectors for Space Applications: From Quantum to Control

Abstract:

In the field of infrared remote sensing, the technical process involves the transmission of infrared photons, photoelectric detection, electrical signal processing, target recognition, and decision-making. A significant bottleneck from infrared detection to target recognition is the efficient enhancement of the ratio of infrared photoelectrons between targets and non-targets to improve target recognition rates. Addressing this challenge at the pixel level of photoelectric conversion has become a crucial direction in the development of infrared optoelectronic devices. Quantum well infrared photodetectors are particularly suited to this trend, especially in space-to-earth observation applications with strong background infrared radiation.



Name: Fengqi Liu

Organization: Institute of Semiconductors, CAS

Biography:

Feng-Qi Liu received the Ph.D. degree in condensed matter physics from Nanjing University, Nanjing, China, in 1996. Since then, he joined Institute of Semiconductors, Chinese Academy of Sciences, where his work has concentrated on the MBE growth and fabrication of high-performance mid-infrared and terahertz quantum cascade lasers (QCLs). He received the National Natural Science Foundation for Distinguished Young Scholars in 2005, and the New Century National Hundred, Thousand and Ten Thousand Talent Project in 2007. He developed a series of room temperature (RT) operated high-performance QCLs with emitting wavelength in the range of 3.5--16 microns, innovated the first quantum dot cascade lasers by two-step strain compensation active region design, developed high power terahertz QCLs with emitting frequencies between 2.95--5.4 THz, developed a series of quantum dot cascade detectors with very low dark current and background noises, high operating temperature, and high detectivities.

Title:

Quantum Dot Cascade Laser

Abstract:

Mid-infrared quantum cascade lasers (QCLs) have experienced tremendous improvement in terms of output power and efficiency in the past years. Wavelength tunable QCLs have found various applications, such as air-pollution, industrial discharge, and toxicant detection. In these application scenarios, high efficiency of QCL is a basic requirement. Due to the essence of the extremely short non-radiative lifetimes commonly associated with the intersubband transitions in the quantum wells, the room temperature wall plug efficiency of QCL is no more than 30%. Quantum dot cascade laser (QDCL), in which quantum well active region is replaced by quantum-dot active region, is predicted as high wallplug efficiency and broad tunability. However, the design and growth of QDCLs is extremely difficult. In this talk we demonstrate the development of QDCLs by two-step strain-compensation active region design and material growth technique. The QDCLs based on three-layer QDs active region, two-layer QDs active region, and single-layer QD active region have been exploited. The QDCL with structure based on two-layer QD active region presents room temperature continuous wave lasing at wavelength of around 7 μm , proving a feasible route for developing QDCLs.



Name: Qi Ji, Ying Gu
Organization: Zhejiang Lab

Biography:

Dr Ji Qi, Research Scientist at Zhejiang Lab and Doctoral Adviser in Zhejiang University. He is currently a key member of the NSFC Key Project team led by Academician Gu Ying, which focuses on the Multimodal Optical Theranostics for Intracavitary Tumors. His primary research interest lies in endoscopic imaging methods and technologies.

Ying Gu, Academician of the Chinese Academy of Sciences, Chief Physician, Professor in laser medicine, Director of the Laser Medicine Center at the PLA General Hospital. Dr. Gu has dedicated her career to the research and application of lasers in clinical medicine. She pioneered vascular-targeted photodynamic therapy, developed a national chemical Class 1.1 photodynamic new drug—Hemoporphin, established tumor-targeted stratified photodynamic therapy, and opened up a new field of non-invasive phototherapy. Currently, she holds positions including President of the Chinese Optical Society, Deputy Chair of the Medical Device Classification Technical Committee of the National Medical Products Administration, Deputy Chair of the National Standardization Technical Committee on Optical Radiation Safety and Laser Equipment, Deputy Director of the National High-Performance Medical Devices Innovation Center, Editor-in-Chief of the Chinese Journal of Laser Medicine, President of the Beijing Women's Association for science, President of the Hainan Federation of Academicians.

Title:

Multimodal Optical Theragnostic Approach for Intracavitary Tumors

Abstract:

Determining tumor margins and controlling light doses in photodynamic therapy for intracavitary tumors under endoscopy presents significant challenges. Here, we report our latest advancements utilizing multimodal optical approaches to address these issues. We have developed multimodal endoscopic systems and explored multimodal analysis methods to aid in tumor margin detection. Additionally, we demonstrate a controllable therapeutic light delivery technique designed for intracavitary environments. These efforts pave the way for a new integrated model of photodynamic diagnosis and therapy, enabling both "visualized" perception of the treatment area and "controllable" regulation of the treatment dose.



Name: Junle Qu
Organization: Shenzhen University

Biography:

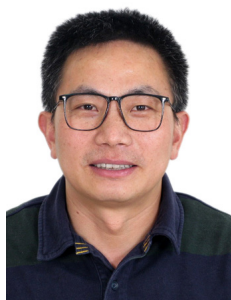
Dr. Junle Qu is a Chair Professor and the director of the Center for Biomedical Photonics at the College of Physics and Optoelectronic Engineering, Shenzhen University. Dr. Qu's research interests encompass multimodal in vivo optical imaging, super-resolution optical imaging, nanobiophotonics technology, and light-induced therapy. He has published over 500 scientific papers in peer-reviewed journals. Dr. Qu is a Fellow of the International Society for Optical Engineering (SPIE), the Optical Society of America (Optica), the Chinese Optical Society (COS), and the Chinese Society of Optical Engineering (CSOE). He is the Executive Editor-in-Chief of PhotoNiX: Life, Associate Editor of Biomedical Optics Express and the Associate Editor-in-Chief of the Journal of Innovative Optical Health Sciences (JIOHS).

Title:

Confocal Super-Resolution Imaging: From STED to FSTM

Abstract:

Stimulated Emission Depletion (STED) super-resolution imaging typically requires high-power depletion lasers, which can cause significant sample damage and phototoxicity. To address this challenge, we developed strategies combining advanced optical methods and fluorescent probes to lower depletion light power while enhancing imaging performance. This enables applications in live-cell imaging and even in vivo imaging. Additionally, leveraging time-resolved detection and computational imaging techniques, we introduced a phase analysis-based spatiotemporal fluorescence modulation strategy(FSTM). This approach allows us to extract precise photon information from both temporal and spatial dimensions. Using a single-pulse laser, we can also achieve multi-color super-resolution imaging of live cells, as well as super-resolution fluorescence lifetime imaging.



Name: Xiaoping Zheng
Organization: Tsinghua University

Biography:

ZHENG Xiaoping is a professor of the Department of Automation, Tsinghua University, director of the Institute of Testing and Electronic Technology, and director of the Chemical Detection Technology Research Center. He is a distinguished professor of Changjiang Scholars of the Ministry of Education, winner of the National Science Foundation for Distinguished Young Scholars, and chief scientist of 973. His research is mainly terahertz detection and imaging technology, and he won the second prize of the National Science and Technology Progress Award, the first prize of the Natural Science Award of the Ministry of Education and the first prize of the Science and Technology Progress Award of the Ministry of Education.

Title:

THz Trace Detection System and Rotational Wave Spectrum Analysis

Abstract:

To solve the detection and analysis of the chemical composition recognition and trace concentration, the analysis method based on the collision broadening effect was created. The reverse design model based on transfer function and one-dimensional multi-channel convolutional neural network is proposed, realizing the high precision and fast electromagnetic modeling and optimization design of passive devices, and developing the high power frequency multiplier source device. A novel recessed gate graded AlGaIn high-electron-mobility transistor (RGGA HEMT) for high-sensitivity terahertz detectors was proposed, and its responsivity and noise equivalent power reach 58 mA/W and 43 pW/Hz^{1/2}. A terahertz spectroscopy system was established, achieving high-frequency spectral resolution at the kHz level and obtaining high-precision rotational spectra of volatile organic compounds, with a detection limit of 1.4 ppm. Based on the constructed terahertz spectroscopy system, a broadband fingerprint spectrum enhancement technique combining multi-mode resonance and scale scaling was proposed, which enhances the signal by 33.7 times. A terahertz spectroscopy analysis method based on collision broadening effect was proposed to explore the component identification and concentration analysis of trace gases. High accuracy trace chemical concentration analysis with a relative error of 0.1% was obtained with a small amount of spectral data.



Name: Jian Chen
Organization: Nanjing University

Biography:

Jian Chen received the B.S. and M. S. degrees in radio physics from Nanjing University (NJU), China,, in 1983 and 1986, respectively. From 1986 to 1989, he was an assistant in NJU. He received D.E. degree in Department of Electrical Engineering from Nagaoka University of Technology (NUT), Japan, in 1992. Then, he was an assistant in Research Institute of Electrical Communication (RIEC), Tohoku University, Japan. From 1998, he was an associate professor in RIEC. He has been a professor in NJU since 2003. His research interest includes superconducting devices, terahertz techniques and their applications.

Title:

Sensitive Superconducting Terahertz Kinetic Inductance Detectors

Abstract:

The terahertz (THz) waveband is of immense interest in astronomy as it encompasses significant energy generated following the Big Bang, offering critical insights into processes invisible in other bands, such as the earliest stages of planet, star, and galaxy formation. Superconducting kinetic inductance detectors (KIDs) have emerged as a formidable contender in the field of THz astronomy, attributed to their exceptional sensitivity and scalability [1,2]. In this study, we introduce a novel class of KIDs incorporating a lumped element (LE) superconducting resonator design, with inductors fabricated on β -Ta film and capacitors on α -Ta film. We characterize the noise of the hybrid α -Ta/ β -Ta LEKIDs, achieving an optical noise equivalent power (NEP) of $4.8 \times 10^{-19} \text{W/Hz}^{1/2}$, demonstrating high sensitivity (Fig.1). Additionally, the LEKIDs exhibited robust stability across multiple thermal cycles. The combination of high sensitivity and robust stability makes the hybrid LEKIDs promising for the stringent demands of astronomy and other applications at THz waveband.



Name: Wei Li

Organization: Changchun Institute of Optics, Fine Mechanics
and Physics, CAS

Biography:

Wei Li is a professor at Changchun Institute of Optics, Fine Mechanics and Physics (CIOMP), Chinese Academy of Sciences (CAS). He also serves as the Director of GPL Photonics Laboratory at CIOMP. Before joining CAS, he completed his Ph.D. and postdoctoral research at Vanderbilt University and Stanford University, respectively. His research interests include thermal photonics, nanophotonics, and their applications in next-generation energy and information technologies. His work has been published in peer-reviewed journals including Science, Nature, and Nature Photonics. He is a Highly Cited Researcher (Clarivate) and a recipient of MIT Technology Review Innovator Under 35 (TR35 Asia Pacific), among others. He is the associate editor of npj Nanophotonics and the faculty advisor of Optica Student Chapter and IEEE Student Chapter at CIOMP, CAS.

Title:

Thermal Photonics and Applications

Abstract:

Thermal radiation represents a ubiquitous aspect of nature. Any object at finite temperatures emits thermal radiation as a result of thermally induced motion of particles and quasiparticles. In the emerging field of thermal photonics, using thermal photonic structures (at least one of the structural features are at a wavelength or sub-wavelength scale) can reshape thermal radiation to be drastically different from conventional thermal emitters, opening up exciting opportunities for various applications. In this talk, I will discuss our recent advances in thermal photonics, including spectral, directional, and symmetry breaking control of thermal radiation, as well as applications in radiative cooling and energy-saving systems.



Name: Xinliang Zhang
Organization: Xidian University

Biography:

Prof. Xinliang Zhang received the Ph.D. degree in physical electronics from Huazhong University of Science and Technology (HUST) in 2001. He is currently the president of Xidian University, Xi'an. He is also with the Wuhan National Laboratory for Optoelectronics, HUST, as a Chair Professor. He has authored or co-authored more than 500 peer-reviewed journal papers, including papers in Nature, Nature Photonics, Science, Science Advances, Nature Communications, etc. His current research interests are InP-based and Si-based devices and integration for optical network, high-performance computing and optical instrumentation. He is OSA Fellow and COS Fellow.

Title:

Key Devices and Integrated Sub-systems for Intelligent Photonics

Abstract:

Intelligent photonics is receiving increasingly attention in recent years for its potential applications in optical computing, flexible optical networks, sensing networks and artificial intelligent systems. One key problem for intelligent photonics is how to detect and process the information carried in the optical wave. All-optical switch and large bandwidth photodetector are two key kinds of devices for intelligent photonic systems. In this talk, research progresses on devices and integrated sub-systems for intelligent photonics in our group are reviewed and discussed. Firstly, we developed two optical switches, one is thermo-optic switch with photonic crystal cavity and graphene and its response time can be hundreds of ns. The other is all-optical switch with photonic crystal cavity and its power consumption can be 86 fJ/bit at 30Gb/s. Secondly, we develop a germanium silicon PIN detector with bandwidth up to 100 GHz and a germanium silicon avalanche photodiode with the gain-bandwidth product up to 1000 GHz. Finally, we review our works on intelligent optical systems, including SOA-based integrated chips for digital logic computing, silicon-based matrix-based photonic computing chips, and photodetector-based phased array chips with integrated measurement and communication functions.



Name: Giulio Cerullo
Organization: Politecnico di Milano

Biography:

Giulio Cerullo is a Full Professor with the Physics Department, Politecnico di Milano, where he leads the Ultrafast Optical Spectroscopy laboratory. Prof. Cerullo's research activity covers a broad area known as "Ultrafast Optical Science", and concerns on the one hand pushing our capabilities to generate and manipulate ultrashort light pulses, and on the other hand using such pulses to capture the dynamics of ultrafast events in molecular and solid-state systems. He has published over 550 papers which have received $\rightarrow$ 33000 citations (H-index: 91 on Scopus). He is a Fellow of the Optical Society of America, of the European Physical Society and of the Accademia dei Lincei and past Chair of the Quantum Electronics and Optics Division of the European Physical Society. He is the recipient of an ERC Advanced Grant (2012-2017) on two-dimensional electronic spectroscopy of biomolecules. He has been General Chair of the conferences CLEO/Europe 2017, Ultrafast Phenomena 2018 and the International Conference on Raman Spectroscopy 2020. In 2023, he received the Quantum Electronics Prize of the European Physical Society. He is the co-founder of two spin off companies (NIREOS and Cambridge Raman Imaging).

Title:

Two-dimensional semiconductors: a platform for nonlinear and ultrafast optics

Abstract:

Layered materials are solids consisting of crystalline sheets with strong in-plane covalent bonds and weak van der Waals out-of-plane interactions. These materials can be easily exfoliated to a single layer, obtaining two-dimensional (2D) materials with radically novel physico-chemical characteristics compared to their bulk counterparts. The field of 2D materials began with graphene and quickly expanded to include semiconducting transition metal dichalcogenides (TMDs). 2D semiconductors exhibit very strong light-matter interaction and exceptionally intense and ultrafast nonlinear optical response, enabling a variety of novel applications in optoelectronics and photonics. Furthermore, stacking 2D materials into heterostructures (HS) offers unlimited possibilities to design new materials tailored for applications. In such HS the electronic structure of the individual layers is well retained because of the weak interlayer van der Waals coupling. Nevertheless, new physical properties and functionalities arise beyond those of their constituent blocks, depending on the type, the stacking sequence and the twist angle of the layers.

This talk will review our recent studies on the ultrafast non-equilibrium optical response of TMDs and their HS. Using high time resolution ultrafast transient absorption (TA) spectroscopy, we monitor the ultrafast onset of exciton formation in TMDs [1] and the dynamics of strongly coupled phonons [2, 3]. Using helicity resolved TA spectroscopy we time-resolve intravalley spin-flip processes [4]. In HS of TMDs we measure ultrafast interlayer hole transfer [5], interlayer exciton formation [6] and use two-dimensional electronic spectroscopy to dissect interlayer electron and hole transfer processes [7]. We also show that strong exciton nonlinear interactions can lead to a complete quenching of the Rabi splitting in TMD-based microcavities [8]. The demonstrated ultrafast switching between the strong and weak coupling regimes paves the way for the development of TMD based high speed all-optical circuits and neural networks



Name: Xiangdong Zhang

Organization: Beijing Institute of Technology

Biography:

Xiangdong Zhang is a distinguished professor at Beijing Institute of Technology, China. He received the National Science Foundation for Distinguished Young Scholars of China in 2008. For many years, he has been devoted to the study of physical properties and applications of low dimensional nanostructures. He is the coauthor of more than 300 international refereed journal papers. His works have been highlighted by many scientific magazines and public media, including Physics Web, Phys. World, ScienceNews, and so on. His current research interest includes the interaction between light and matter, quantum information, quantum computation, integrated circuit, signal processing and machine learning.

Title:

Non-Hermitian Topological Sensors

Abstract:

High-precision sensors are of fundamental importance in modern society and technology. Although numerous sensors have been developed, obtaining sensors with higher levels of sensitivity and stronger robustness has always been expected. In this talk, we will introduce a novel class of sensors with superior performances based on exotic properties of nonHermitian topological physics. The frequency shift induced by perturbations for these sensors can show an exponential growth with respect to the size of the device, which can well beyond the limitations of conventional sensors. At the same time, they are also robust against disorders. The use of these sensors for ultrasensitive water pollution detection will be also introduced.



Name: Xin Ou

Organization: Shanghai Institute of Microsystem and
Information Technology, CAS

Biography:

Xin Ou is a full professor of Shanghai Institute of Microsystem and Information Technology (SIMIT), and director of the Lab of Silicon-based Materials and Integrated Devices in SIMIT, Chinese academy of science. Currently, he leads a research group working on the advanced SOI materials, heterogeneous Integration XOI material fabrication for optics, acoustics and electronics.

Title:

Heterogeneous Integration XOI Technology for integrated optics

Abstract:

Multi-layer heterogeneous integration is emerging as a promising approach for large-scale photonic integrated circuits (PICs), which has the potential in a myriad of applications including optical communications, LiDAR and quantum computing. However, several technical points must be addressed to make it possible, in particular the wafer-scale material platform, facile device manufacturing and on-chip system design. Here, we present a wafer-scale integration technique, termed ion-cutting technique, to obtain functional thin films on insulator (X-on-insulator, XOI) with ultra-high crystallinity, thus offering the commercial possibility of PICs. Given the potential of the XOI materials, such as Lithium Tantalate on insulator (LTOI), Silicon Carbide on insulator (SiCOI) and Indium phosphide on insulator (InPOI), we also discuss some advanced microfabrication methods and versatile nonlinear photonic devices including on-chip soliton generation and high-speed electro-optic modulation, which pave the path for the practical realization of monolithic photonic system.



Name: Baojun Li
Organization: Jinan University

Biography:

Baojun Li received his Ph.D from Xi'an Jiaotong University in China in 1998. After that, he worked in Fudan University, China, as a Postdoctoral Fellow till 2000. From 2000 to 2002, he worked in Singapore-MIT Alliance, first as a Postdoctoral Fellow, then as a Research Fellow. From April to October 2002, he worked in Institute of Materials Research and Engineering in Singapore as a Research Fellow. In October 2002, he joined Sun Yat-Sen University (SYSU) in China as a full Professor and served as the Director for Research Laboratory of Optoelectronic Integration. From May to November 2009, he worked in University of Oxford as a senior visiting scholar. Then, he came back to the SYSU as a Chang Jiang Scholar and served as the Dean for School of Physics and Engineering. In November 2016, he moved to Jinan University in Guangzhou, China, where he founded Institute of Nanophotonics and Guangdong Provincial Key Laboratory of Nanophotonic Manipulation.

Title:

Photonic Probes for Optical Trapping, Manipulation, & Applications

Abstract:

Photonic probes, designed to emit or collect light in the close proximity of a sample, have been extensively used to trap and manipulate objects. However, the available probes, constructed from artificial materials, are incompatible and invasive when interfacing with biological systems. In this talk, the author will mainly present biocompatible photonic probes for sub-wavelength probing of localized fluorescence from single-cell in human blood. The photonic probes were built on a tapered fiber tip by trapping a dielectric sphere-shaped particle as a microlens or a living sphere-shaped cell and a chain of rod-shaped living cells as a high-aspect-ratio nanoprobe. Light propagating along the probes can be focused into a small spot with a minimum full width at half maximum of around 200 nm. By using the probes, both micro- and nano-objects can be trapped and manipulated, localized fluorescent signals from the surfaces of single cell can be detected, and real-time optical imaging of intracellular microstructures can be observed. Moreover, the probes were further used for neural stimulation.



Name: Shih-Chi Chen

Organization: The Chinese University of Hong Kong

Biography:

Dr. Shih-Chi Chen is a Professor in the Department of Mechanical and Automation Engineering at the Chinese University of Hong Kong. He received his B.S. degree in Mechanical Engineering from the National Tsing Hua University, Taiwan, in 1999; and his S.M. and Ph.D. degrees in Mechanical Engineering from the Massachusetts Institute of Technology, U.S., in 2003 and 2007, respectively. Following his graduate work, he entered a post-doctoral fellowship in the Wellman Center for Photomedicine, Harvard Medical School, where his research focused on biomedical optics and endomicroscopy. From 2009 to 2011, he was a Senior Scientist at Nano Terra, Inc., a start-up company founded by Prof. George Whitesides at Harvard University, to develop precision instruments for novel nanofabrication processes. His current research interests include ultrafast laser applications, biomedical optics, precision engineering, and nanomanufacturing. Dr. Chen is a Fellow of Optica (formerly OSA), Fellow of American Society of Mechanical Engineers (ASME), Fellow of International Society for Optics and Photonics (SPIE), and members of the American Society for Precision Engineering (ASPE) and Hong Kong Young Academy of Sciences (YASHK). He currently serves as the Associate Editor of ASME Journal of Micro- and Nano-Manufacturing, IEEE Transactions on Nanotechnology, and HKIE Transactions. In 2003 and 2018, he received the prestigious R&D 100 Awards for developing a six-axis nanopositioner and an ultrafast nanoscale 3-D printer respectively.

Title:

Manipulation of Ultrafast Lasers based on Binary Holography

Abstract:

I will present the development of an ultrafast multi-focus laser scanning method based on a digital micromirror device (DMD) and Lee holography for both open-loop and closed-loop applications, where thousands of laser foci can be simultaneously generated and individually controlled to perform 3D random-access scanning at the DMD pattern rate of 22.7 kHz. To achieve closed-loop application, a parallel algorithm was developed and implemented on a compute unified device architecture (CUDA) via a graphics processing unit (GPU), which enables automatic generation of digital holograms at up to 8000 fps. To demonstrate the unique capability of the method, we present two case studies, including (1) a particle tracking system that can simultaneously trace hundreds of particles in a microfluidic device or for measuring the microrheology dynamics of a 3D nano-assembly hydrogel device, where diffusion properties and morphology changes were measured at the same time; and (2) a closed-loop parallel two-photon lithography (TPL) system, where a custom-built optical diffraction tomography (ODT) module is integrated with the TPL system based on a DMD and binary holography. As refractive index (RI) is directly related to the laser doses, fast RI monitoring enables closed-loop TPL for the first time. In the experiments, we demonstrated that closed-loop TPL presents improved dimensional accuracy, i.e., $200\text{ nm} \pm 30\text{ nm}$ vs. $200\text{ nm} \pm 100\text{ nm}$ (conventional open-loop TPL printing) and reproducibility. This has addressed the long-standing low reproducibility challenge of TPL, making it now suitable for industrial applications, i.e., high-resolution, high-speed, low-cost, and high yield.



Name: Qidai Chen
Organization: Jilin University

Biography:

Qi-Dai CHEN received the Ph.D. degree in Plasma Physics from Institute of Physics, CAS, Beijing, China, in 2004. He worked as a JST postdoctoral researcher in Department of Physics, the Osaka City University, Japan, from 2005 to 2006, and then as an associate professor in College of electronic science and engineering, Jilin University, China. In 2011, he was promoted as a full professor. His research interests have been laser nanofabrication technology for ultrafast laser fabrication and micro-optics. So far, he has published over 220 scientific papers in the above fields, which have been cited for over 1400 times according to ISI search report, H-index 68.

Title:

Femtosecond Laser Micro-Nano-Fabrication: New Technology and Application

Abstract:

In the past decades, research based on nonlinear optical absorption and near-field effects paved the possible ways to this goal. Less than 20 nm ($1/40\lambda$) inside the photosensitive soft materials has been achieved by amplification of the nanoregion chemical reaction. However, such method does not yield the expected material removing for hard material through the fierce laser ablation. Herein, we report an optical far-field-induced nearfield breakdown (O-FIB) for nanometric manufacturing ultrafast laser processing. The solution to this dilemma relies on a technique of polarization-guided light confinement nano-lithography. Seed structure was first deposited on the surface. Meanwhile, a near-field enhancement perpendicular to laser polarization localizes at the endpoint of the slot. Thus, with the steady and directional light-confinement of the nano-slot, optical hot spot, could be dynamically controlled to exploit its asymmetry and to realize a tractable nano-lithography by carefully keeping the scanning direction and laser polarization vertical. The light-confinement factor was deduced from the continuous condition for the normal component of displacement across the boundary of the slot. In this sense, our method is especially suitable for those transparent dielectrics with a higher refractive index.



Name: Zhaohui Li

Organization: Sun Yat-sen University

Biography:

Zhaohui Li, a Professor at the School of Electronics and Information Technology, Sun Yat-sen University, serves as the director of a Guangdong Provincial Key Laboratory of Optoelectronic Information Processing Chips and Systems.

He has been engaged in research in the fields of optical communication systems, photonic integrated circuits, and intelligent optical signal processing for a long time. He has published over 250 SCI papers, including more than 10 papers in internationally influential academic journals such as Nature Communications, Science Advances, and Light: Science & Applications; he has applied for 115 national invention patents, 61 of which have been authorized, and 8 international invention patents have been authorized as the first completer. His research achievements have won the first prize of the Guangdong Provincial Technological Invention.

He has hosted the National Key Research and Development Program of China, the National Science Fund for Distinguished Young Scholars, and the National Natural Science Foundation of China.

Title:

Hybrid-Integrated Chalcogenide Photonics

Abstract:

High-quality photonic materials are critical for promoting integrated photonic devices with broad bandwidths, high efficiencies, and flexibilities for high-volume chip-scale fabrication. Recently, we designed a home-developed chalcogenide glass [ChG]-Ge₂₅Sb₁₀S₆₅ (GeSbS) for optical information processing chips and systems, which featured an ultrabroad transmission window, a high Kerr nonlinearity and photoelastic coefficient, and compatibility with the photonic hybrid integration technology of silicon photonics. Chip-integrated GeSbS microresonators and microresonator arrays with high quality factors and lithographically controlled fine structures were fabricated using a modified nanofabrication process. Moreover, considering the high Kerr nonlinearity and photoelastic effect of ChGs, we realised a novel ChG hybrid integrated chip, inspired by recent advances in integrated soliton microcombs and acousto-optic (AO) modulators.



Name: Chaoyang Lu

Organization: University of Science and Technology of China

Biography:

Chao-Yang Lu is a Chair Professor in Physics at the University of Science and Technology of China (USTC). He completed his BS and PhD degrees at the USTC and the University of Cambridge in 2011. He has been appointed as the Deputy Director of the Shanghai Center for Quantum Sciences and as the Executive Director of the Quantum Computing Division at the Hefei National Laboratory since 2022. His current research interest includes quantum computation, solid-state quantum photonics, quantum teleportation, superconducting circuits, and atomic arrays. He is the author of over 160 papers in major research journals which have attracted →32000 citations. His work has been selected as by Physics World as “Breakthrough of the Year” in 2015, by APS Physics as one of the top ten “Highlights of the Year” in 2021 and 2022, and by UNESCO as “World’s top 10 digital innovation technologies” in 2021. He is an OSA/Optica/APS Fellow, and a recipient of the EPS Fresnel Prize, AAAS Newcomb Cleveland Prize, Nishina Asian Award, IUPAP-ICO Young Scientist Prize in Optics, OSA Adolph Lomb Medal, APS Rolf Landauer and Charles H. Bennett Award in Quantum Computing, CLEO James P. Gordon Memorial Speakership, and OCPA Achievement in Asia Award. He serves as the Divisional Associate Editor for Physical Review Letters, and recent appointed as the Chairman of World Association of Young Scientists

Title:

From Science-for-QC to QC-for-Science

Abstract:

I will go through our recent efforts in my group using photons and atoms to build increasingly large-scale quantum computers and, in turn, how these early quantum computers can already be used for studies of fundamental problems in mathematics, quantum physics, and condensed matter physics. We use the protocol of Gaussian boson sampling to demonstrate quantum computational advantage, with up to 255 detected photons [Zhong et al. Science 2020, PRL 2021, Deng et al. PRL 2023]. We develop an AI-enabled constant-time-overhead rearrangement protocol to prepare a 2024 defect-free atomic array [Lin et al. 2024]. Using a single atom trapped in an optical tweezer and cooled to the motional ground state in three dimensions, we faithfully realize the Einstein-Bohr recoiling-slit gedankenexperiment tunable at the quantum limit [Zhang et al. 2024]. Based on a bottom-up quantum engineering approach, we experimentally created the fractional quantum Hall state using strongly interacting photons [Wang et al. Science 2024]. We further use the quantum computing platform to rule out a real-value description of standard formalism of quantum theory [Chen et al. PRL 2022].



Name: Qionghua Wang
Organization: Beihang University

Biography:

Qiong-Hua Wang is a professor of optics at Beihang University. She was a professor at Sichuan University from 2004 to 2018. She was a research scientist at the School of Optics/CREOL at the University of Central Florida from 2001 to 2004. She was a faculty at the University of Electronic Science and Technology of China (UESTC) from 1995 to 2001. She received B. S., M. S. and Ph. D. degrees from UESTC in 1992, 1995 and 2001, respectively. She published more than 350 papers cited by science citation index and authored 3 books. She holds about 200 U. S. and Chinese patents. She is fellow of SID, OPTICA, SPIE, COS and CSOE. Her research interests include display and imaging technologies.

Title:

Light field 3D display with high performance

Abstract:

Light field 3D display based on integral imaging is an important 3D display. This talk will give an overview of light field 3D display technology, and introduce in detail the desktop light field 3D display and the high-resolution light field 3D display based on integral imaging developed by our team. The former achieves good 3D display effect with 360°horizontal view angle, and the latter achieves good 3D display effect with high resolution. The structure, principle and performance of the light field 3D displays will be given. Finally, the development trend of the light field 3D display is prospected.

USQS 2025 International Conference on Ultrafast Science
and Quantum Sensing (USQS)

超快科学与量子感知国际会议

JANUARY 11-15, 2025 Yachou Bay, China
2025年1月11日-15日 中国 崖州湾



Session 1 JAN. 13-14.2025

Exhibition Center Hall C1

Ultrafast High-Intensity Laser Science and Technology
超快强场激光科学与技术



Name: Zengxiu Zhao 赵增秀

Organization: National University of Defense Technology 国防科技大学

Biography:

赵增秀，国防科技大学教授，博士生导师。2005 年在美国堪萨斯州立大学获博士学位，获教育部新世纪优秀人才、军队高层次科技创新人才、政府特殊津贴。主要从事强场阿秒原子分子物理研究。主持国家重点研发计划课题、国家自科重大研究计划重点等项目，发表论文 150 余篇（包括 PRL 和自然子刊 15 篇）。获湖南省自然科学一等奖、二等奖及军队科技进步二等奖、湖南省教学成果奖一等奖、军队院校教学三等奖和湖南省首届优秀研究生导师团队。

Title:

Quantum Dynamics Probed from Picoseconds to Attoseconds

Abstract:

太赫兹脉冲和阿秒脉冲等新光源，对时域探测与诊断非稳态原子动力学和非平衡物质相变过程具有重要价值。虽然二者动力学时间尺度相差 6 个量级，利用太赫兹时域光谱或阿秒秒吸收/发射光谱或两者结合，可以揭示强光泵浦下电子的阿秒运动和原子的皮秒时间尺度运动之间的关联性和协调性。本报告将介绍课题组相关工作，力图展示太赫兹与阿秒科学的结合对深入认识物质中的极端量子动力学的重大潜力。



Name: Chengyin Wu 吴成印

Organization: Peking University 北京大学

Biography:

北京大学博雅特聘教授，国家杰出青年科学基金获得者。搭建了先进的飞秒强场物理研究平台，在气相原子分子和固体材料微纳结构等强场物理以及阿秒物理研究中取得重要成果，发表 SCI 论文 100 多篇。研究成果入选“中国高等学校十大科技进展”、“中国光学重要成果”、“中国光学科技奖基础研究类一等奖”、“教育部高等学校科学研究优秀成果奖（科学技术）自然科学奖一等奖”等。

Title:

Probing and controlling electron dynamics in condensed matter

Abstract:

The interaction between ultrafast laser pulses and condensed matter has been the subject of extensive investigation over the past decade. This research encompasses ultrafast science, strongfield physics, condensed matter physics, and nano-optics, offering significant potential for groundbreaking scientific discoveries. Both time-resolved photoemission electron microscopy and solid-state high-order harmonic spectroscopy are powerful tools for probing ultrafast electron dynamics in condensed matter induced by femtosecond laser pulses. In this report, we present our recent advancements in probing and manipulating electron dynamics by controlling the interaction between micro-nano structures and synthetic laser fields with attosecond precision. We have successfully built an ultrafast extreme ultraviolet photoemission electron microscope. Utilizing this advanced microscope with ultra-high temporal, spatial, and energy resolution, we have demonstrated the characterization and manipulation of electron pulses emitted from nanostructures on an ultrafast timescale [1,2]. We also built a compact solid-state high-order harmonic spectrometer with high sensitivity, which provides an all-optical ultrafast probe to monitor electron dynamics in condensed matter. By using the time-resolved high-order harmonic spectroscopy with the help of theoretical simulations, we have explored the determination and manipulation of electron dynamics within semiconductor materials [3,4], three-dimensional Dirac semimetals [5], and strongly correlated systems [6]. Our work demonstrates that time-resolved photoemission electron microscopy and solid-state high-order harmonic spectroscopy are effective for probing ultrafast electron dynamics in condensed matter induced by strong femtosecond laser pulses.



Name: Jianxing Li 栗建兴

Organization: Xi'an Jiaotong University 西安交通大学

Biography:

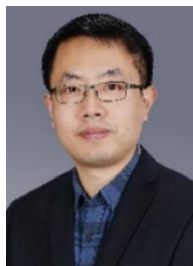
栗建兴，西安交通大学教授、博导，国家自然科学基金委 杰青、优青项目获得者，陕西省高层次人才，中国原子能院核物理所客座研究员、西北核技术研究院客座研究员。主要研究方向为激光等离子体物理、激光核物理等。以第一/通讯作者发表学术论文 60 余篇。近年来依次主持国家 自然科学基金委优青、联合基金重点、杰青、专项重点等 项目，在本领域重要学术会议作大会报告/邀请报告 40 余 次，并多次承办/协办本领域学术会议。

Title:

强激光驱动大角动量粒子源及其核反应研究

Abstract:

利用超强超短激光脉冲与等离子体相互作用，强场量子电动力学（QED）效应会起关键作用，可以产生强流、超快、具有内禀角动量的伽马光子、正负电子等辐射源，在核物理、核天体物理、粒子物理、材料物理等领域具有广泛应用价值。尤其，利用涡旋粒子激发核反应，有望增大反应截面、调控核能级跃迁、激发新反应通道等等。基于此，本报告将简要介绍我们课题组在“大角动量伽马光子、正负电子等辐射源产生原理及其新型核反应”等研究方向取得的阶段性进展。



Name: Hongbo Zhou 周洪波

Organization: Beihang University 北京航空航天大学

Biography:

北京航空航天大学教授、博士生导师、院长助理，教育部青年长江学者。获中国材料学会计算材料学分会计算材料学青年奖；主持国家自然科学基金重大项目课题、科技部 ITER 专项课题、教育部中央高校优秀青年团队培育项目等。主要从事核材料辐照损伤特色模拟程序开发与机理探索研究。

Title:

聚变堆金属材料中子辐照损伤与剂量率效应研究

Abstract:

中子辐照是聚变堆金属材料面临的严峻挑战。钨基合金被视为最有前景的面对等离子体材料，但在 14.1MeV 高能聚变中子辐照下，钨基材料中将一方面形成大量的空洞、位错环等离位缺陷；另一方面，中子辐照将导致钨发生嬗变反应，形成嬗变元素富集析出相，这些都严重劣化钨材料的微观结构和力学性能，严重影响聚变堆运行的安全性和稳定性。在目前缺乏聚变中子源进行辐照实验的情况下，开展聚变堆材料中子辐照模拟研究显得愈发重要和紧迫。

针对聚变堆金属材料中子辐照模拟研究，我们开发了动力学蒙特卡洛、团簇动力学等系列特色模型和程序，程序计算效率和准确性居国际同类程序前列。依托自主开发程序，首次从级联碰撞出发完整给出了空洞阵列的形成过程，揭示了其分段式形成演化机制。空洞阵列的形成并不是一蹴而就，而是依次要经历三个典型阶段：即形核、孕育和生长，分别对应着初始空位聚集形核、空洞核心缓慢生长并孕育阵列雏形、空洞阵列快速生长并向外扩张三个过程。辐照损伤剂量率对辐照缺陷演化具有重要影响，研究发现提高剂量率可以促进空位团簇聚集，促使其数密度升高、尺寸降低。这是由于剂量率升高缩短了缺陷演化时间，降低了空位迁移的频率，促进了空位团簇的初始成核。有趣的是，辐照温度升高会提高空位的迁移频率，从而可以补偿剂量率增加所导致的辐照微结构的差异。通过系统研究嬗变元素与辐照缺陷间的作用，发现自间隙原子在铪/钨扩散聚集起到了重要的媒介作用，提出了嬗变元素辐照诱导析出的间隙扩散聚集机制，给出嬗变元素与辐照缺陷协同演化的相图；提出通过合金化元素钉扎间隙缺陷控制嬗变元素析出的方法；阐明了嬗变元素分布状态对材料力学性能的关键作用。这些研究结果对聚变堆金属材料服役性能评估和抗辐照材料设计具有重要指导意义。



Name: Wenbin Zhang 张文斌

Organization: East China Normal University 华东师范大学

Biography:

张文斌，华东师范大学研究员，博士生导师。长期从事超快激光与分子相互作用超快动力学精密测量与调控研究。迄今在国际重要期刊发表SCI论文50余篇，包括13篇PRL/PRX、6篇Nature子刊、1篇Sci. Adv.、2篇Optica等。曾获德国洪堡学者、欧盟玛丽居里 MULTIPLY学者、中国光学学会王大珩光学奖、光学优秀博士学位论文、入选德国林岛诺贝尔奖得主大会、博士后国际交流派出计划项目等。主持国家自然科学基金青年基金，入选上海市“浦江人才计划”。

Title:

Ultrafast Dynamics of Small Molecules in Superfluid Helium Nanodroplets

Abstract:

The superfluid helium nanodroplets can cool down the molecules to 0.37 K and serve as an ideal nanoreactors for light-induced interaction between the embedded cold molecules and helium environment. The newly developed reaction microscopy of helium-nanodroplet target recoil ion momentum spectroscopy allows us to explore the ultrafast dynamics of in-droplet molecules driven by femtosecond laser pulses, where the electrons and ions ejected from an in-droplet molecule are measured in coincidence. Driven by strong laser fields, we explore how strong the interaction of a charged molecular ion is with its helium surroundings by real-time tracking the ultrafast vibrational decoherence dynamics of in-droplet D_2^+ molecule. Such strong ion-helium-droplet interaction leads to the enhanced dissociation of molecular ions. We also investigate the matter wave nature of a single cold in-droplet molecule, exhibiting as localization and delocalization behaviors depending on the molecule's mass.



Name: Huailiang Xu 徐淮良

Organization: Xidian University/Jilin University
西安电子科技大学/吉林大学

Biography:

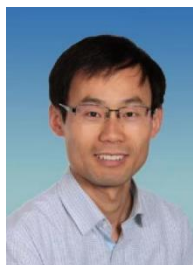
徐淮良，主要从事超快强场激光非线性光谱学和包括激光烧蚀、激光改性、激光取向、激光离化和解离等在内的激光与物质相互作用研究，在 *Phys. Rev. Lett.* 等上发表 SCI 收录论文 200 余篇，在 World Scientific 出版社发表合撰著作《*Fundamentals of Laser Optoelectronics*》(2nd Edition)，在 Springer 系列丛书《*Progress in Ultrafast Intense Laser Science*》上发表 5 章节，在 *Laser & Photon. Rev.* 等期刊上发表综述论文 10 余篇，在国际会议上作大会报告/邀请报告 70 余次。主持国家重大科学仪器研制项目、国家重点研发计划、国家重大科学研究计划(课题负责人)、国家自然科学基金面上等项目。现任西安电子科技大学光电工程学院院长，西安电子科技大学/吉林大学教授、博士生导师，东京大学客座教授，吉林省光学学会副理事长、激光专业委员会主任委员，以及 *Journal of Physics B*、*Nanomaterials*、中国激光等期刊编委等。曾获国家杰出青年科学基金项目资助并入选国家万人计划科技创新领军人才。

Title:

飞秒激光点火和燃烧诊断

Abstract:

贫燃混合物燃烧具有高能量转化效率、低污染物排放等特点，是国际上高效、绿色燃烧领域的一个研究热点。激光点火拥有点火位置可调、点火时间和能量可控、无电极以及采用非侵入式结构等优势，近年来引起人们广泛关注，被认为是未来发动机燃烧领域的重点发展方向之一。然而，长脉冲纳秒激光系统不可避免的能量波动会导致击穿具有随机性，造成潜在的点火失败；同时，在长脉冲激光激发下，人们无法获得激光点火过程中的超快动力学信息。本报告将介绍我们近期有关利用飞秒激光研究燃烧中间产物超快动力学和激光点火方面的研究工作。首先，介绍我们利用飞秒激光非线性传输形成的光丝在甲烷/空气预混合层流气流中实现了高可靠性、超低最小点火能量的新型激光点火技术，并探讨其点火物理机制。随后，将介绍我们利用飞秒激光成丝实现燃烧中间产物超快动力学诊断方面的部分研究工作。



Name: Yi Liu 刘一

Organization: University of Shanghai for Science and Technology
上海理工大学

Biography:

上海理工大学光电学院教授，上海市激光学会副理事长，教育部仪器类教指委委员，获科技部特支计划、中组部海外引进高层次人才(青年项目)等支持。2006 年获得北京大学光学专业博士学位，2006-2009 年期间在法国巴黎综合理工大学从事博士后研究工作。2009 年获聘法国国家科学研究中心(CNRS)终身职位副研究员。2014 年在巴黎第六大学取得博士生导师资格(HDR)。2015 年回到上海理工大学光电学院工作。其研究方向为超快激光与物质的相互作用，空气激光、太赫兹光谱学、激光微纳加工等。累计发表科研论文 100 余篇，其中包括 *Physical Review Letters* 论文 11 篇，所发表论文被他人引用 3000 余次。承担自然科学基金重点项目在内的国家和省部级科研项目 7 项。

Title:

Generation of Spatiotemporal Optical Vortex Attosecond Pulse Trains

Abstract:

The realization of spatiotemporal vortex structure of various physical fields with transverse orbital angular momenta (OAM) has attracted much attention and is expected to expand the research scope and open new opportunities in their respective fields. Here we present theoretically the first study on generation of attosecond pulse trains featuring a spatiotemporal optical vortex (STOV) structure by a two-color femtosecond light field, with each color carrying transverse OAM. Through careful optimization of relative phase and intensity ratio, we validate the efficient upconversion of the infrared pulse into its tens of order harmonics, showing that each harmonic preserves a corresponding intact topological charge. This unique characteristic enables the synthesis of an extreme ultraviolet attosecond pulse train with transverse OAM. In addition, we reveal that ionization depletion plays an outside role therein. Our studies pave the way for generation and utilization of light fields with STOV in the attosecond regime.



Name: Jinping Yao 姚金平

Organization: Shanghai Institute of Optics and Fine Mechanics, CAS
中国科学院上海光学精密机械研究所

Biography:

姚金平，上海光机所研究员、博导，主要聚焦超快强光场驱动的空气激光研究。以第一/通讯作者在 Phys. Rev. Lett.、Nature Commun.、Science Advances 等期刊发表学术论文 40 余篇，研究工作入选“中国光学重要成果”、饶毓泰基础光学奖。获基金委“优青”项目资助，入选上海市优秀学术带头人、上海市青年科技启明星、中国科学院青促会优秀会员、上海市巾帼建功标兵等。任《中国激光》编委、Ultrafast Science 青年编委。获 2022 年度上海市自然科学奖一等奖。

Title:

Air Lasing: From Strong-Field Ionization to Nonlinear Spectroscopy

Abstract:

Air lasing is a kind of cavity-free, laser-like coherent radiation produced by pumping atmospheric molecules with an intense ultrafast laser. As an interesting ultrafast phenomenon, the air lasing has attracted extensive interests in the past decade. The intriguing physical mechanism of N₂⁺ lasing promotes us to revisit the fundamental process of strong-field ionization and subsequent population distribution on various ionic states. Owing to its unique characteristics (e.g., cavity-free amplification, bidirectional emission, narrow bandwidth, etc.), air lasing also opens exciting perspectives in atmospheric remote sensing. In this talk, we will present the recent progress in the gain mechanism of air lasing as well as its application in the detection of gas concentration and temperature.

Session 2 JAN. 13-14.2025

Exhibition Center Hall C1

Ultrafast Laser Technology and Devices
超快激光技术与器件



Name: Jie Li 李捷、Zhongwei Fan 樊仲维

Organization: Aerospace Information Research Institute, CAS

中国科学院空天信息创新研究院

Biography:

李捷，博士，现任中国科学院空天信息创新研究院研究员、博士生导师。2012年毕业于中国科学技术大学物理系，获得学士学位；2018年获美国中佛罗里达大学光学博士学位，研究方向为超快飞秒激光与高次谐波技术。他曾在软 X 射线波段产生了 53 阿秒的单个光脉冲，打破了最短激光脉冲的世界纪录，并首次在软 X 射线波段实现了阿秒脉冲的压缩与脉宽测量，为新一代阿秒光源的发展奠定了基础。近年来，李捷研究员主持研发了高效率极紫外激光器与高效率极紫外单色仪。他在权威期刊共发表 SCI 论文 12 篇，总引用次数超过 500 次。此外，李捷研究员还获得了 2019 年中科院杰出科技成就奖和 2017 年国家优秀自费留学生奖学金一等奖等荣誉。

樊仲维，研究员，博士生导师，现任中国科学院空天信息创新研究院副院长。1986年毕业于浙江大学光学仪器工程学系，1997年在中国科学院长春光学精密机械与物理研究所获理学博士学位。樊仲维研究员长期从事高功率短脉冲激光的应用基础、关键技术和工程应用研究，在高峰值功率、高光束质量和工程化技术等方面取得了系统创新成果，研制出系列短脉冲激光器并实现了工程化应用。他获得了国家技术发明奖二等奖、国家科学技术进步奖二等奖、北京市科学技术奖一等奖和军队科技进步一等奖等多项荣誉。此外，樊仲维研究员还入选了国家级新世纪百千万人才工程、科技北京百名领军人才培养工程和国家“万人计划”等人才项目。

Title:

高效率极紫外高次谐波激光器与应用



Name: Minglie Hu 胡明列

Organization: Tianjin University 天津大学

Biography:

胡明列，天津大学精仪学院教授、博士生导师，兼任 2018-2022 年教育部电子信息类专业教学指导委员会委员。致力于新型高功率光纤飞秒激光技术的相关基础性研究工作，并带领团队开展飞秒激光装备及相关精密测量和加工装备的产业化。作为项目负责人主持了国家自然科学基金面上项目、国际交流项目、优秀青年基金、重点项目、重大仪器研制项目以及 973 计划课题、863 计划课题等多项国家和省部级项目。发表高水平学术期刊论文 300 余篇，被引用 4000 余次。全国优秀博士论文获得者，入选教育部新世纪优秀人才计划。光子晶体光纤飞秒激光技术入选“高等学校十大科技进展”，荣获教育部技术发明一等奖。

Title:

阿秒时间分辨的超快激光非线性动力学分析和全光调控技术

Abstract:

报告从光纤的波导传输方程开始，介绍飞秒激光在光纤中的非线性传输动力学，详细分析光纤的色散和非线性对飞秒激光传输的影响，尤其是对基于光纤的高功率飞秒激光系统输出参数的影响，进而介绍如何通过动力学过程智能控制，实现光纤系统中输出周期量级高性能飞秒激光。

Name: Weitao Liu 刘韡韬

Organization: Fudan University 复旦大学

Biography:

刘韡韬，复旦大学物理系谢希德青年讲席教授，研究方向聚焦在非线性光学在表面与低维科学前沿领域的拓展与突破，建立新型表征方法以探索其中涌现的新现象与新机制，工作发表在 Nature 与 Science 子刊、PNAS、PRL 等期刊，入选 PRL Editor's Suggestions, ACS Editor's Choices、ACS 期刊封面论文、ESI 高被引论文等、“中国光学十大进展”等，获教育部新世纪人才计划、国家自然科学基金委优秀青年基金、中组部青年拔尖人才计划、以及上海市曙光计划支持。

Title:

低维体系的非线性光学研究

Abstract:

低维量子材料的空间限域效应与独特电子结构导致了种种有趣的物性，也为非线性光学开辟了新的探索空间。早期工作中即发现石墨烯线的性色散使得非平衡载流子间的散射过程异于常规材料，导致一种新奇的超快上转换非线性荧光现象，自此使低维体系中的非线性光学走进了人们的视野。近年来，我们探索了多种迥异于常规体系的非线性光学效应，包括利用栅极电压对低维体系的三次谐波、四波混频响应实现了跨越多个数量级的大幅调控、观测到不同光子跃迁通道间的量子干涉效应、高阶的电四极矩二次谐波及其对电子-空穴能带对称性的灵敏度、以及拓扑狄拉克费米子体系中源于电荷共轭对称破缺的光学二次谐波响应、等等。与此同时，我们探索了一系列运用非线性光学对低维材料结构进行原位表征的方法。之前，我们发展了光学二次谐波显微成像用于解析二硫化钼“折纸”双层在原子尺度上的堆叠结构。自此后该技术已成为二维材料最重要的原位表征方法之一，但绝大部分工作都局限于对完美六角晶格的定性探测。目前，我们开发出定量计算二维晶格体系二阶光学极化张量的解析方法，普遍适用于各类原胞结构，可定量探知晶格常数与键角的变化，并将其拓展到其他低维体系。目前该方法也已被越来越多地运用到低维晶格结构的研究中。

Name: Wenkai Zhang 张文凯

Organization: Beijing Normal University 北京师范大学

Title:

X-Ray Free Electron Laser and Its Application in Ultrafast Dynamics Research

Abstract:

Advanced experimental methods with high spatial-temporal resolutions are essential for ultrafast dynamics at microscopic scales, primarily focusing on the movements of individual electrons or nuclei. The rapid development of X-ray free-electron lasers (XFELs) has created a new foundation for ultrafast dynamics research by offering fully coherent ultrabright femtosecond X-ray pulses. The cutting-edge technology developed around the XFELs has enabled revolutionary breakthroughs in multiple disciplines in the past decade. X-ray emission/absorption spectroscopy, X-ray scattering, and X-ray crystallography have quickly adapted to the XFEL facilities, investigating high-resolution structure and dynamics. The principles of the above three characterization techniques are summarized with the associated applications. Together with effective pumping methods triggering dynamics or reactions, time-resolved information can be measured at XFELs using the "pump-probe" approach. The development of the XFEL-based time-resolved methods is particularly significant for light-sensitive macromolecules. Novel insights into the structural dynamics are being gathered for a comprehensive understanding of the detailed process and its underlying molecular mechanism.



Name: Han Zhang 张晗

Organization: Shenzhen University 深圳大学

Biography:

张晗，深圳大学特聘教授，首届国家优青、青年千人、OSA Fellow、RSC Fellow 等；主持包括国家自然科学基金重点项目、科技部重点研发等国家级项目，长期从事脉冲激光器研究，在 PNAS、Light 等期刊上发表 SCI 论文 150 余篇，100 余篇 ESI 高引用论文，总 SCI 他引用 >7 万次，H-因子 160。获得教育部自然科学二等奖、广东省丁颖科技奖、广东省青年科技奖、吴文俊人工智能奖、中国光学十大进展、高被引学者等。

Title:

新型主被动调制超快激光技术研究

Abstract:

光纤激光器作为第三代激光技术代表，具有高效率、高光束质量、结构紧凑、高稳定性等优势，已成为精密加工、国防军事、医疗等领域的重要光源，对国家安全、国民经济可持续发展具有重要战略意义。脉冲激光技术是指在激光器中实现高能量、短脉冲输出的有效技术手段，主要通过被/主动调制两种途径实现，其关键在于调制器件。以半导体可饱和吸收镜 (SESAM) 为代表的被动调制器件，面临国外垄断及卡脖子现状(比如工作波长有限、响应速度慢、工艺复杂等)；以铌酸锂为代表的主动调制器件，受限于损耗高、电光/声光调制带宽窄、工作波段窄等难题。基于此，围绕上述难题：1) 揭示石墨烯、磷烯等二维原子晶体超快非线性光学特性及其调控规律，基于其可控可调光学饱和吸收效应，突破调制深度、工作波段等局限，研制出宽波段高性能可饱和吸收器件，应用于覆盖从可见光到中红外波段超短脉冲产生，填补了中红外被动调制光纤激光器技术空白；2) 基于其独特非线性光学吸收、克尔、电光等效应，解决主动调制器工作带宽、响应波段、能耗等难题，研制出国际上最大带宽 100G 石墨烯电光调制器件，开发基于全光、电光非线性效应的脉冲光纤激光新技术，突破中红外主动调制激光技术壁垒。



Name: Yuping Chen 陈玉萍

Organization: Shanghai Jiao Tong University 上海交通大学

Biography:

陈玉萍, 博士, 教授, 博士生导师。美国 Rochester 大学光学系博士后(导师 R.W. Boyd)。目前为美国光学学会, 中国物理学会及光学学会终身会员, 基础光学委员会委员, 中国感光学会“光学精密成型专业委员会”委员, 曾为中国光学学会青年工作委员会主席团成员; 卓越期刊 COL 杂志 TE。研究方向为非线性光学与微纳光子学, 飞秒激光微纳制造。主持 NSFC 重点项目, 科技部 863 项目和国家重大专项课题, 参与国家重点研发计划课题若干。重要学术贡献包括“基于均匀掺杂铯离子的铌酸锂晶体, 世界上首个报道了通讯波段的片上铌酸锂微盘腔激光器; 推动了铌酸锂集成光子学的发展, 激发了其全新的光源、放大和信息存储的应用”等。该论文工作发表以来连续 3 年为 ESI 高被引论文。

Title:

从准相位匹配到宽带集成非线性

Abstract:

基于铌酸锂基的集成非线性的大规模应用背景, 结合铌酸锂晶体的各向异性与波导相对光轴取向, 首先我们基于跑道环腔的完美准相位匹配(QPM)的实现, 最终获得了无需电场极化的自发准相位匹配(SQPM)的带宽为 1nm 的高效倍频输出。对比上述工作中完美满足 SQPM 条件与部分满足 SQPM 但是完美满足 QGVM 的跑道型微腔, 课题组观察到倍频带宽显著变大, 由 1nm 提升到 13nm; 并通过进一步的亚微米波导色散设计和结构优化, 课题组还将 QGVM 设计应用到了弯曲波导上, 并演示了飞秒脉冲的倍频转换(带宽 16nm50nm), 在跑道环腔和弯曲波导中实现了十至几十倍的倍频带宽增大。该片上 QGVM 结合非完美 SQPM 的宽带集成非线性频率转换新方案 还可应用在飞秒激光脉冲的和频产生(SFG)、差频产生(DFG)和光参量振荡(OPO)等参量过程。



Name: Yunxia Jin 晋云霞

Organization: Shanghai Institute of Optics and Fine Mechanics, CAS
中国科学院上海光学精密机械研究所

Biography:

晋云霞，研究员、博士生导师、国家高层次人才、国务院特殊津贴专家，主攻衍射光学及多功能激光衍射元件技术，主持和承担国家重点研发计划变革性技术关键科学问题重点专项、上海市战略新兴产业等重大项目二十余项，开展体系化研究，突破技术瓶颈，解决多类型高功率高能激光系统中不同光栅“卡脖子”问题。工作以来以通讯或第一作者在国际知名期刊发表该领域学术论文 50 余篇，授权发明专利 26 项，获省部级一等奖 2 项。

Title:

强激光衍射光栅研制新进展

Abstract:

随着大能量高峰值功率脉冲激光器的发展，大口径脉冲压缩光栅逐渐成为其性能进一步提升的瓶颈。上海光机所研究团队这些年着眼于提升阈值、增加口径、拓宽光谱技术研究并取得系列进展，有望为新一代的强激光技术打下基础。



Name: Chunyu Guo 郭春雨

Organization: Shenzhen University 深圳大学

Biography:

郭春雨，深圳大学教授，博导，IEEE Senior Member，中国光学工程学会激光技术及应用专委会委员，中国光学学会光电技术专委会委员。从事于近红外和中红外波段光纤激光器研究，主持国家自然科学基金重点项目 1 项、面上项目 2 项、青年项目 1 项，以及 10 余项产业化和横向课题；获得美国及中国发明专利授权 11 项；开发了多种类型的光纤激光器，相关成果获得 2021 中国国际高新技术成果交易会“优秀产品奖”、2023 中国光学工程学会“光纤激光五年优秀成果”、2024 “红光奖”激光器创新奖，受邀参加 2023 中国光电子信息“自立自强”科技成果专场发布会。曾荣获 2023 中国光学工程学会技术发明二等奖（1/6）、2022 中国专利奖优秀奖（1/6）和 2022 深圳市科学技术奖专利奖（1/6）。

Title:

中红外高功率光纤激光器研究

Abstract:

中红外激光在医疗手术、分子光谱学、遥感和材料加工等领域具有重要的应用价值。课题组提出基于激发态吸收的 $1.7\ \mu\text{m}$ 泵浦的 $2.8\ \mu\text{m}$ 掺铒光纤激光器发光效率提升方法；研制了中红外氟化物光纤合束器、FBG、包层功率剥离器、光纤端帽和氟化物跳线等中红外光纤激光核心器件；开发了基于掺铒氟化物光纤的中红外被动锁模激光器、混合锁模激光器、同步泵浦锁模激光器和时空锁模激光器，实现了 165 MHz 国际最高重频的 $3\ \mu\text{m}$ 高稳定飞秒锁模光纤激光器；进而结合氟化物光纤放大器构建了自由空间和全光纤结构的 $3\ \mu\text{m}$ 中红外高功率超快激光系统，实现了 8.12 W 国际最高平均功率，脉宽 148 fs 的中红外飞秒光纤激光，以及 3.42 W 国际最高功率的 $3\ \mu\text{m}$ 全光纤化中红外飞秒光纤激光器，脉宽为 115 fs。提出基于光纤带内级联放大的改进型孤子自频移（SSFS）系统，实现了 $3\sim 3.8\ \mu\text{m}$ 大范围波长可调谐瓦级纯孤子飞秒脉冲， $3.8\ \mu\text{m}$ 输出功率达到 1.6 W，脉宽为 252 fs。



Name: Chengbo Mou 牟成博

Organization: Shanghai University 上海大学

Biography:

牟成博，上海大学通信与信息工程学院教授、博士生导师。国家海外高层次人才计划青年项目、上海市首批“青年东方学者”、教育部“春晖学者”获得者、教育部“优秀海外留学生奖学金”获得者，主要从事基于新型纳米材料、光纤器件的全光纤超快光纤激光器及其孤子动力学的研究，致力于开发国产化的核心激光器件。

Title:

基于单壁碳纳米管的超快掺铒光纤激光器

Abstract:

超快光纤激光器在光学通信、材料加工、光谱学以及频率梳、精密测量等领域具有广泛的应用。在被动锁模技术中，除了商用型半导体可饱和吸收镜和“9”字腔技术，单壁碳纳米管具有亚皮秒恢复时间、宽工作波段、成熟的量产工艺以及丰富的光纤兼容形式，被认为优异的可替代的材料可饱和吸收体。报告人团队专注于单壁碳纳米管可饱和吸收体的制备、参数调控及其在超快掺铒光纤激光器中的应用研究。通过单壁碳纳米管的直径控制、超声工艺优化和多种表征反馈，可制备多种类型的单壁碳纳米管可饱和吸收体。配合超快掺铒光纤激光器的参数设计，成功地实现了多种特性的超快脉冲输出，包括百飞秒全光纤种子源、抗湿型稳定孤子源、百 MHz 基频孤子源、双向光纤频率梳以及 GHz 重频超快种子源等。



Name: Can Li 李灿

Organization: National University of Defense Technology 国防科技大学

Biography:

李灿，国防科技大学前沿交叉学科学院副研究员。主要 从事高性能超短脉冲/超窄线宽光纤激光技术及应用方 面 的 研 究 ， 在 *Photonics Research*, *APL Photonics*, *Ultrafast Science*, *Optics Letters* 等学术期刊发表论文 60 余篇，授权发明专利 10 余项。获得中国光学工程学会 科技创新奖、湖南省光学科技进展奖等奖项，入选《红 外与激光工程》青年编委。目前作为项目负责人主持国 家重点研发计划课题、国家自然科学基金面上以及 173 计划技术领域基金等项目的研究工作。

Title:

全光纤超快激光啁啾脉冲放大及相干合成

Abstract:

高功率/能量超快光纤激光在基础研究和工业领域中都有广泛的应用，如精密 制造、高次谐波产生等。然而，由于高峰值功率激光被限制在纤芯内会产生 严重的非线性效应，制约了超快光纤激光的功率和能量提升。特别是对于全 光纤啁啾脉冲放大系统而言，由于纤芯直径相对较小且激光距离传输较长， 非线性效应会更加严重。本报告将主要介绍我们团队近期在超快光纤激光啁 啾脉冲放大以及多路相干合成方面的研究成果。

Name: Nanqing Chu 褚楠清

Organization: Ultrafast Science

Title:

Work Progress of Ultrafast Science——Turn the Journal into A Scientific Community

Name: Zhichao Luo 罗智超

Organization: South China Normal University 华南师范大学

Title:

四阶色散驱动的光纤激光孤子动力学

Abstract:

超快光纤激光器无论对于基础科学研究还是工业应用都有重要的价值，是近年来激光技术领域的一个研究热点。除了作为超短脉冲激光光源，超快光纤激光器同时还是研究孤子动力学的一个优良平台。本次报告将回顾课题组近年来利用四阶色散的脉冲整形技术，在超快光纤激光器中孤子脉冲演化特性方面的研究结果。相关结果将有利于研究人员进一步理解孤子非线性行为动力学和提升光纤激光器性能。



Name: Jinxia Feng 冯晋霞

Organization: Shanxi University 山西大学

Biography:

冯晋霞，教授，山西大学光电研究所/量子光学与光量子器件国家重点实验室。致力于全固态激光技术、连续变量非经典光源的研制及其在量子信息处理和量子精密测量等领域的应用研究。主持和参与国家自然科学基金、国家重点研发计划、科技部国家重大科学仪器设备开发专项等科研项目 10 余项。相关成果在 *Phys. Rev. Lett.*, *Appl. Phys. Lett.*, *Opt. Lett.* 等学术期刊上发表论文 60 余篇，授权国内外发明专利 20 余件。研究成果“光场量子态的制备、操控以及在量子信息中的应用”获得山西省自然科学二等奖，入选山西省“三晋英才”青年优秀人才。

Title:

基于低噪声光源的连续波受激拉曼光谱检测

Abstract:

具有高光谱分辨率、高检测信噪比、低光热效应的分子振动光谱检测技术在前沿生物化学研究、高端化工等领域，如活体生物在体检测、复杂化学品合成制备流程原位精密监测、痕迹物证的无损检测等方面有重要的应用。目前，相关领域的常用技术是表面增强拉曼光谱技术或基于超短脉冲光源的受激拉曼光谱技术，这些技术的光谱分辨率通常受限于光源的宽线宽、生物安全辐照剂量下的检测信噪比受限于光源的高峰值功率导致的非线性光损伤和光热效应。本论文针对上述问题研制了自动化、高精度的连续波受激拉曼光谱仪。为降低光谱测量噪声、改善光谱测量分辨率，利用自制的低噪声、窄线宽的多波长连续波单频固体激光器作为光谱仪的光源；为实现拉曼光谱的高频率分辨率测量，设计制备了基于波长计和扫描 F-P 干涉仪的泵浦光频率精确识别装置；为实现自动化拉曼光谱检测、降低测量误差，研制了基于仪器通信技术的集成化光谱测量与控制系统，实现激光波长的自动精细调谐、泵浦光功率实时补偿、泵浦光调制深度实时优化。使用纯二甲基亚砜作为测试样品，测得研制的连续波受激拉曼光谱仪的光谱测量分辨率为 0.02 cm^{-1} 。光谱仪的光谱测量速度为 $624\text{ cm}^{-1}/\text{min}$ ，测量信噪比达 48.2 dB ；拉曼位移的测量不确定度达 0.018 cm^{-1} 。

Name: Jingui Ma 马金贵**Organization:** Shanghai Jiao Tong University 上海交通大学**Biography:**

Jingui Ma is a professor of School of Physics and Astronomy, Shanghai Jiao Tong University. His studies focus on ultrafast nonlinear optics, ultrashort intense laser and mid-infrared ultrafast laser. He has published over 80 research papers, held 17 authorized patents, and won (ranked 2nd) the First-prize Award for Technological Invention issued by Ministry of Education of China. He is the Young Editor of the journals <Ultrafast Science> and <High Power Science and Engineering>.

Title:

Long-Wave Infrared Ultrafast Intense Lasers

Abstract:

Intense long-wave infrared (LWIR) femtosecond pulses within the 8–14 μm atmospheric window present an array of applications, such as in strong-field physics, ultrafast nonlinear spectroscopy, and self-guided atmospheric propagation. However, the realization of an LWIR source capable of delivering millijoule-class energy, few-cycle duration, and kHz repetition rate concurrently remains challenging. Here, we report such an LWIR source via the combination of different nonlinear parametric processes, driven by a 1 kHz Yb:YAG thin-disk laser. The system comprises two parallel multi-cycle optical parametric chirped-pulse amplifiers (OPCPAs) operating at 2.3 μm and 3.1 μm , respectively, alongside a stage of ZnGeP₂-crystal-based difference-frequency generation (DFG). The resulting 9 μm DFG pulses have a record energy of 0.21 mJ, a 3-cycle duration, a 1 kHz repetition rate, and long-term energy stability. The simultaneous output of three synchronized intense lasers at short-wave infrared (2.3 μm), mid-wave infrared (3.1 μm), and LWIR (9 μm), renders the source particularly appealing for multi-color ultrafast applications.



Name: Quan Niu 牛泉

Organization: South China University of Technology 华南理工大学

Biography:

牛泉，华南理工大学发光材料与器件国家重点实验室教授，博导，国家海外高层次人才，广东省“珠江人才计划”引进创新创业团队项目子课题负责人，德国马普所高分子研究所客座研究员，教育部先进材料功能材料国际合作联合实验室副主任，主持国家“海外高层次人才计划”青年项目、国家自然科学基金、广东省自然科学基金、我国核心光电显示企业横向课题等多项国家级和省部级科研基金项目。担任华南理工大学发光材料与器件国家重点实验室新型半导体材料与器件物理课题组组长/独立 PI。旨在探索新型半导体光电材料与器件基本物理机制。包括电荷传输与复合机制，陷阱效应与缺陷本质，器件稳定性机理与高稳定性薄膜发光显示器件的实现等。

Title:

量子点发光二极管的电致老化机理

Abstract:

蓝光量子点发光二极管(QLEDs)的低稳定性和低寿命阻碍了其进一步商业化应用，是业界迫切需要解决的核心问题。从电荷注入、传输和复合角度出发，理解器件电致老化现象的物理本质，是研究和提高 QLEDs 稳定性的关键所在。针对 CdZnSe 基蓝光量子点材料制备单载流子器件研究其电荷传输过程，揭示了其电荷传输机制为跳跃传输。利用扩展高斯无序模型(EGDM)，准确描述迁移率随温度、电场和载流子浓度的依赖特性，并量化了无序量子点薄膜的迁移率、跳跃传输距离以及能量无序性。在此基础上，本研究利用瞬态响应电致发光(TEL)测试，探究了 QLEDs 中的电荷传输过程，证实电荷传输是由空穴主导。进一步，利用 TEL 测试直接追踪器件老化过程中空穴传输的变化，研究发现随器件老化空穴传输时间逐渐增加，这归因于空穴陷阱的形成。在阻抗测试中发现器件通电过程中负电容现象逐渐增强，并伴随电致发光光谱中陷阱辅助复合强度增加，直接证实了空穴陷阱的形成。基于上述结果，构建了电致老化数值模型，计算了空穴陷阱密度随老化时间的变化，结果与负电容测试得到的陷阱密度高度吻合。研究结果证明量子点层中空穴陷阱的形成是蓝光 QLED 电致老化的关键过程，也是导致器件在恒电流密度下电压上升、亮度衰减的关键原因。



Name: Xiaobo Li 李校博

Organization: Tianjin University 天津大学

Biography:

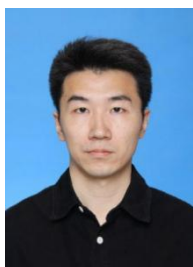
李校博，天津大学海洋科学与技术学院英才副教授，博士生导师，入选中国科协“青年人才托举工程”，全球前2%顶尖科学家榜单等。致力于海洋光学相关领域的研究，以第一/通讯作者身份在 Information fusion, Optics Letters, Optics Express, IEEE Trans 系列等国际知名期刊发表学术论文40余篇，其中二区以上论文30余篇，多篇工作被美国光学学会和英国物理学会因选为 Editor's Pick 及编辑遴选等。累计申请国家发明专利18项，已授权12项。主要参与出版了“十三五”国家重点出版物出版规划项目专著1部，先后主持国家及省部级项目6项。

Title:

浑浊水下双光梳测距增强技术研究

Abstract:

The distance measurement performs as the basis of many sensing functions, including tracking, surface reconstruction, and pose determination. Optical-based ranging sensors have been proven as a promising tool and reach up to micrometer-level accuracy combined with dual-comb interference. Applying them to underwater scenarios is feasible, but one must handle the issue that the ranging signal is significantly affected by the underwater environmental noises. We present enhancement algorithms tailored to the dual-comb signal to improve the quality of measuring signals in different turbid water. Specifically, considering desired dual-comb interferogram characteristics, we design a fitness function applied for the variational mode decomposition (VMD). Accordingly, we optimize vital parameters and decompose the interested ranging signal to ensure final interferogram quality for distance calculation. To handle the computing consumption problem, we introduce extra algorithms based on the short-time Fourier transform (STFT) to improve the processing efficiency. Experiment results verify that our method is superior to others and can improve the SNR level and restore the Gaussian-like shape of interferograms simultaneously. The proposed solution may find important applications in optical ranging and imaging tasks underwater, as well as extend working range and robustness against non-ideal environments.



Name: Gehui Xie 谢戈辉

Organization: East China Normal University 华东师范大学

Biography:

谢戈辉，华东师范大学精密光谱科学与技术国家重点实验室，专任副研究员，主要从事高功率光频梳，双光梳光谱技术研究与应用等领域的研究。

Title:

高功率光纤光频梳及其噪声特性

Abstract:

In recent years, the growing demand in strong-field and nanosecond physics has created a need for lasers with excellent carrier-envelope phase (CEP) stability. Furthermore, many applications which include metrology, spectroscopy, microscopy, and physical chemistry, to name a few, would certainly benefit from a high photon flux, and there is growing interest in high average power, CEP-stable lasers. CEP-stable few-cycle sources have revolutionized science by enabling studies that expose the dynamics of electrons, molecules, and chemical bonds, eventually leading to the formation of a whole new research area — attosecond science. Next-generation femtosecond light sources are currently being developed with the goal of producing few-cycle pulses with a high repetition rate and average power. A higher photon flux, as observed by a number of researchers, would tremendously assist future applications such as high-harmonic generation, attosecond streaking, and precision spectroscopy, which would drastically reduce experiment period or improve signal-to-noise ratio. To date, we have achieved the highest average power high carrier envelope offset (CEO) stabilized fiber frequency comb with a CEP stability of 375 mrad at 132 W.



Name: Zhengru Guo 郭政儒

Organization: University of Shanghai for Science and Technology
上海理工大学

Biography:

郭政儒，上海理工大学副研究员。研究方向为：飞秒激光技术及应用。针对飞秒激光如何在长期运转中“靠得住”的问题，发展了多项飞秒激光产生、时频操控、稳定控制方法与技术，为可调谐、高稳定、长寿命的超快飞秒激光器提供创新解决方案；构建了双波长锁模激光器理论模型，首次揭示并厘清了双波长锁模脉冲演化形成过程，阐明了其从混沌到稳定振荡的过程、方法和机制。相关成果获第九届中国光学工程学会技术发明二等奖。基于光纤-固体混合再生放大技术，开发了基于 Yb 激光晶体的百瓦级、十毫焦飞秒激光装置，突破了激光功率和能量提升的诸多关键限制。研究成果发表在在包括 HIGH POWER LASER SCI., IEEE J. Light. Technol., APPL. PHYS. LETT.等国际国内知名期刊上。授权国内外发明专利十余项。

Title:

基于 Yb:Calgo 晶体的百瓦级十毫焦飞秒再生放大器

Abstract:

我们基于光纤飞秒种子源和 Yb:CALGO 激光晶体，结合啁啾再生放大技术，解决了高功率、高能量固体再生放大中热效应累积、时频窄化、能量/功率提升中的诸多限制，实现其在重复频率大于 10 kHz 时大于 100w 的平均功率输出，同时具有 10 mJ 的单脉冲能量。经光栅压缩后脉冲宽度约 130 fs，峰值功率大于 70GW，为工业加工和科学研究提供优质的超快光源。



Name: Jiale Chao 朝家乐

Organization: Beihang University 北京航空航天大学

Biography:

朝家乐，在读工程博士。2023 年于北京航空航天大学仪器科学与光电工程学院获学士学位。同年入选中组部“卓越 工程师”工程硕博培养专项，继续在北京遥测技术研究所和北京航空航天大学联合培养下直接攻读博士学位。依托“精密光机电一体化技术教育部重点实验室”，从事超快脉冲光纤激光器及应用方面的研究。所获荣誉包括：国家奖学金、北航三好学生、全国大学生光电设计大赛二等奖及首都挑战杯专项赛擂主金奖等。共发表 *Advanced Optical Materials*（内封面）、*Laser & Photonics Reviews*（封底）等 SCI 期刊论文 7 篇，申请国家发明专利 2 项。

Title:

跨波段镍纳米颗粒超快脉冲光纤激光器

Abstract:

近年来，超快脉冲光纤激光器作为峰值功率高、脉冲持续时间短和光谱 宽度宽的脉冲光纤激光器在精密加工、生物医学等领域得到广泛应用。本文 对研究较少的镍纳米颗粒可饱和吸收体应用及基于镍纳米颗粒的超快激光器 展开研究。选择油相合成法和夹合式集成实现镍纳米颗粒的制备与集成，发 现镍纳米颗粒薄膜在 900-2100 nm 范围内表现出良好的线性透过性。对基于 镍纳米颗粒的掺铒脉冲光纤激光器进行实际搭建和优化。在 78 mW 泵浦功 率下得到高质量稳定调 Q 脉冲，脉冲的中心波长在 1563.2 nm，重复频率为 34.18 kHz，脉宽为 10.8 μ s，信噪比为 40 dB。验证了提高泵浦功率对调 Q 脉 冲的优化作用。搭建基于镍纳米颗粒的调 Q 锁模铽钛共掺激光器，首次运用 镍纳米颗粒可饱和吸收体调制产生 2 μ m 波段的锁模脉冲输出。在 215 mW 泵浦功率下，调 Q 锁模脉冲的中心波长在 1910.3 nm，调 Q 包络的宽度为 4.8 μ s，两相邻包络间隔为 16.0 μ s，包络下锁模脉冲两相邻脉冲间的时间间隔为 31.6 ns，重复频率为 31.5 MHz。调节平衡腔内增益，同时在铽钛共掺激光器 内观察到暗孤子的产生。



Name: Junyang Liu 刘俊阳

Organization: Shanghai Institute of Ceramics, CAS
中国科学院上海硅酸盐研究所

Biography:

PhD student of Shanghai Institute of Ceramics, Chinese Academy of Sciences

Title:

The Structure Investigation of Nd³⁺-Doped Alkaline Earth Metal Fluorides

Abstract:

Ultrafast and high power lasers have attracted great interests. The neodymium doped calcium fluoride crystals have played a more crucial role in ultrafast and high power lasers. The crystals have excellent performance for both the high thermal conductivity and the broad photoluminescence band. However, the exploration of microstructure is still challenging in the case of complicated cluster structures. The present work thus combined the first-principles calculation, XRD, single-crystal neutron diffraction, EXAFS, cryogenic spectrum to further figure out the cluster structure in Nd:CaF₂, Nd:SrF₂ and Nd,Y:CaF₂ crystals. Even under heavily doped, the crystals are proved to be single-phase and remain the former structure. Site occupancy of fluorides ions was clarified by applying neutron diffraction and theoretical calculation, both of which were in accordance to each. With support of calculation and spectrum, the clusters were divided into several categories and are quantitatively analyzed by EXAFS.

Session 3 JAN. 13-14.2025

Exhibition Center Hall C1

Fiber Laser and Intelligent Control
光纤激光与智能控制





Name: Xueming Liu 刘雪明

Organization: Southeast University 东南大学

Biography:

曾在剑桥大学、清华大学、新加坡科技研究局、香港中文大学、首尔国立大学等学习和工作。国家杰青获得者、“百千万人才工程”国家级人选、中科院“百人计划”入选者。获得王大珩中青年科技人员光学奖，获得国务院政府特殊津贴。连续十年（2014至2023年）入选爱思唯尔（Elsevier）年度中国高被引学者。3篇论文被评为年度中国百篇最具影响国际学术论文。1篇论文入选“2014中国光学重要成果”，1篇论文入选“2018中国光学十大进展”，1篇论文入选“2021中国光学十大进展”。研究领域为激光技术及应用。

Title:

超快激光测量及智能控制

Abstract:

超短高能量脉冲光纤激光器在通信、传感、精密机械加工等领域均有重要的应用。如何提高激光脉冲的功率和能量，掌握和利用超短脉冲光纤激光的复杂非线性，开展高能量、超宽带全光纤超短脉冲激光应用的关键技术研究，成为了光纤脉冲激光的重要科学问题。我们总结了近年来国内外关于锁模光纤激光器研究的一些关键技术和重要成果，分析了各类激光器及所产生脉冲的优缺点，重点讨论了不同色散区内光纤激光器的典型行为特征，从理论与实验两方面揭示了耗散孤子的产生机理、输出特性及其演化规律。基于AI技术，优化和控制超快激光。



Name: Kan Wu 吴侃

Organization: Shanghai Jiao Tong University 上海交通大学

Biography:

2006 年、2009 年获上海交通大学电子工程系学士和硕士学位，2013 年获新加坡南洋理工大学博士学位。在超快光子学和集成光电子等方向上取得多项成果。多篇论文入选 ESI 热点论文和高被引论文，论文总引用 4000 余次。相关成果发表于 *Light: Science & Applications*、*Nature Communications*、*Optica* 等国际光学期刊。对双光梳及微腔非线性动力学的研究入选多个国际知名会议的 Postdeadline Paper，包括 CLEO 2024、ECOC 2024、CLEO Europe 2021 等。2020-2024 年连续入选由 Stanford 大学评选的全球前 2% 顶尖科学家。在系统应用上，研制的集成光束扫描芯片获 2023 年源创杯一等奖，并入选中国空间站元器件试验任务，试验样机于 2023 年 5 月发射已在轨运行一年有余。

Title:

薄膜铌酸锂片上增益及锁模光源研究进展

Abstract:

本报告将介绍本团队近年来在薄膜铌酸锂集成光子平台上，对掺铒增益、单频激光器和锁模光源开展的研究进展，本工作有望为实现片上高性能光放大器、窄线宽激光器和脉冲激光器奠定基础。



Name: Zinan Wang 王子南

Organization: University of Electronic Science and Technology of China
电子科技大学

Biography:

电子科技大学信息与通信工程学院教授，国家级青年人才项目入选者，爱思唯尔“2023中国高被引学者”。长期从事智能信息感知与先进激光研究，主持国家自然科学基金重点项目、激光聚变基础前瞻项目、科技部国际合作项目；代表性成果分别入选美国光学学会评选的年度30项最激动人心的光学进展、美国物理联合会《科学之光》高亮报道、中国光学工程学会技术发明一等奖等；发表一作/通讯作者期刊论文60余篇，包括 *Light: Science & Applications*, *Matter and Radiation at Extremes* 等刊物的封面论文4篇；出版专著《光纤随机激光原理及应用》（科学出版社）。

Title:

光纤随机激光的相变特性研究

Abstract:

从自然界的浩瀚星河到人类社会的纷繁交织，无数复杂系统构成了这个世界的奇妙图景，人类也从未停止对其背后规律的探索，而自旋玻璃理论是研究复杂系统的基础理论。随机激光由于其独特的反馈和增益机制，表现出与自旋玻璃系统类似的复杂动力学特征，因而可成为深入探索自旋玻璃理论的重要平台。

本研究中，我们利用基于瑞利散射的光纤随机激光这一独特的光学平台，通过建立瑞利散射时变模型以及相应的实验探索，探究了一维瑞利散射系统中光学相变的内在机制。该研究进一步拓展了当前对光学相变机制的认知，对各种复杂系统的研究均有参考价值；此外，它还有望推动光纤随机激光器在高功率激光装置等重要领域的应用。



Name: Junqing Zhao 赵俊清

Organization: Shenzhen Technology University 深圳技术大学

Biography:

赵俊清，长期从事高功率超快激光技术、非线性光学等方面的研究工作，取得了大量创新性或指标突破性的成果。主持 国家级、省部级、市厅级等科研项目 9 项。截至目前，已发表学术论文 80 余篇，授权发明专利 10 余项，出版专著、译著各 1 章，在国内外学术会议做特邀报告 20 余次，担任分会主持人 10 余次。多次入选美国斯坦福大学和 Elsevier 联合发布的全球前 2% 顶尖科学家榜单。任美国光学学会（OPTICA）高级会员和终身会员、电气与电子工程师协会（IEEE）高级会员、“鹏程孔雀计划”特聘岗等。

Title:

高功率超快激光器及其高效参量转换研究

Abstract:

随着各类激光光源的不断发展，人们对于波长的选择和需求越来越多样化。波长处于 2-5 微米的中红外激光，近年来在光谱学、成像、气体监测、生物医药、强场光学等领域获得了越来越多的关注。为此，课题组在开展基于近红外波段超快、高功率激光器的研究基础上，进一步拓展了中红外波段的研究工作。本报告将介绍课题组近期在高功率光纤光源和全固态光源泵浦的中红外参量转换方面的研究工作，包括连续光泵浦的中红外单频快速可调谐差频参量光源、皮秒脉冲泵浦的高功率参量转换光源等。



Name: Xiaosheng Xiao 肖晓晟

Organization: Beijing University of Posts and Telecommunications
北京邮电大学

Biography:

肖晓晟，北京邮电大学副教授。2007 年于清华大学获得光学工程博士学位，2007-2008 年在新加坡南洋理工大学任 Research Fellow，2009-2019 年在清华大学工作，历任助理研究员、副研究员。2019 年加入北京邮电大学。长期从事锁模光纤激光器、光通信与光学检测等方面的研究。在 Phys. Rev. Lett.、Laser & Photonics Reviews 等期刊发表论文百余篇，有关时空锁模激光器的研究工作曾入选“2021 中国光学十大进展”（中国激光杂志社发布）。

Title:

时空锁模多模光纤激光器中三维孤子的非线性动力学研究

Abstract:

Spatiotemporal mode-locking, simultaneously locking of multiple transverse and longitudinal modes, is a general form of mode-locking and has been realized in multimode fiber cavities recently. Spatiotemporal mode-locked (STML) multimode fiber lasers, which support various 3D solitons, are ideal platforms for investigating high-dimensional nonlinear dynamics. In this talk, recent progress of STML multimode fiber lasers will be reviewed, and our latest research on the spatiotemporal nonlinear dynamics in the STML lasers will be presented.

Name: Luming Zhao 赵鹭明

Organization: Huazhong University of Science and Technology 华中科技大学

Biography:

赵鹭明，教授/博导，长期从事非线性光纤光学研究。Google Scholar 引用次数>1.2 万次，h 指数 54。连续 3 年入选爱思唯尔中国高被引学者榜单。

Title:

超快光纤激光器中纳秒孤子的产生研究

Abstract:

工作在反常色散区的超快光纤激光器可以产生稳定脉冲输出。脉冲在腔内的固定位置可以保持参数不变，同时脉冲在腔内的演变可以用孤子理论进行描述，因此超快光纤激光器中产生的稳定脉冲也被称为孤子。由于腔的周期性扰动而伴随孤子产生的凯利边带通常被当作孤子产生的标志之一。取决于常用光纤的参数，皮秒/飞秒孤子容易在超快光纤激光器中产生。孤子在光纤中的传播满足孤子面积定理，理论上，任意脉宽的孤子都应该能够获得。我们从孤子面积定理出发，通过增加腔内的反常色散，数值仿真实现了纳秒孤子在超快光纤激光器中的产生。目前的实验结果已实现百皮秒脉宽。



Name: Sha Wang 汪莎

Organization: Sichuan University 四川大学

Biography:

汪莎，四川大学研究员、博士生导师。2010 年 于德国柏林工业大学获博士学位，2011 年-2014 年先后任职于美国 Quantronix 公 司、Alcon Lensx 公司任激光工程师、激光高级工程师，2014 年 12 月加入四川 大学电子信息学院至今。任中国电子学会量子电子学与光电子学会分会第九届委 员会委员、中国仪器仪表学会光机电技术与系统集成分会第三届理事会理事、中 国光学学会光学技术专业委员会第八届委员会委员。获四川省高层次人才计划资 助。汪莎研究员长期聚焦激光技术及光场调控相关研究，在 *Laser & Photonics Reviews*, *ACS Photonics*, *Optics Letters* 等期刊发表 SCI 论文 40 余篇，授权国家发 明专利多项。多次参加国际国内学术会议并做受邀报告。担任 *Light: Science & Applications*、*Optics Letters*、*Optics Express* 等期刊审稿人。负责国家级项目 4 项，省市级项目 2 项。

Title:

基于光谱特性的激光器智能锁模控制

Abstract:

光谱信息可用来判定锁模激光器的锁模状态，常被用来作为锁模激光 智能控制的目标函数。一般可采用光谱仪测量激光光谱，但其测量时间长、且仅 通过光谱仪较难获取激光的时域信息。激光经粗糙表面反射或透射后会形成无数 独立的散射子波，这些子波在空间传播过程中将发生干涉现象，形成颗粒状的斑 纹图样，即散斑。通过对散斑信息的分析和反演，可获得对应的激光信息或光束 所通过的物体的信息。我们通过对散斑特性的分析，实现了 SESAM 锁模固体激 光器及 NPR 锁模光纤激光器的智能调控。此外，时间拉伸色散傅里叶变换 (TS-DFT)光谱仪是一种实时单镜头光谱仪，测量速度远大于光谱仪，且可兼具激光输出的时域特性。我们利用 TS-DFT 光谱构建适应度函数，实现了光纤激光器 中基于波长复用的单腔双光梳输出。

Name: Bowen Li 李博闻

Organization: University of Electronic Science and Technology of China 电子科技大学

Biography:

李博闻，电子科技大学信息与通信工程学院教授，国家青年人才。2017 年博士毕业于香港大学，2018 年至 2022 年在美国科罗拉多大学博德分校从事博士后研究。近年来以超快光学计量为特色研究手段，揭示了若干频梳瞬态动力学机理，研发高能单腔光纤双频梳架构。作为第一作者或通讯作者在《Nature Communications》、《Light: Science & Applications》《Optica》等期刊发表论文 20 余篇。荣获 2021 全球唯一的超快光学奖项 Couillaud Prize，持有美国发明专利 4 项，创立 Poseidon Photonics 有限公司，研发小型化高能双频梳系统。担任 Frontiers 客座编辑，以及 OSA，IEEE 旗下 7 个权威期刊审稿人。

Title:

双向锁模全正色散光纤频梳噪声机理研究

Abstract:

The counter-propagating all-normal dispersion (CANDi) fiber laser, a novel single-cavity dual-comb laser (SCDCL) with unprecedented pulse energy, shows great potential for nonlinear dual-comb applications. However, its noise characteristics and underlying physical mechanisms, along with those of other SCDCLs, have not been systematically studied. To maximize the CANDi laser's potential and provide a reference for the SCDCL community, we comprehensively analyze its noise performance and physical mechanisms.

Name: Jian Wu 吴坚

Organization: National University of Defense Technology 国防科技大学

Biography:

吴坚，国防科技大学前沿交叉学科学院副研究员。聚焦高功率激光，交叉融合光学工程、材料科学、人工智能、半导体技术等学科，开展固体物理、先进功能材料颠覆性器件、新体制光纤激光和大功率光纤激光相干合成等的教学与科研。近年，在 *Light-Sci. & Appl.*, *Adv. Mater.*、*Adv. Fun. Mater.*，*ACS Nano*，*Appl. Phys. Lett.*，*Opt. Lett.*、*IEEE JSTQE* 等学术期刊以第一作者/通讯作者发表论文 50 余篇，授权发明专利 10 余项。

Title:

超快光纤激光时频谱灵活动态调控

Abstract:

超快光纤激光已在极端物理、生命健康、工业加工等领域广泛应用。但是，传统超快光纤激光因调控参量、调制速度和鲁棒性等限制，动态调控无法满足智能化下数字编码信息量大和主动控制难等需求。近年，新的各向异性材料发现和半导体工艺发展，推动无源偏振光纤器件发展，并为光纤激光调控提供额外自由度。将各向异性准一维材料被动偏振光纤器件应用于传统光纤激光振荡器，有望实现超快光纤激光主动动态调控，在数字编码等领域有重大意义。创新制备新材料光纤无源偏振光学器件，在光纤振荡器中实现了一种鲁棒性好、实用化的可控超快光纤激光输出，并开展典型数字编码应用，在信息通讯领域具有巨大的应用前景。

Name: Aiping Luo 罗爱平

Organization: South China Normal University 华南师范大学

Biography:

罗爱平，研究员，IEEE Senior Member。2004年7月毕业于中国科学院上海光学精密机械研究所，获光学工程博士学位。任职于华南师范大学光电科学与工程学院，一直从事非线性光纤光学与光纤激光器的研究工作。

Title:

时空锁模光纤激光器中的孤子脉动力学特性研究

Abstract:

作为一种新型的锁模，时空锁模不仅需要同时锁定多个纵模，还需要同时锁定多个横模，是一种比传统单模锁模更高维度的锁模。由于横模自由度和模场面积的增加，基于多模光纤的时空锁模光纤激光器在提高通信容量和脉冲能量方面具有潜在的应用。此外，由于横模间相互作用的存在，时空锁模光纤激光器成为研究复杂三维非线性现象的理想平台。孤子脉动，作为一种有趣且重要的非线性现象，在时空锁模光纤激光器中却鲜有报道，其时空相互作用尚未被完全揭示，更加复杂而丰富的时空动力学特性仍需要进一步研究。我们在时空锁模光纤激光器中实现了不同调制周期的孤子脉动，并研究了其模式相关动力学特性。在时空锁模单周期孤子脉动中，不同横模均具有相同的脉动周期，而脉动的能量演化是异步的，实时光谱演化也是不同的，这也在数值模拟中得到了证实。此外，我们还实现了多种时空锁模多周期孤子脉动，包括双周期单孤子脉动、双周期双孤子脉动、三周期单孤子脉动和三周期双孤子脉动。在双周期单孤子脉动和双周期双孤子脉动中，不同横模的长周期脉动是同步的，而短周期脉动则是异步的。在双周期双孤子脉动中，我们还发现两个孤子之间的同步或异步演化关系并不受横模的影响。在三周期单孤子脉动和三周期双孤子脉动中，不同模式的长周期脉动也是同步的，而双周期脉动和短周期脉动具有异步的演化。以上研究结果探索和揭示了时空锁模光纤激光器中的孤子脉动力学特性，有助于进一步理解和探索时空锁模光纤激光器中复杂的时空动力学现象。



Name: Xing Liu 刘星

Organization: Shenzhen Technology University 深圳技术大学

Biography:

刘星，特聘研究员，深圳市海外高层次人才、深圳技术大学首届润园PI，主要从事超快碟片激光技术、固体克尔锁模激光器、再生放大和多通路碟片放大技术、非线性光学方面的研究。主持国家自然科学基金，科技部重点研发项目子课题等多个项目，2024年课题组成成功研发出了国内首台千瓦级皮秒/飞秒超快薄片激光器及核心器件，在 *Physical Review Letter*, *Nanophononics*, *Optics Letters*, *Photonics Research* 等期刊发表学术论文五十余篇，并且在 CLEO 多次报告研究进展。相关研究进展被 *Nature Photonics*、*Nature communications*、*Nature Physics* 等重要期刊引用报道。

Title:

超快碟片激光技术研究进展

Abstract:

高重复频率 ($>500\text{kHz}$)、大脉冲能量 ($>1\text{mJ}$)、高平均功率 ($>1000\text{W}$)、高光束质量 ($M^2<1.5$) 的超快激光器在先进制造、材料加工、EUV 产生、阿秒光源、相干 X 射线产生等众多领域具有非常重要的应用，一直以来都是科研和工业界追逐的目标。碟片激光器是将增益介质从传统的棒状晶体更换为圆盘状的薄片结构，既克服了传统棒状晶体结构在高功率泵浦下的热透镜效应问题，又可以避免光纤结构由于激光损伤和非线性影响难以实现大能量的缺点，是目前同时实现大脉冲能量、高平均功率、超短脉宽、极紫外波长的最佳方案，也被认为是新一代工业激光器的最佳技术平台。本次报告主要介绍，课题组在大口径碟片增益器件及多冲程泵浦系统等的研制工作，分享大能量千瓦飞秒/皮秒碟片激光器的最新成果。



Name: Dingyuan Tang 唐定远

Organization: Shenzhen Technology University 深圳技术大学

Biography:

唐定远，深圳技术大学讲席教授。1993 年博士毕业于德国汉诺威大学。曾先后在德国标准局、澳大利亚昆士兰大学、悉尼大学、新加坡南洋理工大学从事教学科研工作。主要研究方向为激光物理与技术、非线性光学、超快光学、透明激光陶瓷制备。在国际著名学术期刊上发表论文 500 余篇，被引 35000 余次。2017-2023 年度连续获评物理学领域或交叉学科领域全球前 1%高被引科学家。

Title:

近零色散光纤孤子激光器特性研究

Abstract:

在该报告中我们将从理论和实验两方面描述近零色散光纤孤子激光器的工作特性，特别是三阶色散对光纤激光器中不同类型光孤子，如常规亮孤子，暗孤子，耗散孤子，色散管理孤子等的生成及特性的影响。我们首次从实验上观测到了由于三阶色散所导致的反暗孤子的形成，常规及耗散亮孤子的 Cherenkov 辐射等，在准矢量腔光纤激光器中，我们是还首次观测到了矢量暗孤子，矢量反暗孤子，矢量亮-暗孤子。近零色散光纤孤子激光器能提供一个理想的实验平台研究不同类型光孤子间的相互作用。



Name: Mingjiang Zhang 张明江

Organization: Taiyuan University of Technology 太原理工大学

Biography:

张明江,教授、博导,太原理工大学物理与光电工程学院院长、精密测量山西省重点实验室主任,入选国家级高层次人才。主要研究方向为混沌激光产生及传感应用、分布式光纤传感技术,近 5 年,主持国家重点研发计划项目、国家重大科研仪器研制项目、国家自然科学基金联合基金重点项目等项目,以第一/通讯作者在 *Nature* 子刊 *Light* 等期刊发表 SCI 论文 60 多篇,入选 ESI 高被引论文、全球 Top2% 科学家,出版中、英文学术专著 2 部,授权美国专利 4 项、中国发明专利 46 项。获山西省技术发明一等奖、自然科学二等奖、中国专利优秀奖、中国光学工程学会技术发明二等奖、“金燧奖”中国光电仪器品牌榜铜奖等奖励,相关成果入围 2023 年度中国十大光学产业技术提名奖。

Title:

混沌分布式光纤传感

Abstract:

混沌分布式光纤传感以混沌激光取代传统脉冲激光和调频啁啾激光作为传感信号,突破了传统方案中传感距离和空间分辨率无法兼顾的技术瓶颈。其中,混沌拉曼分布式光纤传感系统在 40km 距离上将空间分辨率提升至 10cm;混沌布里渊分布式光纤传感实现了传感距离和空间分辨率的同时提升,有效传感点数突破至 300 万个。研发了混沌分布式光纤传感仪,应用于隧道火灾和裂缝、输气管网泄漏和形变、煤田采空区自燃与煤矿巷道变形等重大基础设施的长距离安全监测与精准预警。



Name: Dong Mao 毛东

Organization: Northwestern Polytechnical University 西北工业大学

Biography:

Mao Dong, a professor and doctoral supervisor at Northwestern Polytechnical University, is the recipient of the Outstanding Youth Science Foundation of Shaanxi Province, a Highly Cited Scholar of Elsevier. He used to be the vice dean of the School of Physical Science and Technology. His main research field is ultrafast fiber lasers. He has won the First Prize of the Scientific and Technological Research Outstanding Achievements of Higher Education Institutions in Shaanxi Province, the Youth Science and Technology Award of Shaanxi Province, etc. He serves as the director of the Xi'an Branch of China Laser Press and a youth editorial board member of journals such as Chinese Optics Letters. As the first author or corresponding author, he has published more than 60 papers in journals such as Nature Communications, Science Advances, Light: Science & Applications, and Laser & Photonics Reviews, and the related papers have been cited more than 9,000 times in total.

Title:

Multicolor Composite Soliton Fiber Laser

Abstract:

For multi-color mode-locked fiber lasers, due to the influence of group velocity dispersion, mode-locked pulses of different wavelengths cannot be synchronized in the cavity. Therefore, how to generate multi-color composite solitons in fiber lasers is one of the difficulties in the field of ultrafast lasers. By actively regulating the frequency and phase of different bands in the fiber laser, multi-color composite solitons were obtained in the fiber laser for the first time, and it was found that group delay compensation and saturable absorption effect played a dominant role in its formation process; further, an improved Talbot theory including dispersion and nonlinearity was proposed, revealing the self-imaging and steady-state - breathing state evolution mechanism of multi-color composite solitons; finally, concave-convex phase and birefringence regulation were introduced into the cavity respectively, and heteronuclear multi-color composite solitons and dissipative multi-color composite solitons were obtained.

**Name:** Lei Gao 高磊**Organization:** Chongqing University 重庆大学**Biography:**

高磊，重庆大学副教授，入选巴渝青年学者、首届国家“博士后创新 人才支持计划”。围绕超快激光单脉冲偏振测量涉及的科学难题及与单脉冲激光 高速成像涉及的技术难题，开展了偏振测量基本物理机制探索和单脉冲高速成像 系统设计与优化，解决了飞秒/皮秒激光单脉冲偏振态实时测量难题，在此基础 上探究脉冲激光及非线性光学过程的新物理现象，研制的高速单像素成像系统成 功应用于中国工程物理研究院高能激光系统光学镜片损伤监测。主持国家自然科 学基金面上项目 2 项、国家自然科学基金青年项目 1 项，国家博士 后创新计划 1 项、装备预研重点实验室基金 1 项。在 *Appl. Phys. Lett.*、*Photon. Res.*、*Opt. Lett.*等期刊发表学术论文 56 篇，参与编写英文专著 2 部。授权发明专利 9 项， 美国发明专利 1 项。激光精密测量技术应用于航天火箭发动机检测获 2023 年中 国光学学会科技进步奖一等奖（排名第 3）。

Title:

单脉冲超快激光偏振态精密测量、控制与高速成像

Abstract:

单脉冲超快激光偏振态的精密测量与调控是当前研究前沿。然而，国 内外相关研究主要集中于直流激光，而对超快激光的偏振特性研究相对空白。我 们提出基于色散傅里叶变换及分振幅的超快激光单脉冲偏振测量原理，通过远场 傅里叶变换在频域实现单脉冲激光光谱的精密测量，进而通过分振幅原理实现波 长分辨的单脉冲偏振态表征，同时重构出单脉冲时域偏振态精密分布。该成果解 决了单脉冲超快激光偏振态测量难题，实现了跨时间尺度超快激光的连续精密测 量，研制出的偏振态分析仪样机时间分辨率达到 125 ps，光谱分辨率为 0.05 nm， 误差优于 3%。相关成果为超快光谱分析、手性分子超快动力学、单脉 冲激光偏振 调控、泵浦探针技术等提供了新的思路和技术途径，也为单脉冲全参数（振幅、相位、偏振态）表征补齐了最后的技术拼图。进一步，基于该技术，系统研究了 耗散孤子、传统孤子以及色散管理孤子的波长分辨下的偏振演化特性。如发现耗 散孤子激光器的启动过程存在光谱展宽、光谱带宽振荡以及稳定锁模三个典型阶 段，揭示了耗散孤子偏振结构对双折射的敏感性，存在偏振对称性破缺。最后， 基于超快激光单脉冲参数测量的高速成像技术，在百 μm 分辨率下突破 MHz 的成 像帧率，实现对不可重复瞬态过程的精密高精度成像，应用于中国工程物理研究 院高能激光系统中光学元件缺陷监测，解决了强光元 件表面缺陷分布及其激光损 伤过程动态测量的问题。



Name: Anbang Wang 王安帮

Organization: Guangdong University of Technology 广东工业大学

Biography:

王安帮，广东工业大学先进光子技术研究院教授，国家优青、霍英东青年教师奖获得者。从事混沌激光理论与应用研究，主持国家自然科学基金重点项目、国家重点研发计划项目课题、军科委创新特区项目等，在 *Light Sci Appl*, *Photon Research* 等发表论文 80 余篇，获山西省技术发明一等奖、山西省专利一等奖；获国家出版基金资助出版专著 1 部。兼任全国光电专委会常务委员、混沌与非线性电路专委会委员。

Title:

高速混沌保密光纤通信

Abstract:

混沌保密光纤通信是一种基于硬件的经典物理层加密传输技术，具有高速率以及兼容现有光纤通信系统的潜力。半导体激光器因其可集成的结构和高度的信号复杂性而成为混沌收发器的主要候选者。然而，混沌激光保密通信的速率仍远落后于光纤通信。报告将介绍我们在高速混沌保密光纤通信方面的研究进展，包括宽带混沌激光产生、同步、传输等单元技术以及通信系统的实验结果。



Name: Gang Xu 徐刚

Organization: Huazhong University of Science and Technology
华中科技大学

Biography:

徐刚，华中科技大学光学与电子信息学院教授，入选国家级青年人才计划和湖北省高层次人才计划，主持国家自然科学基金面上项目和湖北省重点研发项目。主要研究方向包括非线性光学、激光物理学、超快光学、可见光激光器等。在 *Nature Communications*、*Physical Review Letters*、*Optics Letters* 等期刊上发表论文 50 余篇，进行国际会议报告 30 余次。

Title:

Generalization of Vector Cavity Soliton Families in Passive Kerr Resonators

Abstract:

In optics and photonics, temporal cavity solitons (CS) are localized structures that manifest themselves as persisting pulses of light, and underpin numerous applications from ultra-short pulsed mode-locked lasers to microresonator optical frequency combs (OFC) [1]. The refinement of OFC generation technology has demonstrated unprecedented measurement accuracy and expanded new applications in a wide range of fields, including spectroscopy, atomic clocks, and quantum technology [2]. For the generation of high-quality OFCs in resonators, the ideal choices are short, bright and stable CSs, originating from the dual-balance of nonlinearity and dispersion, pumping and cavity losses [1,2]. In most cases, stable bright cavity solitons (BCS) are excited in the presence of anomalous dispersion. Such dispersion choice can limit the center wavelength of the OFC and the waveguide material of the resonators. To this end, several theories and experiments have been proposed in recent years dealing with normal dispersion. For example, in the scalar case, stable dark pulses of different durations have been predicted and observed with normal dispersion cavities [3,4,5]. Moreover, BCSs mediated with the near-zero dispersion have been predicted and observed not only in fiber rings [6] but also in microresonators [7]. In order to extend the existence regime of BCSs, crossphase modulation (XPM) has been introduced with the aim of locking pulses and provide new degrees of freedom. Two mainstream approaches to CSs with XPM and normal dispersion are two- and three-coupled micro-cavities [8] and interlocked single-peak (termed as faticons) in a single cavity supporting two circular polarization modes [9]. For the second case, however, the full spectrum of these localized structures, their excitation mechanism, the symmetry properties, and the existence and stability regimes remain unexplored. In this work, we provide a general description of novel vector dissipative CSs in a normally dispersive passive resonator. These localized structures, either bright or dark, can contain single or multiple peaks occupying certain ranges of the parameter space, spanning from locked fronts (LF) to polarization modulation instability (PMI) patterns. Our investigation provides a panoramic view to understand the formation mechanisms of vector soliton families, thus facilitating the control of OFCs in normally dispersive resonators.

Name: Yudong Cui 崔玉栋

Organization: Zhejiang University 浙江大学

Biography:

崔玉栋研究员 2016 年毕业于中国科学院大学，获得工学博士学位，2018 年加入浙江大学光电科学与工程学院。主要从事于超快光纤激光产生、调控、测量与应用研究，在孤子束缚态调控产生与信息编码、交叉相位调制诱导的非线性演化机制、超快激光皮米干涉测量等方面开展了开创性工作，相关研究成果发表在 *Physical Review Letters*、*Laser & Photonics Reviews*、*Optica* 等高水平学术期刊上。

Title:

超快光纤激光孤子束缚态非线性调控与应用

Abstract:

超快光纤激光在精密激光加工、医疗美容、高精度测量、激光雷达等领域得到越来越广泛的研究和应用，多种多样的的应用场景不仅要求产生超短时间、宽带光谱的锁模激光脉冲，在时频特征、脉冲数量与分布、乃至纵模相位等方面都提出了新的调控需要。另一方面，作为一种复杂非线性耗散系统，超快光纤激光一直是非线性光学研究的重要平台，有效促进了孤子理论的发展，同时，非线性光学理论研究也为超快光纤激光的特性调控提供了解决方案。报告人近年来聚焦于超快光纤激光调控、测量与应用研究，提出了色散复参量调控方法，实现了孤子束缚态可控产生，演示了其在信息编码方面的应用潜力；发现了交叉相位调制诱导的倍周期非线性演化机制，获得了非对称矢量孤子等新型孤子束缚态激光；通过交叉相位调制作用产生了时频两维度孤子束缚态，结合激光器内调 Q 机制实现了双色呼吸子，获取了多维度孤子耦合作用下的非线性演化行为。



Name: Yuanfei Zhang 张远飞

Organization: Southeast University 东南大学

Biography:

张远飞，2022 年于香港中文大学电子工程系获得博士学位，现任东南大学电子科学与工程学院副研究员。研究方向 包括集成光学芯片的非线性光学效应及其应用、全光信号处理和光纤通信系统。他在 APL Photonics、Journal of Lightwave Technology、Optics Letters、Optics Express 等国际重要期刊 和会议上发表了 20 余篇学术论文，并担任 IEEE Journal of Lightwave Technology 和 IEEE Photonics Journal 的审稿人，在 CLEO、OFC 等光学领域国际顶级会议上作口头报告，获得 2 项中国发明专利和 1 项欧洲专利授权。

Title:

光学频率梳与机器学习在大容量光纤通信中的应用

Abstract:

光学频率梳在高速相干光纤通信系统中展现出广阔的应用前景，尤其为波分复用大容量光通信提供了一个低成本、高质量的相干光源。与此同时，机器学习在提升光通信性能和优化器件设计方面的作用日益凸显。通过基于机器学习的优化方法，不仅可以显著提升光通信系统的数据容量，还能大幅度提高集成模分复用器件的设计效率与性能表现。本报告将分为两部分：第一部分聚焦于硅基光学频率梳的生成技术以及可编程硅基光学多播的实现方法；第二部分深入探讨机器学习在熵加载提升光通信容量和模分复用器件设计优化中的具体应用，并展望多维光通信系统与光子集成技术的未来发展方向。



Name: Jianxiang Wen 文建湘

Organization: Shanghai University 上海大学

Biography:

文建湘，上海大学教授/博士生导师。目前在上海市特种光纤与光接入网省部共建教育部重点 实验室国家培育基地从事新型特种光纤设计与制造，光纤激光器与光纤传感应用研究。担任上海市先进光波导智能制造与测试专业技术服务平台副主任；上海市惯性技术学会理事/副秘书长；在 ACS Photonics、Photonics Research、Nanophotonics、Journal of Lightwave Technology、Optics Letters 等国际著名期刊上发表学术论文百余篇，授权发明专利十余项，美国专利 1 项；受邀参与撰写 3 本英文书籍多章节，并担任英文书籍 Bismuth-Fundamentals and Photonic Applications (ISBN: 978-1-83968-243-8) 联合主编。参与国家“十五”科技攻关计划“光纤预制棒 产业化技术开发”，国家 863 项目，其产品应用于神舟六号、七号飞船，2008 年获江苏省科学技术进步奖二等奖；参与的国家重点研发计划“全波段、低噪声放大光纤”项目获得重要突破。2023 年获上海市科学技术进步奖一等奖，2022 年中国光学工程学会科学技术进步奖一等奖；2020 年在国际先进光纤激光研讨会(AFL2020)获光纤激光领域最佳创新奖“Fiber laser in 2020”。

Title:

全光纤型腔内振荡涡旋光激光

Abstract:

涡旋光束携带轨道角动量 (OAM) 为经典光学和量子光学中的通信与操控提供了新的自由度。可调谐偏振 OAM 激光光源能够满足不断增长的信息容量需求，并提高光束传输的稳定性。而传统自由空间涡旋光束生成技术如空间光调制器和螺旋相位板易受衍射效应影响，且光学元件对准困难，限制其应用。相比之下，全光纤型 OAM 激光光源兼容性更好，成本低、串扰少，可满足高信息容量需求，并提高传输稳定性。针对上述研究背景，研究团队设计并制作了在高增益高双折射少模有源光纤、环芯有源光纤和保持稳定传输 OAM 模式的少模光纤。通过扭转少模有源光纤在光纤内实现了圆偏振涡旋光束的产生和激发，成功获得光纤型腔内涡旋光振荡激光。其激光器波长与拓扑荷数均具有可调性，为开发多功能涡旋光器件，应用于超高分辨率成像、超高精度检测、精细激光加工及量子通信等领域具有较大发展潜力。



Name: Wenjun Liu 刘文军

Organization: Beijing University of Posts and Telecommunications
北京邮电大学

Biography:

刘文军，北京邮电大学教授，博士生导师。长期从事超快光学及技术的应用基础研究工作，围绕“飞秒激光非线性效应的有效控制”这一前沿问题，取得了系列有重要影响的成果，创新地探索出“混合锁模”方案，通过引入新方法、新材料和新机制有效控制非线性效应，提升了飞秒光纤激光的脉宽、功率和稳定性，为飞秒光纤激光器的研制与应用开辟了新途径，部分成果已实现转化，研制设备的综合参数达到世界同类型设备的一流水平，有效突破了关键元器件的进口依赖及“卡脖子”技术难题。他是北京杰出青年基金（2021年）、北京市青年拔尖人才（2017年）获得者。先后承担国家重点研发计划、国家面上项目、北京市重大专项等项目10余项。已在以 *Laser & Photonics Reviews* 等为代表的国际顶级期刊上发表SCI论文200余篇，其中ESI高被引论文40余篇，ESI热点论文20余篇，引用次数共计10000余次，H指数62。两篇论文入选中国百篇最具影响国际学术论文。相关成果以第一完成人入选北京市自然科学二等奖、中国光学学会光学科技奖二等奖、中国产学研合作创新奖（个人奖）等。2020-2023年连续四年入选爱思维尔中国高被引学者。

Title:

高功率紫外飞秒激光器及其应用

Abstract:

本报告中主要关注飞秒激光器在具有复杂微观结构的先进制造中发挥着不可替代的独特作用，可用于加工超硬、脆性和柔性材料等特殊材料。为了进一步提高飞秒激光器的加工能力和规模，实现从实验室研究到工业制造的跨越，迫切需要高平均功率、高光束质量和对比度相结合的高性能飞秒激光器。本报告将针对当前飞秒激光器脉冲能量、重复频率和对比度等参数难以平衡的瓶颈，探索开发国际先进的紫外飞秒激光器的制造方法。



Name: Yueqing Du 杜岳卿

Organization: Northwestern Polytechnical University 西北工业大学

Biography:

杜岳卿，西北工业大学物理科学与技术学院副教授，研究方向为超快激光耗散孤子动力学及其调控特性，围绕振动孤子形成机理、束缚态孤子相互作用及矢量孤子动力学等内容开展了一系列研究，在 *Laser & Photonics Reviews*、*Physical Review A* 和 *Optics Letters* 等期刊发表论文二十余篇。

Title:

基于线性耦合诱导的新型矢量孤子特性与演化动力学

Abstract:

矢量孤子是一种双分量局域化结构，在光学、力学和凝聚态物理等领域都被广泛地研究。从偏振维度看，光纤激光器中的耗散孤子属于矢量孤子，它是由两个正交偏振分量构成，因此，偏振分量间的相互耦合对锁模脉冲的演化动力学和稳定性具有重要影响。除了传统的交叉相位调制和四波混频等非线性耦合外，我们近期提出偏振分量之间的线性耦合对矢量孤子的形成与演化特性具有重要影响，能引发多样性的瞬态现象和孤子类型，如矢量孤子的反常捕获、双周期振动孤子、异核和同核矢量孤子等。通过在孤子传输方程中引入线性耦合项，可以获得能与实验现象良好吻合的模拟结果。我们的工作有助于理解耗散系统中高维孤子的基本特性，此外，线性耦合作为一种新的孤子调控机理，也有望应用于锁模激光的智能控制。

Name: Chaoqing Dai 戴朝卿

Organization: Zhejiang A&F University 浙江农林大学

Biography:

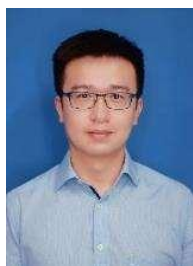
戴朝卿，博士，浙江农林大学教授。连续入选 2015-2023 年度中国高被引学者、浙江省自然科学基金杰出青年基金获得者、浙江省 151 人才工程第二层次。已在 Laser Photon. Rev.、Science China: Physics, Mechanics and Astronomy、Phys. Rev. A 和 E、Commun.Phys.、Opt. Lett.、Opt. Express 等期刊发表 300 余篇论文，论文累计被引 9600 多次，H-index 为 56。主持国家自然科学基金项目 5 项、省自然科学基金项目 3 项，成果曾获省自然科学二、三等奖。

Title:

Switching Dynamics of Multicolor Soliton in The Passive Mode-Locked Fiber Laser

Abstract:

The multicolor fiber laser has potential applications in many fields, such as optical communication network, optical sensing and photon calculation. However, there are few reports on its internal dynamic characteristics due to the complexity and difficulty of realizing the multicolor soliton state. In this report, the switching process of the multi-wavelength soliton state in negative dispersion passively mode-locked fiber laser is realized, which is accompanied by the periodic soliton explosion. The generation of the multicolor soliton state goes through the process from noise to oscillation and then to stable mode locking, and the splitting and annihilation of solitons with different group velocities have a direct impact on the generation and disappearance of three wavelengths, which is verified by the the intracavity loss characteristics of the multicolor solitons. From results of the simulation and deep learning methods indicates that soliton experiences the relative phase oscillation, chaos and oscillation, as well as the convergence and separation before and after the explosion. With the increase of parameters related to pump power, single soliton oscillation, multicolor soliton and chaos are all found in experiment and simulation. This work will promote the dynamical study of multi-soliton collisions in nonlinear science and the development of chaos theory in multi-comb lasers.



Name: Wenbin He 何文彬

Organization: Shanghai Institute of Optics and Fine Mechanics, CAS
中国科学院上海光学精密机械研究所

Biography:

何文彬研究员，于 2011 年在哈尔滨工业大学获得学士学位，之后在法国巴黎高等光学学院与德国耶拿大学学习，于 2014 年获得联合硕士学位。之后进入德国马普光科学研究所攻读博士学位，于 2018 年获得德国埃尔朗根-纽伦堡大学博士学位，之后继续从事博士后研究。2019 年获得德国马普学会青年科学家最高奖项“奥托·哈恩”奖章。2021 年入职中科院上海光机所罗素先进光波科学中心任研究员。研究方向为光子晶体光纤，超快锁模激光与非线性光纤光学。

Title:

声光高阶锁模自稳定机制研究

Abstract:

高阶锁模是一种在超快光纤激光中产生高重频超快脉冲的有效机制。然而，高阶锁模的稳定性通常会受到外界扰动的显著影响，使得脉冲间隔或者腔内脉冲数发生不可控的变化。通过在锁模激光器中引入光子晶体光纤，使得腔内的高阶锁模脉冲重频通过声光相互作用自发锁定于其纤芯的声学振动频率，可以实现自稳定的高阶锁模状态。本工作研究高阶锁模光脉冲的自发重定时动力学原理，以及腔内高阶锁模阶数的自发调整动态过程，揭示了声光锁模激光器自稳定性质的底层物理机制，也为高阶锁模激光器设计提供了全新的动力学依据。

Name: Xuewen Shu 舒学文

Organization: Huazhong University of Science and Technology 华中科技大学

Biography:

Dr Shu Xuewen is a full-professor at Wuhan National Laboratory for Optoelectronics, Huazhong University of Science and Technology, China. He received his Ph.D. degree in optoelectronics from Huazhong University of Science and Technology, China, in 2000. From 2001 to 2013, he worked first as a Senior Engineer at Indigo Photonics Ltd. and then as a Senior Research Fellow with the Aston Institute of Photonic Technologies at Aston University, UK. He has published over 300 papers in major international journals and conferences and also holds about 30 patents. He serves as an Associate Editor for IEEE Sensors Letters and other two journals. He is a Fellow of Optica (previously known as the Optical Society of America), and a Fellow of the Institute of Physics, and has been recognized as one of the Highly Cited Chinese Researchers by Elsevier. His research interests include laser based micro-/nano-fabrication, fiber gratings, optical fiber communications, fiber lasers and optical sensors.

Title:

Fs-Laser Inscribed In-Fiber Microstructures for Fiber Laser Applications

Abstract:

Femtosecond laser inscription technology has become essential for creating intricate microstructures in various materials. Compared to traditional UV-laser writing, femtosecond laser writing offers advantages such as highly localized material modification and no photo sensitivity requirements, making it promising for micro-/nano-structure fabrication. This technology, combined with laser-beam scanning or sample translation, enables the creation of complex structures in three dimensions. Recently, we've used it to develop fiber optic microstructures like gratings and interferometers, with practical applications in fiber lasers. In this presentation, we'll explore our research in this area.



Name: Jinwei Zhang 张金伟

Organization: Huazhong University of Science and Technology
华中科技大学

Biography:

张金伟，华中科技大学教授，国家级海外青年人才。主要从事超快激光技术、超快碟片激光器前沿创新及应用研究。近年来采用一系列创新技术，在近红外超快碟片激光器的平均功率、重复频率、脉冲宽度以及转换效率等方面取得多项世界最好的结果；首次实现了中红外波段碟片激光的被动锁模，获得了平均功率最高的 $2\ \mu\text{m}$ 波段飞秒激光振荡输出；产生了世界上光谱最宽的相干中红外超快激光，上述结果在 *Light: Science & Applications*、*Laser & Photonics Reviews*、*Ultrafast Science* 等期刊上发表论文 40 余篇，在 CLEO, CLEO-Europe 等国内外会议做邀请报告 30 余次，两次入选 CLEO-Europe 会议 Postdeadline 报告。

Title:

高功率超快碟片激光器

Abstract:

高能量飞秒激光振荡器在基础科研、工业生产、生物医学以及国防军事等领域有着广泛且重要的应用。碟片激光器采用大径厚比的薄片材料作为增益介质并与通有水冷的热沉相连接，具有极高的散热效率，且碟片介质内仅存在沿着厚度方向的一维热梯度，因此非常适合产生高平均功率、高脉冲能量、高光束质量的超快激光。基于此，我们开展了超快碟片激光振荡器的实验研究，在锁模机制、转换效率、平均功率以及脉冲宽度等方面进行优化，最终在驻波腔条件下和环形腔条件下实现了平均功率 100W 的百飞秒激光脉冲输出。该振荡器可以作为非线性频率变换以及超快激光微纳加工的激光驱动源。



Name: Han Wu 吴函

Organization: Sichuan University 四川大学

Biography:

Han Wu received the PhD degree from the Key Lab of Optical Fiber Sensing & Communications (Education Ministry of China), University of Electronic Science & Technology of China, Chengdu, China. He was with Tampere University, Finland, as a joint-training PhD student from 2018 to 2019. He is now an associate professor at Sichuan University. He has authored or co-authored over 70 papers in international journals, including Nature Communications, Light: Science and Applications, Optica and Laser Photonics Reviews, and his research was highlighted in Optics in 2014 by OSA Optics and Photonics News. He won the SPIE Optics and photonics education scholarship and Young Scientist Award in Advanced Fiber Laser Conference. Dr Wu's current research interests include random fiber lasers, mid-infrared lasers and ghost imaging.

Title:

Mid-Infrared Temporal Ghost Imaging Based on Frequency Conversion of Fiber Laser

Abstract:

Ghost imaging in the time domain allows for reconstructing fast temporal objects using a slow photodetector. The technique involves correlating random or pre-programmed probing temporal intensity patterns with the integrated signal measured after modulation by the temporal object. However, the implementation of temporal ghost imaging necessitates ultrafast detectors or modulators for measuring or pre-programming the probing intensity patterns, which are not available in all spectral regions especially in the mid-infrared region. Here, we report a frequency downconversion temporal ghost imaging scheme that enables us to realize computational temporal ghost imaging in the mid-infrared. The approach modulates a signal with temporal intensity patterns in the near-infrared fiber laser and transfers the patterns to an idler via difference-frequency generation in a nonlinear crystal at a wavelength where the temporal object can be retrieved. As a proof-of-concept, we demonstrate computational temporal ghost imaging in the mid-infrared with operating wavelength that can be tuned from 3.2 to 4.3 μm . We further demonstrate mid-infrared data encryption and transmission over a 3 m free space link at a speed more than 60 times higher than MIR detector bandwidth based on the frequency downconversion computational temporal ghost imaging.



Name: Junsong Peng 彭俊松

Organization: East China Normal University 华东师范大学

Biography:

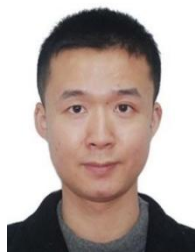
Junsong Peng received his Ph.D. in Physics from Shanghai Jiaotong University (China) in 2013. His research interests include mode-locked fiber lasers and nonlinear fiber optics. He did his postdoc research at Royal Institute of Technology, Sweden and Aston University, UK, successively from 2013 to 2016. He is now a professor at State Key Laboratory of Precision Spectroscopy, East China Normal University. Dr Peng's research areas focus on nonlinear science of mode-locked lasers. His research activities have been awarded with the Marie Curie International Incoming Fellowships in 2014, National Science Fund for Excellent Young Scholars in 2020, and Shanghai Rising-Star Program in 2020.

Title:

锁模激光器中的混沌和同步

Abstract:

Breathing solitons are localized structures showing periodic variations in parameters. They are found in various fields of science, and are currently attracting significant research interest in virtue of their relationship with a rich set of important nonlinear phenomena. They have recently emerged as a universal ultrashort pulse regime in passively mode-locked fibre lasers. Here, we reviewed our recent works in this fast-growing field, including the first observation of breathing solitons and their complexes in mode-locked fibre lasers, and breather explosions. Besides, we will show that the internal two competing frequencies in a breathing soliton laser opens the possibility to study the universal synchronization dynamics, and we observe the fractal dynamics, as well as chaos and an new intermediate state (modulated subharmonics) between synchronization and desynchronization in the laser. We also show that modulated subharmonic can lead to chaos under certain conditions, namely, a new route to chaos being observed.



Name: Yiyang Luo 罗亦杨

Organization: Chongqing University 重庆大学

Biography:

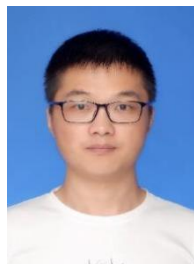
罗亦杨，现任重庆大学光电工程学院副教授。2013年6月获华中科技大学光电信息工程专业学士学位，2017年10月获华中科技大学光学工程博士学位。2017年11月加入华中科技大学激光技术系从事博士后研究工作。2018年9月至2020年12月在新加坡南洋理工大学CINTRA中心开展访问学者和博士后研究工作，2021年1月至今于重庆大学光电工程学院开展教学与科研工作，从事可控超快激光及精密测量应用研究。主持国家自然科学基金面上项目、国家重点研发计划子课题、重庆市留创计划优秀资助项目等。在 *Light: Sci. & Appl.*, *Optica*, *Photonics Research*, *APL Photonics* 重要学术期刊发表论文40余篇。现为中国激光杂志社青年编委；曾获第二届中国互联网+创新创业大赛金奖；获评2022全球光电大会青年科学家奖、ICAIT2024青年科学家奖。

Title:

可控超快激光脉冲串及应用研究

Abstract:

激光物理与技术的蓬勃发展衍生出诸多新兴应用研究。其中，激光测距在现代化军民应用场景发挥着重大作用。伴随测距应用场景日益广泛，激光测距技术也逐步从近程测距向长程测距延伸，静态测量向动态测量转变，单点探测向多线扫描扩展。近年来，先进激光技术为精密测距的发展提供了新思路，按需定制超快脉冲时频特性，将赋能激光测尺探得更远、测得更准、看得更清。本报告将介绍近期课题组在超快激光控制技术及其精密测距应用中的研究进展。（1）超快激光脉冲串的重构技术。以多脉冲动力学研究为基础，结合激光全场时频分析技术，实现基于激光增益可编程控制的相位操控，实现相位的按需定制，并验证脉冲串在全光编码中的应用。（2）超快激光精密测距技术。通过实时光谱干涉法，引入大尺-小尺的大范围高精度相位解析，实现微尺度距离测量，解决动态声波信号的精准拾取问题；开展超快激光类噪声脉冲串测距应用，协同时频联合调控，实现多波长并行混沌光的抗干扰测距。



Name: Tianhao Xian 贤天浩

Organization: Shanghai Jiao Tong University 上海交通大学

Biography:

独立开发了可以用来研究超短脉冲时间相位演化特性的色散时域干涉技术，并实现了亚纳米精度、10MHz 采样的激光测距。目前致力于孤子动力学、飞秒脉冲合束、色散时域涉型光纤传感等方面的研究。以第一作者身份在 *Physical Review Letters* 等知名物理学、光学期刊发表学术论文 7 篇，6 次在 OFC, CLEO, FIO 等国际会议上做报告。入选上海市“超级博士后”人才资助计划，获国家自然科学基金青年项目、中国博士后科学基金面上项目和上海市科委启明星培育（扬帆专项）项目。

Title:

智能解析色散时域干涉技术

Abstract:

色散时域干涉法是一种新型的激光干涉技术。该技术以飞秒脉冲作为光源，利用色散傅里叶变换技术将不同波长的光写入时域包络的不同位置，可以实现多波长干涉法的时域解析，从而能够利用单个探测器实现对不同频率成分的干涉信号的实时表征；利用 FPGA 智能算法，可以在亚微秒尺度解码得到光程信息，实现对激光光程的实时精确测量；结合飞行时间测量方法，能够精确测量千米级甚至天文级的距离信息。该方案的采样频率可达 10MHz 量级，单次采样的精度在亚纳米量级，信号处理时间在亚微秒量级，是高采样率、高精度、快速解码的新型激光测距方法，在自动驾驶、激光成像、天文观测、传感等领域有广阔的应用前景。

Session 4 JAN. 13-14.2025

Exhibition Center Hall C1

Ultrafast Laser Intelligence Manufacturing
超快激光智能制造





Name: Yan Li 李焱

Organization: Peking University 北京大学

Biography:

李焱，北京大学物理学院教授、全国优秀科技工作者、中国光学学会会士、政府特殊津贴专家。长期从事飞秒激光三维微纳制造和光场调控与焦场整形研究，取得了一系列创新成果。任国家重大科学研究计划项目首席科学家和课题负责人、国家重点研发计划项目课题负责人、国家自然科学基金委重大项目课题负责人、国家自然科学基金委重点项目负责人等。

Title:

玻璃基三维波导拓扑光子器件

Abstract:

拓扑光子结构拓展了拓扑概念，如高阶拓扑绝缘体、反常弗洛凯拓扑绝缘体、安德森拓扑绝缘体和分形结构拓扑等。此外，光子学还为拓扑这一领域引入了新奇的物理现象，如非厄米拓扑光子学和非线性拓扑光子学。同时，拓扑理论在光学中的引入也为光学体系带来了新的调控手段，为集成光子器件中光场和量子态的稳定传输和操控提供了新的思路和方法，例如拓扑保护的鲁棒态转换、拓扑保护量子纠缠、拓扑量子计算等。

飞秒激光直写技术凭借其高精度三维直写能力，可以快速制备复杂的波导阵列晶格和线路复杂、任意截面形状的三维光波导器件，进而构建拓扑光子结构。通过调控波导损耗，还能研究非厄米系统的拓扑性质。本报告介绍最近在玻璃基三维波导拓扑光子器件方面的进展，包括分形反常弗洛凯拓扑绝缘体，支持多重拓扑束缚态的耦合反转拓扑系统，实现本征态鲁棒产生的环绕奇异点系统和利用奇异线的手性模式转换系统。



Name: Yiping Wang 王义平

Organization: Shenzhen University 深圳大学

Biography:

王义平，深圳大学、物理与光电工程学院，讲席教授、国家杰青、万人领军、美国光学学会会士、博导、光电子器件与系统教育部重点实验室主任、广东省光纤传感技术粤港澳联合研究中心主任，长期从事光纤传感技术及应用研究。获教育部自然科学奖一等奖和二等奖、深圳市自然科学奖一等奖、四川省科学技术进步奖一等奖、全国优秀博士学位论文奖、欧盟玛丽居里国际引进人才基金奖、德国洪堡研究基金奖等。主持国家重点研发计划、JGW专项、国自然重点等项目 32 项。发 SCI 论文 452 篇（SCI 引用 12000 余次、H 指数: 55），22 篇论文单篇 SCI 引用超过 100 次；授权发明专利 65 项（美国发明专利 10 项）；Applied Optics 主题编辑、Photonic Sensors 编委、广东省光学学会副理事长。

Title:

极端环境光纤传感技术及应用

Abstract:

本文报告了光纤光栅阵列制备技术及其在高温高压等极端环境中的应用。重点介绍了大规模光纤光栅阵列飞秒激光全自动制备技术及其在航空航天、油井勘探、核能安全、周界安防等极端环境结构健康监测中的应用。该技术透过涂敷层直接在光纤纤芯中高效率全自动制备高质量光纤光栅，不需要剥除涂敷层和二次涂敷。该光纤光栅保留了光纤原有的抗拉抗弯强度，长期稳定性好，耐高温，单根光纤上可以连续制备大于 10000 个光纤光栅，光栅间距、波长、反射率等参数随意可调。该大规模光纤光栅阵列在海洋监测、油井勘探等分布式光纤传感领域具有广泛应用前景，可以极大地提高 DAS、DTS、OFDR 等分布式光纤传感技术的测量精度、测量距离和空间分辨率等关键指标，是分布式光纤传感技术的“助推器”。

Name: Yingchun Guan 管迎春

Organization: Beihang University 北京航空航天大学

Biography:

管迎春，北京航空航天大学学科责任教授，国家海外高层次青年人才，大型 金属构件增材制造国家工程实验室激光精密加工方向学术带头人。专注跨尺度多 材料激光精密制造核心装备和关键工艺研究，发表高水平论文 100 余篇，授权国 内外发明专利 20 余项，出版英文专著章节 5 章，应用于罗罗、普惠、波音、格 芯等跨国 500 强企业等。

Title:

超快激光制备结构材料微纳结构组织演变及表面性能

Abstract:

近年来，超快激光精密加工技术迅猛发展。本报告主要介绍了我们团 队近年来在结构材料跨尺度激光精密制造方面的研究进展，主要包括飞秒激光制 备金属、复材等功能微纳结构。本次报告将涵盖上述技术的基本原理、材料表面 /亚表面组织结构演变、机械-力学/润湿/腐蚀等性能表现以及服役环境下表界面 特征等内容。

Name: Ye Dai 戴晔

Organization: Shanghai University 上海大学

Title:

飞秒激光在透明材料内诱导纳米光栅的机理及应用

Abstract:

超快激光通过非线性光学效应能实现透明材料内的三维选择性加工，从而在集成光子器件的制备上有独特优势。超快激光辐照玻璃材料时，通过入射脉冲与激发的电子等离子耦合干涉，可以得到一类具有亚波长周期的自组织结构——纳米光栅，它展示了很强的光学双折射效应，可应用于高密度光存储、微流体芯片和微纳光子元件。我们课题组近十年在纳米光栅的形成机制、调控方法和光学应用做了一些探索，在玻璃材料组分对纳米光栅形成过程的影响机制做了系统研究，并提出了飞秒+皮秒复合脉冲提升纳米光栅形成效率的方案，也制备了菲涅尔波带片和特种光纤光栅等。上述成果对推动超快激光加工微纳光学元件方面有一定的参考价值。



Name: Lu Chen 陈璐

Organization: Nankai University 南开大学

Biography:

陈璐，博士生导师，南开大学“百青”人才。2018 年于美国匹兹堡大学物理与天文系取得物理学博士学位，之后在美国国家标准与技术研究院从事博士后研究，2023 年加入南开大学。长期从事光场时空调控、二维电子气纳米尺度操控、光与物质相互作用等方面的理论和实验研究。近年来在 *Science Advances*、*Light: Science & Application*、*Optica* 等知名国际期刊发表研究论文 25 篇。

Title:

基于超表面的光场四维时空调控

Abstract:

飞秒光脉冲是现代超快科学与技术发展的基石，按需调控飞秒脉冲光场在时域和空域所有基本自由度的能力，对研究原子、分子、电子的超快动力学行为并最终实现对这些体系的操控具有重要意义。利用单层透射式电介质超表面作为调控元件，我们提出并展示了一种可按需定制超短光脉冲时空演化的新方法。该方法通过对超表面样品的分级调控函数设计，并结合时空傅里叶合成，可实现同时且独立控制脉宽仅为 10 fs(对应频谱覆盖从 700 nm 至 900 nm 的超宽频率范围)的超短脉冲的相位、振幅、偏振以及空间波前等自由度。在实验上，利用这一方法我们成功展示了具有螺旋强度分布的“光卷”、携带随时间极快速变化的轨道角动量(OAM)的飞秒脉冲等以往只存在于理论中或只能通过高次谐波等非线性过程才能生成的复杂时空波包。除极高的设计自由度外，该方法还可直接被推广至太赫兹、紫外等其他具有重要科研和战略价值的波段，为通过调控光场时空属性研究并操控光与物质相互作用提供了前所未有的可能性。



Name: Dun Liu 刘顿

Organization: Wuhan Jindun Laser Technology Co., Ltd
武汉金顿激光科技有限公司

Biography:

湖北工业大学机械工程学院教授，超快激光加工研究中心负责人，武汉金顿激光科技有限公司总工程师。中国光学学会激光加工专委会常务理事、武汉市激光学会副理事长，湖北省省级特聘专家。2003-2012 年在英国利物浦大学攻读硕士、博士学位并从事博士后研究，2012 年 9 月回国工作。近年来承担国家、省、市各级项目 30 余项，发表学术论文 130 余篇，获发明专利 30 余项。长期从事超短快激光精密加工的研究工作，主要研究领域包括基于空间光调制器的多光束并行加工、偏振控制、光束整形技术；超快激光材料表面改性、浸润性控制、激光直写光子器件、激光清洗等。

Title:

光场调控及其在超快激光微纳加工领域的应用

Abstract:

随着超快激光微纳加工工业应用的快速发展，加工精度、效率和质量之间的矛盾越来越突出。利用光场调控技术可以动态调整激光束的振幅、相位、偏振态以及脉宽，从而实现多光束并行加工、动态偏振控制、光束整形、脉冲整形等，可有效缓解上述矛盾。本报告介绍了光场调控技术，如二维多光束、三维多焦点、动态球差校正、光束整形的方法，及其在激光精密加工领域尤其是半导体、3C 等领域的应用，包括 Low-K 晶圆开槽、全切、改质切割、玻璃倒角、钻孔等。



Name: Jianjun Yang 杨建军

Organization: Changchun Institute of Optics, Fine Mechanics and Physics, CAS
中国科学院长春精密机械与物理研究所

Biography:

杨建军，博士，现任中国科学院长春精密机械与物理研究所研究员、博士生导师。长期从事飞秒激光对材料烧蚀和微纳制造等方面的研究工作，系统掌握了微纳结构快速灵活制造的关键技术，成功实现了对金属表面光学、润湿和生物兼容等性能的有效调控。现已在国际重要学术期刊（例如：*Advanced Materials*, *Light: Science & Applications*, *Physical Review Letters*, *ACS Photonics* 等）上发表论文 120 余篇，获授权国内发明专利 10 余项，省、部级科技进步奖 4 项、技术发明奖 1 项。

Title:

飞秒光控金属表面次晶态形成及其应用

Abstract:

飞秒光控金属表面次晶态形成及其应用：提出采用飞秒激光元素掺杂微纳结构与循环低温退火相结合的研究方法，在金属铝合金表面成功构建了一种以次晶相态形成为主导的微尺度仿生蚁穴状结构，成功实现了无需有机涂层修饰也可获得高效稳定的超疏水效果。进一步的实验测量表明，该金属样品即使在经历了长达 2000 小时的腐蚀性盐水浸泡后，其表面依然能够保持良好的超疏水性能。不仅如此，这种结构的耐腐蚀性能也尤为突出，在经过严酷电化学反应测试后，材料表面的超疏水特性也依然能够保持，实验测得的样品腐蚀电流较未加工情况降低 5 个数量级。这为未来金属表面超水应用开辟了新的广阔前景。



Name: Dezhi Tan 谭德志

Organization: Zhejiang Lab 之江实验室

Biography:

之江实验室研究员，浙江大学博士生导师，国家级高层次青年人才。获中国硅酸盐学会青年科技奖、浙江省自然科学二等奖等，主持多项国家自然科学基金委项目以及浙江省杰出青年基金项目等。成果入选科技部 2022 年度中国科学十大进展、2022 中国光学十大进展。以第一/通讯作者在 *Science*、*Nat. Commun.* (2 篇)、*Adv. Mater.*、*Light Sci. Appl.* 等高影响力期刊发表论文 50 余篇。本科（2009 年）和博士（2014 年）均毕业于浙江大学。曾在日本京都大学（JSPS 特聘研究员）、韩国基础科学研究所、新加坡南洋理工大学、浙江大学等单位从事研究工作。担任《光学精密工程》编委，*Journal of Materials Science & Technology*、*Ultrafast Science*、*Information & Functional Materials*、《中国激光》及《硅酸盐通报》等学术期刊的青年编委。

Title:

超快激光诱导玻璃结构与光子功能调控

Abstract:

光电集成器件具有高速、低功耗、高并行性、超宽带的优势，可以为大数据存储、传输和处理提供支撑。我们团队揭示了超快激光诱导玻璃内部微区离子迁移与分布调控新规律，解决了在微纳尺度对玻璃结构与光子功能进行调控的难题，实现了三维微区荧光宽波段连续调控，开发了新型多维光存储玻璃与集成光显示器件；提出了高光敏玻璃设计制备新思路，开发了单脉冲超快激光调控技术，将调控效率提升两个数量级以上并降低了调控阈值，实现了超快写入超高稳定大容量数据存储应用；发展了玻璃微区折射率调控新方法，制备了低损耗三维光波导，提出了异质集成非线性光调制思路，研制了三维光信息处理器件，实现了玻璃集成光子器件在光互连与光计算领域的应用，为光功能玻璃开拓了新的应用场景。



Name: Yunlu Sun 孙允陆

Organization: Fudan University 复旦大学

Biography:

孙允陆，在美国密歇根大学安娜堡分校、德克萨斯大学奥斯汀分校等国际顶尖学府，从事科研工作多年，现于复旦大学信息科学与工程学院任研究员。聚焦激光微纳加工等激光应用技术，利用激光与物质作用中相互关联或耦合的多样化学、物理效应，提出并实现一系列具有多维度特性的激光微纳加工以及光/电器件化新颖方法，拓展了功能化集成光子/电子先进制造技术。以第一或通讯作者发表 *Nature Communications* (2 篇), *Light: Science & Applications* (封面), *Advanced Materials* (卷首), *Angewandte Chemie International Edition* (内封/highlighted/热点文章), *Advanced Science* (背封), *Materials Horizons* (内封)等顶尖 SCI 论文。研究工作获多院士等著名专家在内的国内外同行广泛引用和积极评价，被中国《科学通报》、《中国激光》、德国 *Wiley Angew.Chem.Int.Ed.* press release/room 和 *MaterialsViewsChina*、英国皇家化学协会 *ChemistryWorld*、美国 *LaserFocusWorld*、*ScienceDaily*、*Nanowerk* 及欧洲 *ElectroOptics* 等国内外权威学术媒体专题报道。

Title:

多物理场耦合激光微纳加工及仿生光子学应用

Abstract:

光或激光，能以多样的空间、时间和光谱特性传递和施加光能量，引发光动力化学、物理效应，乃至光与物质相互作用，进而实现各种微纳加工技术。我们的工作面向集成光子/电子先进制造，聚焦多物理场耦合激光微纳加工的思路，利用激光与物质作用中相互关联或耦合的多样化学、物理效应，提出并实现一系列具有多维度特征的激光微纳加工新机制、新方法，拓展了功能化集成光子/电子器件的微纳加工技术，更为仿生光子学、激光医学、半导体制造等领域，提供可扩展的新工具箱。本报告将主要介绍我们在仿生光子学方面的最新进展。在近期工作中，我们基于微纳光学结构的微区限域激光与物质作用，提出并构建了仿生“光子纤毛”全光矢量力学传感器原型，开发了用于难加工金属的近场调制激光诱导表面微纳结构化，实现其光辐射调制，乃至仿生辐射制冷表面。各种生物纤毛状机械感受器，具有极为相似的“电极阵列+纤毛”紧凑结构，是单器件实现矢量力学传感的少有构型，其仿生版本被愈加广泛的用于集成水下/空中流体检测、声波探测、机器触觉等。自然界和人造仿生的纤毛机械传感器都是基于电学机制，限制其高温高压、强电磁干扰等特殊环境适用性。全光仿生机械纤毛器件，是其可能解决方案。受生物纤毛机械感受器启发，“师法自然而高于自然”，我们引入全光传感机制，提出并实现了一种模仿生物纤毛机械感受器的仿生光子学方案；以玻璃空心泡光学微腔作为激光微区限域结构，构建了毫微米尺寸的方向性或矢量性全光机械传感器概念原型。尤其，其异质异构三维集成制造，可基于激光微纳加工技术实现。此外，我们利用微纳预结构实现激光近场微纳限域，即利用种子结构等离子体热点，钳位和增强飞秒激光与物质相互作用，研究并利用其多物理场耦合过程及其正负反馈机制，优化了激光诱导超波长结构化的可控性和质量，实现了激光诱导超波长微纳孔（阵列）的可控自组织制备。基于此，实现了高熔点（钨、钨）或高硬度（钨钛基金属玻璃）等难加工金属的直接表面微纳结构化，并保护其体材料玻璃态及特殊性质，尤其实现了红外等波段的光辐射调制，乃至模拟撒哈拉银蚁的日间仿生辐射制冷表面。本报告也对我们的未来工作加以展望。

Name: Jianfeng Yan 闫剑锋

Organization: Tsinghua University 清华大学

Biography:

闫剑锋，清华大学副教授。主要研究领域：超快激光、微纳制造。曾获清华大学优秀博士论文指导教师，国家级青年人才，清华大学青年教师教学大赛一等奖，教育部自然科学二等奖，清华大学优秀博士论文等多项奖项。主持国家自然科学基金项目、北京市科技计划项目；参与国家重大专项、国家重点研发计划项目、国家自然科学基金项目等。

Title:

微纳米材料、结构与器件的超快激光加工制造

Ultrafast Laser Processing and Fabrication of Micro-Nano Materials, Structures, and Devices

Name: Lisha Fan 范丽莎

Organization: Zhejiang University of Technology 浙江工业大学

Biography:

范丽莎，教授/博士生导师，浙江工业大学机械工程学院，曾就职于美国内布拉斯加州大学林肯分校激光纳米工程实验室和美国橡树岭国家实验室。主要从事微纳尺度的激光材料制备新方法、工艺及设备前沿与工程研究工作。承担国家重点研发计划课题、国家自然科学基金优秀青年（海外）基金、国家青年基金、浙江省“尖兵领雁”科技攻关项目等，在激光应用和先进材料领域的国际知名杂志上共发表近 50 篇，包含 *Light Science & Applications*、*Advanced Science*、*Science Advances* 等期刊论文。获 2015 年“橡树岭国家实验室支持贡献奖”，获 2019 年浙江省“特聘专家”称号。

Title:

超快激光微纳制备压电纳米结构研究

Abstract:

Piezoelectric sensors play a crucial role in applications such as energy conversion and monitoring. Piezoelectric nanostructures facilitate stress concentration, which is a common approach to enhancing piezoelectric response. However, conventional micro-nano fabrication techniques suffer from drawbacks including low efficiency, low precision, template limitations, complex processes, and high costs. We propose a large-scale, high-efficiency femtosecond laser direct writing method that leverages the local thermal deformation effect induced by laser to create size-adjustable microstructures like bumps, craters, and grooves at nanoscale on lead zirconate titanate (PZT) piezoelectric films. We analyzed the impact of various micro-nano structures on the piezoelectric response. The results show that the 450 nm high nano-bumps increases the piezoelectric response voltage by about 30%. Theoretical analysis indicates that stress concentration occurs at the top of the nano-bumps, providing a larger strain for enhancing the piezoelectric response. This study verifies the droplet impact detection response of these piezoelectric nano-bumps, demonstrating the potential value of ultrafast laser micro-nano manufacturing in the field of rainfall monitoring.



Name: Liping Shi 石理平

Organization: Hangzhou Institute of Technology of Xidian University
西安电子科技大学

Biography:

Prof. Liping Shi received a diploma degree in Physics (2009) and a doctor degree in Optics (2014) from East China Normal University, Shanghai, China. He occupied postdoctor research positions from 2014.09 to 2020.06 at the Institute of Quantum optics and PhoniexD excellent cluster at Leibniz University, Hannover, Germany. From 2020.09 to 2023.05, he was a research associate professor at Westlake University, Hangzhou, China. Currently, Liping Shi is working as a PI at Hangzhou Institute of Technology, Xidian University. His research interests include fundamentals and applications of laser-matter interaction, attosecond science, ultrafast laser nanofabrication and nonlinear nanophotonics.

Title:

Improving the Regularity of Lipss by Burst Laser-Driven Heat Accumulation

Abstract:

Heat accumulation caused by high-repetition-rate femtosecond lasers is generally considered a disadvantage for high-precision ultrafast laser manufacturing. However, using 40 MHz femtosecond pulse bursts, we investigate a rarely explored femtosecond laser processing technique, which employs laser-induced chemical reaction to selforganize large-scale periodic subwavelength nanostructures on thin films. Compared to non-burst femtosecond pulses, we find that heat accumulation induced by highrepetition bursts not only improves the quality of nanofabrication but also increases processing throughput by an order of magnitude. The underlying physical mechanism is that oxidation-dominated self-assembly involves a nonlinear feedback mechanism, where surface electromagnetic waves excited by already-formed oxide nanoparticles induce the formation of subsequent nanostructures. Heat accumulation can promote the oxidation reaction, thereby enhancing this nonlinear feedback mechanism. This study provides new insights into improving femtosecond laser micro/nanofabrication by controlling photothermal effects.



Name: Zhiqiang Gao 高志强

Organization: Shenzhen Monochrome Technology Co., Ltd
深圳市单色科技有限公司

Biography:

富士康、中广核等国内外知名企业多年机床相关行业从业经验。从事多年飞秒激光设备研发制造经验。

Title:

飞秒激光赋能极端制造

Abstract:

随着现代工业各领域中关键仪器的核心零部件的加工精度、效率和复杂度要求的不断提高，传统制造技术逐渐难以满足极端制造的需求，如极小尺寸（微米级甚至亚微米级）无法加工、极端精度（如亚微米甚至纳米级）无法实现、高硬度材料（如高温合金、金刚石、陶瓷等）难加工等。飞秒激光技术以其超短脉冲宽度、高峰值功率密度和极高的时空分辨率等独特优势，成为实现极端制造的理想工具。本次会议旨在分享飞秒激光在极端制造领域的最新应用，以及单色科技在飞秒激光智能装备在极端制造领域的加工能力，旨在促进产业界与学术界的深度交流与合作，推动基于飞秒激光的极端制造技术的发展，助力我国制造业迭代升级，以期在超快激光复合加工技术的研究和应用上占据国际领先地位。



Name: Miaomiao Yu 于苗苗

Organization: Guangdong Original Point Intelligent Technology Co., Ltd
广东原点智能技术有限公司

Biography:

于苗苗，广东原点智能技术有限公司产品经理，博士毕业于长春理工大学，攻读电子科学与技术专业，主要研究方向为激光加工超硬材料及金属微纳结构及性能。博士期间从事纳秒与飞秒激光加工理论、工艺及功能性表面制备研究，系统分析了激光作用机理，完成铜基金属材料的激光增材制造和超疏水表面的制备。累积在《Optics and Laser Technology》《Applied Surface Science》等国际期刊发表论文 10 余篇，其中第一作者 4 篇。参与科技部重点研发计划等多项科研项目，具备材料学、光学和机械工程学的交叉研究背景。

Title:

精密五轴数控激光机床的技术创新与工业应用

Abstract:

重点介绍了广东原点智能技术有限公司的精密五轴数控激光机床相关成果。

一、精密五轴数控激光机床技术创新：

在技术创新上，相较于传统的电火花加工和磨削技术存在的效率低、成本高、材料受限及污染大等问题，激光加工技术优势显著，如精度高、热影响小、环保且适用材料广泛。原点智能的多轴联动控制系统能实现 13 轴联动插补，在速度、精度等方面表现出色且兼容性强；自主研发的多款激光加工 CAM 软件应用广泛；水导激光、旋切钻孔、椭圆光斑等技术独具特色，还有多种先进的激光器、检测模块和机器视觉系统保障加工质量。

二、原点智能解决方案

原点智能的激光五轴联动加工中心等系列产品在医疗器械、航空航天、汽车零部件制造、模具制造以及 3C 电子产品等领域应用广泛。产品有效解决了高性能难加工材料及复杂零件的加工难题。

三、关于原点智能

广东原点智能技术有限公司（以下简称“原点智能”）是中国工业母机——数控机床行业的新锐企业，是一家由高端人才团队成立的集高端数控机床、高端数控系统关键技术研发、生产、制造、销售于一体的高科技企业。主营产品包括激光磨削机床、激光五轴加工中心、激光旋切钻孔机床、水导激光等，同时多项技术已成功突破领域内“卡脖子”难题，其中“面向复杂零件精密加工的多轴五联动激光加工机床关键技术及应用”已达到国际先进水平；高端数控系统产品已定型并进入市场推广阶段，打破国外对我国高端数控系统的封锁与垄断。

Session 5 JAN. 13-14.2025

Exhibition Center Hall C1

Optical Frequency Comb and Applications
光学频率梳及应用

Session 7 JAN. 13-14.2025

Exhibition Center Hall C1

Quantum Metrology and Devices
量子精密测量与器件



Name: Elisabeth Giacobino

Organization: Sorbonne Université

Title:

Quantum Simulation with Fluids of Light

Abstract:

Quantum fluids of light can be created in an optical cavity containing a nonlinear medium. In such conditions, propagating photons behave like massive particles, because they acquire a small effective mass. Moreover, they interact with each other thanks to the nonlinear material. In the past few years, exciton-polaritons in a semiconductor microcavity have been shown to behave like a quantum fluid of light and to constitute an interesting platform for quantum simulation. We will show how this system allows to model quantum hydrodynamics, including Bose-Einstein condensation, superfluidity, Cerenkov waves, quantum turbulence or topological excitations like vortices.

Then, we will show that this quantum fluid of light is very promising for the study of analogue gravity physics. An event horizon appears in an accelerated polariton fluid where the fluid velocity becomes larger than the speed of sound. This can be used to simulate the physics of black holes, and in particular observe correlated Hawking radiation that has been predicted to be emitted on each side of this horizon.

Polaritons as quantum fluids of light are thus very interesting for the quantum simulation of various systems, ranging from condensed matter to astrophysics.



Name: Chaohong Li 李朝红

Organization: Shenzhen University 深圳大学

Biography:

李朝红，深圳大学讲席教授、量子精密测量研究所所长，广东省量子精密测量与传感重点实验室创始主任，国家杰出青年科学基金获得者，国家特支计划科技创新领军人才，科技部创新推进计划领军人才。2003 年从中科院武汉物理与数学研究所获博士学位，2003 年至 2009 年先后在德国马普复杂系统研究所和澳大利亚国立大学从事科学研究，2009 年加入中山大学任教授，2022 年加入深圳大学任特聘教授。主要研究冷原子物理与量子精密测量，研究工作涵盖：冷原子晶格体系的量子关联与新奇量子物态；玻色凝聚原子体系跨越相变的普适量子临界动力学；冷原子量子精密测量与量子传感等。已在 Rev. Mod. Phys.、Nature Physics、Phys. Rev. Lett.、Nature Communications、PRX Quantum、Appl. Phys. Rev. 等高水平国际期刊发表 SCI 论文 120 余篇。多个理论工作被苏黎世理工学院 Esslinger 教授团队、诺贝尔物理奖得主 Wineland 教授团队等国际著名研究组的后续实验证实。

Title:

Quantum Lock-In Measurement with Cold Atoms

Abstract:

The detection of weak time-dependent alternating signals in a strongly noisy background is an important problem in physics and a critical task in metrology. Generally, lock-in measurement is usually used in high-efficiency classical detector to extract a signal from noises, which can be achieved via nonlinear devices. In analogy to the classical lock-in measurement, quantum lock-in measurement can be realized by making use of quantum non-commutativity. The quantum lock-in measurement with a single particle has been widely used for magnetic field sensing, vector light shift detection, and force detection. However, all existing studies of quantum lock-in measurement concentrate on singleparticle systems. Thus, it is challenging to achieve a quantum lock-in measurement via a many-body quantum system. Moreover, due to the typical target signal has unknown initial phase, it is also a challenge to extract complete information about the signal's amplitude, frequency, and initial phase. In this presentation, I will present our recent two works on quantum lock-in measurement with cold atoms: (1) our work for achieving an entanglement-enhanced lock-in amplifier via use of many-body multipulse quantum interferometry. On the basis of our protocol, the frequency and amplitude of an alternating signal can be efficiently extracted with a high signal-to-noise ratio, even in an extremely noisy environment. In particular, if we input spin cat states and apply interaction-based readout operations, the measurement precisions for frequency and amplitude can both approach the Heisenberg limit; (2) our work for achieving a quantum double lock-in amplifier by employing two quantum mixers operating under orthogonal pulse sequences. This scheme establishes a quantum counterpart to the classical double lock-in amplifier and enables the extraction of the complete characteristics, including frequency, amplitude, and initial phase, of the target AC signal. Further, we discuss the experimental feasibility using a five-level double- Λ coherent population trapping system with Rb atoms.



Name: Zhenda Xie 谢臻达

Organization: Nanjing University 南京大学

Biography:

谢臻达，南京大学电子科学与工程学院教授、博士生导师、曾获“千人计划”青年项目和江苏省双创人才项目支持。研究方向：非线性光学、量子光学和无人机光信息网络，共发表包含 National Science Review、Nature Photonics、Physical Review Letters、Light: Science & Applications 在内的 SCI 论文 100 余篇。无人机纠缠光子分发的成果入选 2021 年中国光学领域十大社会影响力事件（light10），获得江苏省青年科技奖“江苏省十大青年科技之星”和教育部高等学校研究优秀成果奖自然科学一等奖，并作为主要完成人先后三次获日内瓦国际发明展金奖。

Title:

低噪声微腔光学频率梳的研究

Abstract:

光学频率梳可以用作光频和微波频段之间的桥梁，实现时间频率的高精度计量。而基于光学微腔的光学频率梳具有小型化、低成本、易集成的特性，有望发展出可现场部署的精密时频计量和微波光子学设备。其中，低噪声的微腔光学频率梳产生及其自参考锁定是上述应用的关键。我们采用高品质因子(Q)的光纤微腔光频梳实现了全集成封装的近量子噪声极限克尔孤子光频梳产生，封装尺寸最小为 4mL，合成的 10.1 GHz 和 1.7 GHz 微波拍频信号相噪分别低至 -105 和 -80 dBc/Hz @ 100 Hz, -125 和 -106 dBc/Hz @ 1 kHz, -148 和 -133 dBc/Hz @ 10 kHz, Allan 方差低于 3×10^{-11} (2×10^{-11}) @ 1 s; 采用铌酸锂薄膜微腔实现了高稳定、宽带宽的克尔光梳产生，带宽达 0.7 倍频程，并采用铌酸锂薄膜波导首次实现了微腔克尔光梳的跨倍频程超连续谱展宽。上述工作为全集成低噪声微腔光梳提供了新方案，也为微腔光梳的全片上自参考锁定打下了基础。



Name: Jieci Wang 王接词

Organization: Hunan Normal University 湖南师范大学

Biography:

王接词，湖南师范大学教授，主持国家自然科学基金优秀青年基金和湖南省杰出青年科学基金，入选湖南省科技领军人才，担任湖南省物理学会副秘书长。研究领域是相对论量子信息、黑洞物理与引力波。在 *Physics Reports*、*Nature Communications*、*Astrophysical Journal Letters*、*Physical Review A/D* 等期刊发表论文 70 余篇，单篇最高他引 480 余次。

Title:

Quantum Sensing in Curved Spacetime

Abstract:

Quantum sensing is a quantum technology that uses quantum systems, quantum properties or quantum phenomena to improve the measurement accuracy of physical quantities. Recently, quantum sensing has emerged as a unique and rapidly growing branch of research in the field of quantum science and technology. As one of the most important tasks of quantum sensing, quantum channel-position finding is an entanglement assisted target detection scheme that uses an optimal quantum receiver and has a good advantage over the optimal classical strategy in terms of error exponent. In this talk, I will briefly introduce the recent progresses on the study of quantum enhanced channel-position finding and quantum ranging in the near-Earth curved spacetime. Particularly, I will focus on how the gravitational effect of the Earth influences the performance of the quantum channel-position finding and ranging protocols.



Name: Yao Huang 黄焱

Organization: Institute of Precision Measurement Science and Technology
Innovation, CAS 中国科学院精密测量科学与技术创新研究院

Biography:

黄焱, 自 2007 年博士研究生阶段至今长期从事钙离子光频标研究工作, 参与研制出国内首台光频标, 随后通过不断改进光频标的性能指标, 使钙离子光频标不确定度和稳定度均进入 E-18 量级。同时逐步提高了钙离子光频标绝对频率测量精度, 绝对频率值被第国际计量局采纳, 同时钙离子光频标被新增为次级秒定义。研究成果“高精度钙离子光钟”获 2018 年中国计量测试学会科技进步一等奖(排名第三)。在包括 Phys. Rev. Lett.、Phys. Rev. Applied、Phys. Rev. A 等在内的国际学术期刊上发表论文 70 余篇。入选中国科学院青年创新促进会会员, 为基金委创新研究群体核心成员之一。主持科技部重点研发计划青年项目、基金委优秀青年项目、面上项目和青年基金等。

Title:

钙离子光频标研究进展及应用展望

Abstract:

光钟是钟跃迁频率处于光频波段的一类原子钟。目前, 国际上的一些光钟在不确定度和稳定度上都已经比最好的微波钟 2 个数量级, 未来国际单位制“秒”可能会定义到光钟的光频跃迁上。目前, 我们已实现 E-18 量级实验室型钙离子光钟的研制, 并在 E-19 量级光钟研制方面有所突破。同时, 光钟也可应用于测地学研究。我们研制了一台可搬运钙离子光钟, 其系统不确定度为 E-17 量级, 通过与另一台高度不同的钙离子光钟进行引力红移的测量, 验证了该可搬运光钟具有分米量级高程差测量分辨率。之后, 我们将可搬运钙离子光钟由武汉搬运至北京, 同中国计量科学研究院合作实现了钙离子钟跃迁绝对频率的溯源测量, 测得钙离子光钟钟跃迁绝对频率为 411 042 129 776 400.26(13) Hz, 相对不确定度 3.2E-16。我们测得的钙离子钟跃迁绝对频率测量值被国际计量局, 并推荐钙离子光钟的钟跃迁成为新增的二级秒定义参考(SRS)。

Name: Oliver Heckl

Organization: University of Vienna

Biography:

Oliver Heckl is currently serving as an Assistant Professor at the Faculty of Physics at the University of Vienna. In 2007, he earned his diploma in physics from the University of Augsburg, Germany. His introduction to photonics occurred during a one-year student research project with Prof. Bachor at the Australian National University (ANU) in Canberra. In 2011, Heckl chose to further his academic pursuits by joining Prof. Keller's group at ETH Zürich in Switzerland, completing his PhD in laser. His thesis focused on peak power scaling with modelocked thin-disk lasers. In 2014, Oliver Heckl was awarded a Feodor Lynen research scholarship, leading him to join Prof. Jun Ye's group at JILA, CU Boulder, Colorado. During this period, his research interests expanded to include optical frequency combs, nonlinear optics, and molecular spectroscopy with frequency combs.

Since 2017, Oliver Heckl has been at the forefront, heading the Christian Doppler Laboratory for Mid-IR Spectroscopy and Semiconductor Optics at the University of Vienna. His current focus involves advancing frequency comb technology into the mid-IR spectral region, aiming for applications in trace-gas detection, precision spectroscopy, and molecular fingerprinting.

Title:

High-power, low-noise mid-IR frequency combs

Abstract:

This presentation will discuss our research on the development of low-noise, high-power mid-infrared (mid-IR) frequency combs designed for precision spectroscopy. The talk will begin with an overview of our efforts in developing low-noise seed lasers, which are crucial for the stability and performance of the frequency comb. Following this, we will delve into our innovative techniques for spectrally tuneable and stable amplification, ensuring robust and reliable performance across the desired spectral range. The presentation will conclude by highlighting our successful conversion into the mid-IR range, culminating in the demonstration of a 10 W mid-IR optical frequency comb. This advancement represents a significant step forward in the field of precision spectroscopy, offering enhanced capabilities for various scientific and industrial applications.

Name: Baicheng Yao 姚佰承

Organization: University of Electronic Science and Technology of China 电子科技大学

Biography:

姚佰承，电子科技大学教授、博导、实验室副主任，国家青年专家、国家青年首席专家。聚焦于光频梳器件与传感系统研究，主持国家、国防和业界项目 10 余项，近年来在 Nature/Science 及其子刊等发表论文 80 余篇，在国际会议上做大会和特邀报告 40 余次，授权美国发明专利 4 项，中国发明专利 20 余项，获国内外学术荣誉 10 余项。任 IEEE/OSA/COS/CEOS 高级会员和 中国电子学会、光学学会、光学工程学会、感光学会和兵工学会专委，《Photonic Sensors》青年编委会主席和 6 个国际 SCI 期刊编委。

Title:

基于双光频梳的精密感知

Abstract:

精密光感知是现代信息化工业的核心支柱之一，随着技术的发展，光源越来越成为限制光感知性能的因素之一。光频梳，以光为尺，是革命性的光子计量和传感新工具，其具有快脉冲、宽光谱、高相干和多通道的突出优势，能有效服务光感知应用。本报告汇报分享我们基于光纤、WGM 和片上谐振腔的双光梳光源研究及其驱动的多样化感知新进展，包括高精度激光雷达、超灵敏光纤传感和多功能声学定位等。



Name: Zhen Wang 王震

Organization: The Chinese University of Hong Kong 香港中文大学

Biography:

王震博士现为香港中文大学研究助理教授，在激光光谱和光学传感领域发表论文 30 余篇，其中两篇高被引论文，光频梳相关的研究发表在 *Nature Communications* 和 *Light: Science & Applications* 等知名期刊，目前的研究方向主要集中在高灵敏、低耗气量气体传感技术的研究以及在深海深空等极端环境的应用。

Title:

High Sensitivity and Broadband Infrared Cavity-Enhanced Spectroscopy

Abstract:

基于激光光谱的气体传感技术以其高灵敏度、高选择性、高精度、在线分析、长寿命和快速响应等特点越来越受到人们的关注。光学频率梳（光频梳）是一种可以发射数千个高相干、等间隔频率成分的激光光源。自诞生以来，光频梳通过原子钟对计量学、光谱学和精密计时等领域产生了革命性的影响，并获得了 2005 年诺贝尔物理学奖。双光梳光谱采用两个具有微小梳齿频率差的光频梳进行异步光学取样，通过解析多外差干涉信号反演分子的光谱信息。近年来，研究者从多外差拍频产生强度调制的视角审视异步采样过程，使光频梳与光声光谱的结合成为热点，不仅可以继承双光梳光谱超高分辨率和超快测量速度的优势，而且外差拍频过程将气体吸收转化为局域的声波信号，可以通过声学传感器探测。由于不依赖高带宽光电探测器和高速数据采集系统，该技术大大简化了测量系统的复杂性，而且光声信号只依赖于光源功率而非吸收距离，可以显著缩小测量系统的体积，为提高双光梳光谱的探测灵敏度提供了可能。在报告中，我将介绍我的研究内容，包括光频梳与光学谐振腔的锁定技术、宽带声学谐振腔的设计以及双光梳光谱与光声 / 光热光谱的结合。



Name: Xiulai Xu 许秀来

Organization: Peking University 北京大学

Biography:

许秀来，北京大学博雅特聘教授，1996 年毕业于吉林大学电子工程系，1999 年在中国科学院长春光机与物理研究所获得硕士学位，2005 年于剑桥大学卡文迪许实验室获得博士学位；随后在日立剑桥实验室先后担任博士后研究员和高级研究员，2011 年加入中科院物理所，先后担任副研究员、研究员，并兼任中国科学院大学岗位教授，2021 年加入北京大学物理学院，主要研究方向为低维半导体体系的光电物理与器件。

Title:

Strong Coupling of Two-Dimensional Excitons with Plasmonic Nanocavity

Abstract:

Plasmonic nanocavity with mode volume beyond the diffraction limit can greatly enhance the interaction of light and matter. At the same time, two-dimensional excitons in transition-metal dichalcogenides layers have attracted wide attention because of the large exciton binding energy, highly efficient single photon emission from defects and so on. Here in order to realize exciton-polaritons formed by two-dimensional excitons and plasmonic nanocavity at a low exciton number, we fabricated a compact bowtie nanocavity and successfully realized a strong coupling of MoS₂ excitons and bowtie nanocavity with high robustness. The number of excitons involved in the coupling is reduced to about 40-48. Furthermore, we investigated the coupling of single localized defect excitons in a two-dimensional layer with chiral plasmonic nanocavity. By designing a chiral plasmon mode with high quality factor and coupling it with a WSe₂ monolayer, we have successfully achieved cavity-dependent photon output from a single quantum emitter. The solution of the dynamics model of this coupled system shows that the chiral photon output mainly comes from the spontaneous emission of the quantum emitter which is strongly modified by the chiral plasmonic nanocavity. Therefore, the valley-dependent optical selection rules are absent in such quantum emitters.



Name: Linjie Zhang 张临杰

Organization: Shanxi University 山西大学

Biography:

张临杰，教授，博导，入选国家级高层次人才计划，山西省国防创新团队带头人。从事里德堡原子电场量子精密测量与传感研究。主持国家重点研发计划等项目 20 余项，研究工作入选“中国高校科技十大进展”和“中国光学领域十大社会影响力事件”。

Title:

基于里德堡原子的电场传感

Abstract:

基于 Rydberg 原子的射频电场传感因其具有超高灵敏度、超宽带响应以及良好可追溯性等潜在性能，已经成为近年来热门的研究方向。本报告介绍了基于 Rydberg 原子的射频电场传感的基本原理、实验技术以及国内外研究团队在射频电场探测灵敏度提升方面的进展；特别是证明基于缀饰 Rydberg 原子超外差技术可实现逼近原子标准量子噪声极限的电场测量，Rydberg 原子超外差技术与 MZ 干涉仪相结合实现的原子复电极化率测量，并展示电极小原子天线实现的射频电场灵敏度提升，实现了 MHz 电场灵敏度指标的提升。



Name: Teng Wu 吴腾

Organization: Peking University 北京大学

Biography:

Dr. Teng Wu is currently working as a tenure-track assistant professor at the School of Electronics, Peking University. He received his B.S. degree in Electronics Information Science and Technology and Ph. D degree in Radio Physics (Quantum Electronics) from the Peking University in 2011 and 2016, respectively. From 2016 to 2019, he worked as a post-doctoral researcher at the Helmholtz Institut Mainz, Germany. His research interests focus on high-sensitivity atomic magnetometry and the applications in nuclear magnetic resonance, biomagnetism and fundamental physics. Dr. Wu has published more than 70 peer reviewed papers in Nature Physics, Science Advances, Physical Review Letters. He is the receiver of the National Natural Science Fund for Excellent Young Scientists Fund Program and takes the lead of several key projects from the National High-Tech Research Program.

Title:

量子技术: 量子磁传感--基础及应用

Quantum Technologies: Quantum Magnetic Sensing

Abstract:

In this talk, I will give an overall introduction on our recent progress on the applications of high sensitivity atomic magnetometry in this field of biomagnetism, magnetic-field standard, and searches for exotics physics. For biomagnetism, I will introduce the basic idea of measuring the bio-magnetic field signals with atomic magnetometers in unshielded environment, as well as the significance and potential applications of measuring magnetic field signals from different organs of the human being. For magnetic-field standard, I will introduce our recent work on the active magnetic field stabilization with atomic magnetometers, including the basic principle of generating a magnetic field with both high precision and low noise level. For probing the frontiers of the fundamental physics, I will introduce several kinds of novel design and adaptation of the atomic magnetometry, all of which are focused on suppressing the different kinds of systematic errors in the searches for exotic physics beyond the standard model.



Name: Haidong Wang 王海东

Organization: Peking University 北京大学

Biography:

Dr. Haidong Wang, an Assistant Researcher at the School of Electronics, Peking University. He received his Ph. D degree in Electronic Science and Technology (Quantum Electronics) from the Peking University in 2020. From 2020 to 2024, he worked as a post-doctoral researcher at the School of Electronics, Peking University. His research interests focus on quantum precision measurement, and he has been engaged in technical research on high-sensitivity atomic magnetometers, high-stability lasers, magnetic compensation for aerial platforms, suppression of environmental magnetic interference, and other related technologies. Several of his accomplishments have significant application value in fields such as magnetic anomaly detection, geological exploration, geomagnetic navigation, and biomagnetism. He has applied for 12 national invention patents (with 7 already granted) and published more than 20 peer reviewed papers. He has led or participated in more than 10 National High-Tech Research Programs and National Natural Science Foundation Programs.

Title:

量子技术: 量子磁传感--工程及技术

Quantum Technologies: Quantum Magnetic Sensing Related Engineering and Techniques

Abstract:

This talk focuses on the engineering technology of quantum magnetic sensors, including aspects such as the engineering technology of the magnetic sensor's light source and the magnetic optical component. For the complex and diverse practical application environment, we have conducted in-depth research on the stabilizations of laser frequency and power, and innovatively proposed a technical solution for light sources that resistance to temperature changes, magnetic interference, and vibration. Furthermore, for the challenges of magnetic anomaly detection on dynamic platforms, we have put forward effective design solutions to eliminate dead zones and reduce heading errors. These engineering technologies have established a robust technical foundation for the widespread deployment of quantum magnetic sensors in various practical applications.



Name: Ziyang Chen 陈子扬

Organization: Peking University 北京大学

Biography:

Dr. Ziyang Chen, a Research Assistant Professor at the School of Electronics, Peking University. His research interests focus on quantum secure time-frequency transfer based on novel optical technologies. In recent years, he has been engaged in theoretical, technical, and security research on ultra-long-haul time-frequency transfer. He has published more than 60 peer-reviewed papers in Optica, npj Quantum Information, and Physical Review Letters (including 3 highly cited papers in ESI). He has applied for/granted more than 10 patents. Dr. Chen is the receiver of the Young Talents Lift-up Project. He leads several projects including the National Natural Science Fund Program and the National High-Tech Research Programs.

Title:

量子时频传递——研究及进展

Quantum Technologies: Quantum Secure Time & Frequency Transfer

Abstract:

In response to the evolving demands for high-precision, long-distance time-frequency transfer in complex networked environments, this talk introduces a new method of fiber-optic time-frequency transfer using optical frequency combs. Addressing challenges such as limited noise compensation capabilities over long distances, restricted time resolution of optical pulse measurements leading to degradation in time-frequency transfer performance, we propose enhancing the long-distance transmission capability of all-optical regeneration systems through active noise compensation and improving the precision of time-interval measurements and synchronization with microwave clocks through linear optical sampling methods. The results indicate the technical feasibility of achieving high-precision frequency transfer exceeding thousands of kilometers, femtosecond-level electrical signal time-interval measurements, and microwave clock synchronization. This technology provides technical support for expanding the application of high-precision time-frequency networks in the future.



Name: Yufei Zhang 张宇飞

Organization: Peking University 北京大学

Biography:

Yufei Zhang is a Ph.D. candidate at the School of Electronics, Peking University, under the supervision of Prof. Hong Guo. His main research areas are quantum time-frequency transfer technology and its applications. He has published 7 papers and holds 5 granted patents.

Title:

无中继放大时间传递的挑战与进展

Challenges and Progress in Time Transfer without Inline Amplification

Abstract:

High-precision long-distance time-frequency transfer plays an indispensable role in fields such as satellite navigation and geodesy. As an infrastructure with long transmission distances and wide coverage, fiber link is particularly suitable as a medium for long-distance time-frequency transfer. However, in special and critical application scenarios, such as extreme environments and emergency communications, it is challenging to establish effective relay nodes, which has created an urgent demand for high-precision, relay-free time-frequency transfer technology. In this talk, I will introduce the challenges faced by inline-amplification-free time transfer, analyze its technical limit from the perspective of the finite gain-bandwidth product, and propose a system solution based on waveform-resolved single-photon detection, thereby providing theoretical and experimental support for high-precision time transfer without inline amplification.



Name: Xiao Yang 杨潇

Organization: Peking University 北京大学

Biography:

Xiao Yang is a Ph.D. candidate at Peking University. His primary research focuses on quantum sensing technologies and their applications, with a particular emphasis on biomagnetic source localization. To date, he has published two research papers.

Title:

生物磁中的源定位问题研究及进展

Research and Advances in Source Localization in Biomagnetism

Abstract:

Biomagnetic source localization technology enables high spatiotemporal resolution imaging of electrical activity within the body, providing new avenues for physiological research, disease diagnosis, and therapy monitoring. Compared to bioelectric source localization, biomagnetic source localization has the potential to achieve higher localization accuracy but faces challenges such as maintaining cryogenic environments and the high costs of constructing magnetically shielded environments. With advancements in optically pumped magnetometers (OPMs) and active magnetic shielding technologies, the application prospects of biomagnetic source localization in unshielded environments based on OPMs have drawn increasing attention. In this talk, I will introduce the principles and fundamental methods of biomagnetic source localization, compare the characteristics of bioelectric and biomagnetic source localization techniques, and highlight recent advances in biomagnetic source localization in unshielded environments.

Name: Jietai Jing 荆杰泰

Organization: East China Normal University 华东师范大学

Biography:

荆杰泰，华东师范大学教授，博士生导师，国家杰出青年科学基金获得者，上海市优秀学术带头人，东方学者，曙光学者以及浦江人才。2004 年在山西大学量子光学与光量子器件国家重点实验室获得博士学位，而后赴美国弗吉尼亚大学和马里兰大学从事博士后研究，2008 年加入华东师范大学。主要从事量子光学与量子信息方面的研究，尤其聚焦量子光源的制备与应用。近五年发表通讯作者论文 50 余篇，包括 *Physical Review Letters* 13 篇，*Nature Communications*、*Optica* 及 *PNAS* 各 1 篇。培养学生 3 人次获中国光学学会王大珩高校学生光学奖，1 人次获饶毓泰基础光学奖，1 人次获中国光学学会郭光灿光学优秀博士学位论文。

Title:

全光量子信息体系的实验构筑

Experimental Implementation of All-Optical Quantum Information Systems

Abstract:

量子信息是一种利用量子资源实现高安全、高保真、高容量的信息处理方式。随着量子信息技术的发展，量子信息领域发展出了一系列基于分离变量和连续变量的量子信息协议。在连续变量领域中，量子信息协议的实现通常需要基于光电和电光转换的前馈技术。而光电和电光转换的引入在一定程度上限制了信息处理的带宽。因此，发展无需光电和电光转换的全光量子信息协议对量子信息的发展具有重要意义。本报告将介绍我们基于四波混频过程实验实现的系列全光量子信息协议，包括全光量子隐形传态协议、全光纠缠交换协议、全光量子态远程克隆、全光擦除纠错协议、部分无实体全光量子态传输协议、全光量子克隆协议以及全光量子态共享协议。我们的工作为实现全光量子信息网络奠定了坚实的基础。

Name: Xinyou Lv 吕新友

Organization: Huazhong University of Science and Technology 华中科技大学

Biography:

吕新友, 华中科技大学物理学院教授, 博士生导师, 国家自然科学基金“杰出青年基金”、“优秀青年基金”和湖北省“百人计划”获得者。主要从事腔量子电动力学(QED)和腔光力学等方面的理论研究。

Title:

Waveguide Qed: Manipulating the Interaction of Photons and Atoms

Abstract:

In this presentation, I will firstly introduce the background of waveguide quantum electrodynamics (QED) and its applications. Secondly, I will introduce the analytical expression of the n -th-order equal-time correlation functions. Based on the analytic solution, I mainly introduce the perfect photon blockade (PB) effect induced by the chiral interaction in waveguide-cavity QED system. Specifically, the destructive interference of two-photon paths only appears in the chiral region. We find that the perfect PB points rise as the number of cavities increases, and the required chirality also decreases exponentially. Lastly, I will introduce our recent work regarding the exotic long-range interaction and the associating quantum many-body phases in topological waveguide QED system. We theoretically predict a kind of power-law exponential (PLE) dipole-dipole interaction between quantum emitters. Applying PLE interaction to a spin model, we find that PLE interaction can induce the unique ordered and critical spiral phases in comparison with other types of interaction, owing to the strong frustration of PLE interaction. Our works is of fundamental interest in enriching the waveguide QED system by introducing the chiral and the exotic long range interaction, and has potential applications in the on-chip single-photon source with integrability and quantum simulation of strong correlated matters.

Name: Yu Wang 王宇

Organization: Changcheng Institute of Metrology & Measurement
北京长城计量测试技术研究所

Biography:

王宇，博士，研究员，航空工业集团首席技术专家，航空工业计量所前沿技术研究部副部长。长期从事量子测量与量子计量前沿技术研究。主持研制重力场测量相关系列量子测量仪器。任全国量子计算与测量标准化技术委员会委员，中国振动工程学会振噪控制专业委员会副秘书长，常务理事。作为第二完成人获得国防科技进步一等奖 1 项，发布国家标准 2 部，文章 20 余篇，授权发明专利 6 项。

Title:

重力加速度量子测量技术进展

Advances in Quantum Measurement Technology of Gravitational Acceleration

Abstract:

This paper first introduces the application background of gravitational acceleration measurement, the development process of various types of gravimeters, and the basic situation of quantum measurement technology of gravitational acceleration. Then, the latest progress of quantum measurement technology of gravitational acceleration of Changcheng Institute of Metrology and Measurement is introduced, and the latest work and related test results are reported in detail from two aspects: ground static quantum gravimeter and sea and air dynamic quantum gravimeter. Finally, the development of quantum measurement technology of gravitational acceleration and related quantum measurement technology is prospected.



Name: Jieqiao Liao 廖洁桥

Organization: Hunan Normal University 湖南师范大学

Biography:

廖洁桥，湖南师范大学“潇湘学者”特聘教授，博士生导师，曾获得国家自然科学基金“优秀青年”项目（2018 年）和湖南省自然科学基金“杰出青年”项目（2016 年）资助，入选湖南省科技创新领军人才（2019 年）、湖南省“百人计划”（2016 年）和长株潭高层次人才聚集工程（2017 年）。2003 年与 2008 年先后于湖南师范大学获得学士和博士学位；2008 年至 2012 年先后在中国科学院理论物理研究所和香港中文大学从事博士后研究工作，2012 年至 2014 年在日本理化学研究所任 JSPS 外国人特别研究员，2015 年至 2016 年任美国加州大学默塞德分校 Associate Specialist。主要从事量子物理、量子光学和量子信息领域的基础理论研究，已在 Phys. Rev. Lett.、Laser Photonics Rev.、Phys. Rev. A、New J. Phys. 等刊物上发表 SCI 论文 88 篇（APS 论文 55 篇），论文被引用 4380 余次（Google Scholar），H 因子为 37。主持承担国家自然科学基金优秀青年项目、面上项目、湖南省科技创新领军人才项目和湖南省自然科学基金杰出青年项目等科研项目 10 余项；参与国家自然科学基金创新研究群体项目、重点项目、理论物理专款重点专项，国家重点研发计划（政府间国际科技创新合作）重点项目，湖南省重大科技攻关“揭榜挂帅”制项目等科研项目 5 项。兼任中国物理学会量子光学专业委员会委员、第六届中国青年科技工作者协会理事、湖南省青年科技工作者协会理事（基础科学专业委员会主任委员）、湖南省光学学会副理事长、湖南省量子科技学会常务理事兼副秘书长、湖南省物理学会常务理事等。

Title:

Dark-Mode Theorems for Quantum Networks

Abstract:

How to determine the dark-mode effect in an arbitrary quantum network is an important task in quantum physics and quantum information. In this talk, I will introduce two theorems for determining the number of dark modes in linear two-component quantum networks composed of two types of bosonic modes. This is achieved by diagonalizing the two sub-networks of the same type of modes, mapping the networks to either a standard or a thick arrowhead matrix, and analyzing the linear dependence and independence between the column vectors associated with degenerate normal modes in the coupling matrix. As an application of the theorems, we examine the simultaneous ground-state cooling of mechanical modes in linearized optomechanical networks. The arrowhead-matrix method can be extended to study the dark-state effect in driven atom systems and to construct decoherence-free subspaces for processing quantum information. Our theorems pave the way for studying the basic theory and application of quantum networks with dark modes.

Name: Yanli Zhou 周艳丽

Organization: National University of Defense Technology 国防科技大学

Biography:

周艳丽，国防科技大学理学院副教授、硕士生导师。曾在奥地利因斯布鲁克大学、德国斯图加特大学留学访问。主要从事开放量子系统、量子精密测量等相关的理论研究。主持国家自然科学基金、湖南省自然科学基金等项目 3 项，参与国家、军委科技委等项目 8 项，发表 SCI 论文 30 余篇（一作与通讯 20 篇，其中 1 篇 Nature Communications 通讯）。

Title:

Accelerating Relaxation of Open Quantum System

Abstract:

We investigate speeding up of relaxation of Markovian open quantum systems with the Liouvillian exceptional point (LEP), where the slowest decay mode degenerates with a faster decay mode. The degeneracy significantly increases the gap of the Liouvillian operator, which determines the time scale of such systems in converging to stationarity and thus accelerates the relaxation process. We explore an experimentally relevant three-level atomic system whose eigenmatrices and eigenspectra are obtained completely analytically. This allows us to gain insights into the LEP and examine the respective dynamics with details. We illustrate that the gap can be further widened by Floquet engineering, which further accelerates the relaxation process. Finally, we extend this approach to analyze laser cooling of trapped ions, where vibrations (phonons) couple to the electronic states. An optimal cooling condition is obtained analytically, which agrees with both existing experiments and numerical simulations. In this paper, we provide analytical insights into understanding LEP as well as controlling and optimizing the dissipative dynamics of atoms and trapped ions.



Name: Yidong Gong 龚屹东

Organization: Shanghai Finchuang Information Technology Co.,LTD
上海芬创信息科技有限公司

Biography:

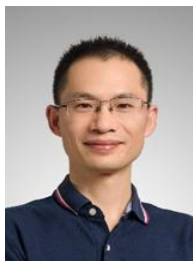
龚屹东，男，1976年生，工商管理硕士学位，清北工匠研究院客座教授（人工智能领域），曾就职于世界500强企业，期间多次赴意大利 MARPOSS、日本 MITUTOYO、日本 HITACHI 研修先进检测技术与变频技术。2013年至今任上海芬创信息科技有限公司副总经理、首席质量官兼技术中心副主任（主要负责微振动隔离系统研发及检测与标准化中心管理），获先进激光装备及微振动控制领域专利13项，国内知名期刊与杂志发表论文3篇。

Title:

量子精密测量外围保障系统——隔振系统

Abstract:

本文介绍了量子精密测量技术及其外围保障系统，特别是微振动隔离系统的相关内容。通过概述量子测量技术的核心组件和底层物理介质，外围保障系统等量子测量技术体系框架；并介绍了上海芬创信息科技有限公司的技术背景、企业文化、核心产品以及其在微振动隔离系统方面的应用案例和技术特点。重点讨论了不同类型的除振技术和光学桌的选择标准，并展示了公司在精密设备安装与设计制造过程中提供的解决方案。



Name: Wenfu Zhang 张文富

Organization: Xi'an Institute of Optics and Precision Mechanics of CAS
中国科学院西安光学精密机械研究所

Biography:

张文富，博士，博士生导师，中国科学院西安光机所二级研究员，中国科学院大学岗位教授，超快光科学与技术全国重点实验室副主任，国家重点研发计划首席科学家，某重点项目首席科学家，国家级青年人才项目获得者。致力于光子集成芯片研究，包含硅基光互连芯片、集成微腔光学频率梳、窄线宽半导体激光器、激光测距与双光梳光谱测量等，主持国家重点研发计划项目、JKW 某重点项目、JKW 1XX 重点课题、中科院战略先导专项项目、中科院稳定支持青年团队项目等 10 余项，近 5 年以通讯作者(含共同)在 Nature Communications、Science Advances、Physical Review Letters 等一区期刊发表文章 10 余篇，申请专利 20 余项（美国专利 5 项）。

Title:

定位集成微腔光频梳及应用

Abstract:

光学频率梳是激光技术与计量科学领域具有里程碑式意义的重要发明，芯片化的集成光频梳是目前国内外研究的热点问题。本报告将介绍集成微腔光学频率梳的研究背景；低损耗光波导、微腔器件等方面的工艺进展；基于微腔器件的孤子光频梳研究进展；微腔光频梳在精密测量、经典与量子通信等方面的应用探索等。



Name: Chengying Bao 鲍成英

Organization: Tsinghua University 清华大学

Biography:

鲍成英，清华大学精密仪器系副教授，主要从事非线性光学、光频梳、集成光学、高 Q 值微腔、精密测量等领域的研究。其于 2016 年毕业于清华大学精仪系，此后曾于普渡大学、加州理工学院从事博士后研究。以第一/通讯作者在 Nature Physics, Nature Communications, Light S&A, PRL, Optica 等期刊发表论文 30 余篇；入选海外高层次人才（青年）项目，曾获中国光学工程学会 PhotoniX Prize，中国光学工程学会优秀博士论文，瑞士 Chorafas 基金会青年研究奖，加州理工学院 Resnick Fellowship 等奖励。

Title:

高相干微腔双光梳应用

Abstract:

耗散光孤子是一种维持增益-损耗与非线性-色散双平衡的光脉冲，利用谐振腔产生耗散孤子也是近年来产生光学频率梳的常见方法。特别是所对应的基于高 Q 值微腔的孤子光梳，在集成度、量产、单梳齿功率、功耗等很多方面有着众多优势。但因耗散孤子的运转涉及复杂的非线性与耗散过程，对应光梳的调控也存在着许多挑战。本报告将主要介绍基于微腔的双光梳产生方法及其在双光梳测量领域的应用。



Name: Yu Zhou 周宇

Organization: Harbin Institute of Technology 哈尔滨工业大学

Biography:

周宇，哈尔滨工业大学（深圳）集成电路学院青年拔尖教授，博士生导师，第九届中国科协青年托举人才。本科毕业于西安交通大学，博士毕业于新加坡南洋理工大学（导师 高炜博 教授），曾任腾讯量子实验室高级研究员。主要研究方向为量子缺陷与微纳光学，以第一作者或共同一作在 *Nature Communications* (4 篇), *Science Advances*, *Photonics Research* (封面) 等杂志发表多篇文章，主持国自然青年，广东省量子战略项目重点项目，深圳市基础科学重点项目等，任 *Chips*、*Chinese Optical Letters* 青年编委，获 2018 年国家自费留学生奖，2020 年福布斯 30 岁以下科技精英榜等荣誉。

Title:

波导集成的碳化硅量子寄存器

Abstract:

量子光子集成电路正在通过为实用的量子应用提供紧凑、高效的平台，重塑量子网络和传感技术。尽管取得了连续的突破，但在 CMOS 兼容平台上将纠缠寄存器集成到光子器件中仍面临重大挑战。在此，我们展示了单电子-核自旋纠缠及其在碳化硅 (SiCOI) 波导中的集成。我们成功地产生了单个空位电子自旋和接近完全的单个 ^{13}C 核自旋初始化。单个核自旋和电子自旋都可以被相干控制，并且在环境条件下制备了保真度为 0.89 的最大纠缠态。基于纳米级定位技术，纠缠量子寄存器首次被进一步集成到 SiC 光子波导中。我们发现，寄存器的固有光学和自旋特性得到了很好的保持，纠缠态的保真度仍然高达 0.88。我们的发现突出了 SiCOI 平台作为未来量子应用的有力候选者的光明前景，该工作与 11 月 26 日在线发表在 *Nature Communications* 上。



Name: Guangqiang He 何广强

Organization: Shanghai Jiao Tong University 上海交通大学

Biography:

何广强，博士，上海交通大学电子工程系区域光纤通信网与新型光通信系统国家重点实验室教授、博士生导师。2006年毕业于上海交通大学电子工程系并获得通信与信息系统博士学位。2009年5月2010年5月，访问美国罗切斯特大学光学中心、物理与天文系。目前为美国光学学会(OSA)高级会员和美国电气与电子工程师协会(IEEE)会员。目前从事微腔光频梳、量子光频梳和量子时频方面的理论与实验研究。在 *Photonics Research*、*Physical Review A/B/Applied*、*Advanced Optical Materials*、*Journal of Lightwave Technology*、*OL/OE*、*Nanophotonics* 等期刊上发表期刊论文 80 余篇，被 SCI 收录 70 余篇；获得授权国家发明专利 16 项，授权软件著作权 4 项。目前担任 *Nature Communications*、*PRA/PRB*、*OPTICA* 系列等期刊审稿人。作为项目负责人主持国家自然科学基金项目 3 项、国家高技术研究发展计划(863 计划) 2 项、广东省重点领域研发计划项目 1 项。

Title:

基于光学微腔的光学频率梳型量子光源及其拓扑传输

Abstract:

量子纠缠在量子计算、量子通信以及量子计量中发挥重要作用。集成谐振腔的谐振特性可将连续频率模式离散化，在频率维度上极大扩展维度，这种离散化的双光子态在频谱上呈现梳状，称为量子光频梳(Quantum frequency comb, QFC)。由于量子光频梳可在其频率-时间量子模式中存储和处理大量信息，受到研究人员广泛关注。我们研究基于集成光学微腔的四波混频过程制备量子光频梳。首先仿真氮化硅微腔的光场、色散和耦合效率，优化谐振腔的性能。然后通过控制泵浦光的频率和功率，实现了超宽带量子光频梳的生成，并验证频率纠缠及能量-时间纠缠特性。通过实验验证量子光频梳在谷光子晶体拓扑波导(直波导和“Z”字形波导)中的传输，并保持了其纠缠特性。将基于氮化硅微腔制备量子光频梳耦合至拓扑波导，利用联合谱强度测量和符合计数系统对其纠缠特性进行了检验。结果显示，量子光频梳在拓扑波导中对急转弯表现出鲁棒性，频率纠缠状态在拓扑传输后未受破坏，验证了量子信息的拓扑保护效应。此外，通过密度矩阵、Schmidt 分解等量子态分析方法，进一步证实了量子光频梳的高度量量子纠缠。



Name: Yue Tao 陶悦

Organization: National University of Defense Technology 国防科技大学

Biography:

陶悦，国防科技大学前沿交叉学科学院助理研究员，主要从事高性能高功率单频光纤激光技术研究。以第一作者身份在 *High Power Laser Science and Engineering*, *Journal of Lightwave Technology* 以及 *Optics Letters* 等期刊发表学术论文十余篇。目前作为项目负责人主持国家重点研发计划（青年科学家）子课题，作为核心骨干成员参与国家重点研发计划课题以及国防科技 173 计划技术领域基金等项目，研究成果获湖南省光学科技进步奖。

Title:

高性能高功率单频光纤激光产生及放大研究

Abstract:

单频光纤激光具有线宽窄、噪声低和相干性好等优点，在量子探测、光纤传感以及相干通信等领域具有重要应用价值。为满足一些特定的应用场合诸如以里德堡原子探测、激光雷达、和激光干涉引力波天文台（LIGO）为代表的前沿科技平台对探测灵敏度、分辨能力以及精度的需求，对单频光纤激光的功率、噪声、线宽和波长拓展等性能提出了更高的要求。本报告旨在汇报本研究小组在高性能高功率单频光纤激光产生及放大方面的研究工作，主要包括：1）采用双超高斯函数作为相移光纤光栅切趾剖面，大幅提升了相移光纤光栅的有效长度，实现分布反馈（DFB）单频光纤激光器的效率提升和波长拓展；2）基于布里渊增益、布里渊/掺铒混合增益机制实现高功率、窄线宽、低噪声单频光纤激光产生；3）提出纤芯同带泵浦方式在提升受激布里渊散射阈值的同时，实现低噪声高功率单频光纤激光放大输出；4）采用大模场锥形增益光纤，结合同步泵浦和脉冲整形技术，实现大能量窄线宽脉冲单频光纤激光放大输出。

Name: Lei Dong 董磊

Organization: Shanxi University 山西大学

Biography:

董磊，山西大学激光光谱研究所二级教授、博士生导师，教育部激光碳监测技术国际合作联合实验室主任。他于 2007 年在山西大学获得光学专业博士学位，2008 年至 2011 年在美国莱斯大学电子计算机工程系从事博士后研究，专注于光学传感与探测领域。研究主要集中在激光光谱传感技术及其在工业、环境、电力、医疗等领域的应用基础研究，特别是在光声光谱用于痕量气体检测方面取得了重要成果。主持了包括国家重点研发计划、国家自然科学基金等在内的多项国家及省部级项目，发表 SCI 论文 240 余篇，拥有多项中国和美国发明专利。科研成果获得了教育部技术发明一等奖、山西省自然科学一等奖等多项奖励。此外，还担任山西省光学学会副理事长、山西省计量测试学会副理事长等职务，为相关领域的发展作出了积极贡献。

Title:

石英增强共振双光梳光谱



Name: Long Jin 金龙

Organization: Jinan University 华南师范大学

Biography:

金龙，华南师范大学研究员，国家优秀青年科学基金获得者，从事光纤传感与成像技术研究。已主持国家级科研项目5项，省级项目3项。曾荣获国际光学前沿会议、国际光纤传感会议、国际生物医学光子学与成像会议的多个最佳论文奖项，被美国光学学会官网、Science Daily、中国科学网等科技媒体报道。光纤光声内窥镜成果入选了美国光学学会2023年度光学进展；《光学与光子学新闻》（Optics & Photonics News）把研究成果“Fiber laser for endoscope”作为光纤技术在现代医学应用的代表性成果之一进行报道。

Title:

光纤光声成像

Photoacoustic Fiberscopy

Abstract:

光声成像技术通过融合利用激光与超声对生物组织进行成像，其成像质量决定于光致超声信号的探测能力。与传统压电探测方案不同，我们采用光纤传感器进行超声探测，利用光学方法对超声信号进行放大与读取。光纤超声传感器具有体积小、灵敏度高的优势，在可穿戴成像与内窥成像中具有显著优势。例如，我们基于光纤传感器构造了微型化头戴式光声显微镜，对自由运动状态下的小动物进行高分辨率脑成像，并对脑组织氧合状态的异常变化进行连续性监测。利用该传感器实现了光声内窥成像，能够以高分辨率观察活体消化道在疾病状态下的血流动力学及氧合功能的异常变化。报告还将就光纤超声传感器的阵列化、全光学超声成像等技术进行讨论。



Name: Lulu Yan 闫露露

Organization: National Time Service Center, CAS
中国科学院国家授时中心

Biography:

闫露露，中国科学院国家授时中心副研究员，博士，主要研究方向为超稳光生微波、毫米波信号产生以及激光稳频技术。

主持国家自然科学基金青年基金、军科委、中科院 C 类基金、西部之光项目等 8 项，西部之光结题优秀，获第一届“率先杯”优胜奖，中科院院长奖，发表 SCI/EI 论文 20 余篇，授权发明专利 10 项。

Title:

超稳微波信号助力高精度原子频标

Ultra-Stable Microwave Signals Contribute to The Development of High Precision Atomic Frequency Standards

Abstract:

超高频率稳定度的微波信号在高精度原子频标中具有重要作用，可以作为铯原子喷泉钟的本地振荡器，消除 Dick 效应的影响，提升铯喷钟的短期稳定度，可应用于光钟中将钟激光信号转换到微波/射频频段，可应用于高精度地基授时系统中微波频率传递的微波源，还可应用于高精度雷达系统中提升雷达的探测精度。本文报道了以超稳光学腔为参考的光生微波信号产生技术，利用掺铒光纤光频梳，将秒稳为 $7\text{E-}16$ 的超稳激光信号的频率分频至微波 9.6GHz，得到了秒稳达到 $2.1\text{E-}15$ 的 9.6GHz 微波信号。并以该技术为基础，设计了低噪声光电倍频器，将其倍频至毫米波段，最终获得了秒稳达到 $6.7\text{E-}15$ 的 100 GHz 毫米波信号。该研究内容为高精度集成光频标的发展奠定了一定的技术基础。



Name: Chi Zhang 张驰

Organization: Huazhong University of Science and Technology
华中科技大学

Biography:

张驰，华中科技大学武汉光电国家研究中心教授，长期从事非线性光学、光学频率梳、光学参量过程等领域研究，在时域透镜及其应用，超快成像及光谱测量等领域开展了多项开拓性研究。作为项目负责人承担国家自然科学基金面上项目2项、青年基金、国防科技创新特区项目、华为横向等。入选湖北省楚天学者计划、光谷产业教授，担任《光子学报》青年编委。在 *Science Advances*, *Light: Science & Applications*, *Photonics Research* 等期刊发表论文70余篇，授权国际/国内发明专利10余件。

Title:

基于飞秒光频梳的大带宽实时矢量光信号测量技术

Abstract:

大带宽实时光信号测量是超快光学研究的重要方向。为实时获取大带宽矢量光谱和波形，结合飞秒光频梳技术，将有限的频率带宽光学转换为无限的时间轴，并与啁啾相干探测相结合以获得全场光谱及相位。基于25GHz相干接收机实现了3.4THz的采集带宽，在20MHz采集帧率下，实现了520ps的时间窗口及280-fs的时间分辨率；首次同时观测了4×160Gbit/s的QPSK波分复用信号，有望成为高速光通信信道监测和超快光学测量的重要工具。通过获取微腔孤子光频梳的实时矢量光谱，反演全场时域波形，首次实时观测了多稳态孤子碰撞融合等全场孤子动态。



Name: Minkang Zhou 周敏康

Organization: Huazhong University of Science and Technology
华中科技大学

Biography:

Dr. Minkang Zhou (周敏康) is now working as a professor in school of physics at Huazhong University of Science and Technology. He was awarded the PhD degree in 2011 from Huazhong University of Science and Technology. He did the postdoc research from 2012 to 2014 at LNE-SYRTE of Observatoire de Paris in France. He has a wide research interests in quantum sensing with atom interferometers, such as inertial sensing for practical application and precision measurements in fundamental research.

Title:

High Precision Atom Interferometers and Its Application

Abstract:

We present a high-precision atom-interferometric test of the parity-odd spin- and velocity-dependent (SVD) interaction between the spin-polarized proton and unpolarized nucleons. The test utilizes the Bragg atom interferometer loaded with ^{87}Rb atoms, of which the single unpaired proton within the nuclei plays the role of the test spin. The differential measurement of the acceleration of the atom in two well-chosen inner states is designed to eliminate the influence from the polarized electron in the ^{87}Rb atom. Moreover, the atom interferometer is particularly placed in the cave laboratory within the Yujia Mountain in the campus, and the mountain source of unpolarized nucleons allows to improve test of the SVD interaction on the length scale around 5-100m. Our experiment improves the test precision of the universality of free fall to 9.2×10^{-9} , which is about 10 times better than the previous experiment with polarized atoms. More importantly, it provides a new constraint on the coupling of the SVD interaction exerting to the spin-polarized proton $|\lambda_{\text{SVD}}| \leq 6.5 \times 10^{-32}$ at $\lambda=10$ m, resulting in a substantial sensitivity improvement over the previous limit. Our work extends the scope of atom interference measurements and shines a new light on the testing of new physics with polarized-atom interferometer.

Name: Junfeng Wang 王俊峰

Organization: Sichuan University 四川大学

Biography:

王俊峰，四川大学研究员，博导，国家级青年人才。长期从事碳化硅色心等固态 体系量子信息实验方面的研究，在碳化硅色心的单色心制备与观测，量子调控， 量子精密测量方面取得了一系列成果。目前共发表 SCI 论文 46 篇，其中第一作 者或通讯作者论文 28 篇，包括 Nature Materials 1 篇、Nature Communications 2 篇、Physical Review Letters 1 篇等，论文总引用 1700 余次（谷歌学术）， h 因子 24，其中 National Science Review 9, nwab122 （2022）论文获得 2023 年度 NSR 优秀论文。主持国家自然科学基金面上项目 2 项和青年基金 1 项。

Title:

碳化硅色心量子精密测量研究

Abstract:

近些年来，碳化硅色心由于其易于加工集成，优异的光学性质，长的自旋相干时间，吸引了人们越来越多的关注，它是当前固态量子信息领域的非常前沿方向之一。碳化硅色心具有以下优点：一、碳化硅是第三代半导体，有成熟的生长和微纳加工工艺，基于碳化硅色心的量子技术便于扩展。二、碳化硅色心波长处在近红外波段。三、自旋相干时间长。因此研究基于碳化硅色心的性质是非常重要的。本报告结合自己的工作，介绍碳化硅色心量子精密测量方面的一些应用。主要分为四部分，第一部分介绍碳化硅色心的研究背景。第二部分介绍磁场、电场、温度、应力、高压，磁性材料等几方面的量子传感应用。第三部分总结和展望。



Name: Pengbo Li 李蓬勃

Organization: Xi'an Jiaotong University 西安交通大学

Biography:

李蓬勃，西安交大物理学院教授，博导，物理学院副院长。国家级青年人才，陕西省杰青，西安交大青年拔尖人才 A 类。长期从事量子光学与量子信息中的基础物理问题研究，聚焦于杂化量子系统的耦合作用机制与调控理论研究。以第一或通讯作者在物理科学领域代表性期刊 *Phys. Rev.* 系列上发表学术论文 60 余篇（包括 6 篇 PRL）。主持国家自然科学基金重点国际合作项目 1 项、重大研究计划培育项目 1 项、面上项目 3 项、陕西省杰出青年基金 1 项，研究成果获陕西省科学技术奖一等奖。

Title:

Hybrid Quantum Systems with Nv Spins, Magnons, and Skyrmions

Abstract:

The coherent interaction between different quantum systems is a fundamental scientific issue in the fields of quantum physics and quantum technology. The Jaynes-Cummings (JC) model describes the coherent interaction between a two-level quantum system and a quantized field. It is a typical representation of light-matter interaction in the quantum regime and serves as the theoretical foundation for describing interactions in hybrid quantum systems. In this talk, I will first provide a brief introduction to the research background of hybrid quantum systems based on JC interactions, and then present the work made by our research group in the study of hybrid quantum systems with NV spins, magnons, and Skyrmions.

**Name:** Qiang Zhang 张强**Organization:** Shanxi University 山西大学**Biography:**

张强，量子光学与光量子器件国家重点实验室，副教授，博士生导师，入选山西省“三晋英才”青年优秀人才。主要从事量子腔光力学及其精密传感技术的研究，在 *Phys. Rev. Lett.* 和 *ACS Photonics* 等学术期刊上共发表学术论文二十余篇，获国家发明专利授权 6 项，主持国家自然科学基金面上项目和青年基金各 1 项，联合基金集成项目子课题 1 项，参与科技创新 2030—“量子通信与量子计算机”重大项目 2 项，担任 *ACS Photonics*, *Photonics Research*, *Optics Letters*, *Physical Review A* 等学术期刊的审稿人。

Title:

腔光力传感器网络技术

Abstract:

腔光力学为基础物理和超灵敏传感提供了一个独特的研究平台。得益于光学与声学双共振，已实现低于 SQL 的力和单细胞的振动谱等极弱信号的测量。报告人一直致力于光纤腔光力传感技术的研究，主要包括光纤机械振子[*ACS Photonics* 7, 695 (2020), *Phys. Rev. Lett.* 132, 033801 (2024)]、光纤 Fabry-Perot 腔[*Opt. Express* 32, 14780 (2024), *Rev. Sci. Instrum.* 93(9), 095004 (2022)]，并用于超灵敏测量[*Opt. Express* 32, 13873 (2024)]。近期，针对现有腔光力传感器组网困难的挑战，我们验证了首个腔光力传感器网络[Under Review]。该传感器网络可以与光源实现稳定、低噪声、无损耗、偏振波动不敏感的耦合。结合磁致伸缩材料，在常温常压无磁屏蔽的情况下获得了 8.73 pm/Gs 的 DC 磁场灵敏度和 537 fT/Hz^{1/2} 的 AC 磁场灵敏度。该工作为腔光力学和光纤传感技术的交叉融合提供了新的思路。



Name: You Xiao 肖游

Organization: Shanghai Institute of Microsystem and Information Technology
上海微系统与信息技术研究所

Biography:

肖游，2023 年博士毕业于中国科学院上海微系统与信息技术研究所，现为微系统所博士后，获上海市“超级博士后”计划，基金委青年基金项目资助。主要研究方向为超导单光子探测，光子集成器件，高灵敏光谱仪。相关成果以第一/共一作者身份发表在 ACS Photonics、Photonics Research 等。

Title:

Research Progress of Superconducting Nanowire Single-Photon Detector at Simit

Abstract:

Superconducting nanowires enable the operation of excellent single-photon detectors, which are particularly needed for quantum information and other weaklight applications. Here we report on our team's latest progress in time jitter, spectral and photon number resolving, and on-chip integration. For practical demands, we have improved the processing quality of nanowires based on Si/SiO₂-DBR instead of Ta₂O₅ process and reduced the system jitter to less than 20 ps with a home-made low temperature amplifier. Meanwhile, for the photon number resolving demand, we have realized high-fidelity photon number resolving single-photon detectors using cascaded nanowire parallel resistors or multi-pixel nanowire arrays, which discriminate photon numbers up to 32-61 and achieve a maximum detection efficiency of 98%. For the weak-light spectral detection demand, we have implemented a series of reconstructive single-photon spectrometers by integrating photonic structures such as Roland circular gratings or 3D-printed filters with superconducting nanowires, with resolutions as low as 0.4-5 nm. We have also explored some on-chip integration work, integrating SNSPDs with passive pump rejection filters achieved by cascading silicon Bragg gratings on a single substrate. Working as an entanglement receiver chip, the integrated devices exhibit unity quantum efficiency, a system detection efficiency of 20.1% and a pump rejection ratio of approximately 56 dB.



Name: Tengfei Wu 武腾飞

Organization: Changcheng Institute of Metrology & Measurement
长春计量测量研究所

Biography:

武腾飞，研究员，毕业于中国科学院上海光学精密机械研究所，获光学工程专业博士学位。中国航空工业集团特级技术专家，博士生导师，北理 / 北航卓越工程博士联合培养博士生导师，工信部工程硕博优秀导师，前沿技术研究部长，动态测试与校准技术航空科技重点实验室副主任。学术兼职，《航空标准化与质量》编委，《计测技术》青年编委，《失效分析与预防》青年编委，中国光学工程学会微纳专委会委员。南航空天信息与材料物理工信部重点实验室学术委员会委员，长期从事飞秒频率梳量子波长标准、飞秒频率梳光谱测量等前沿科学研究。在飞秒激光研究领域取得了一系列技术突破。其研究成果已在时频最高标准的高精度原子时频传递、航空精密传感、精密光谱研究方面得到了很好的应用。先后荣获国防科技进步二等奖 1 项，三等奖 1 项，航空科技进步一等奖 1 项，航空科技进步二等奖 2 项，个人荣获航空工业“十三五”个人一等功各 1 次，中国航空工业集团科技创新先锋，中国航空研究院“十大杰出青年”。

Title:

飞秒激光频率梳多波长标准研建

The Research of Multi-Wavelength Standard by Using of The Femtosecond Optical Frequency Comb

Abstract:

在几何量计量领域，国际计量局推荐了若干条频率稳定的激光辐射谱线用于复现米定义，激光波长（频率）的测量已经在激光干涉仪校准、工程测量、光谱测量、光纤通讯等领域发挥了巨大作用。目前，我国通过稳频激光仅能实现 633nm、612nm、1542nm 等少数波长的检定及溯源，无法满足生产生活中应用广泛的其他波长的计量需求。随着超快激光技术和光纤技术的发展，促进了飞秒光学频率梳的成熟。光频梳同时包含成千上万个分立的激光纵模，在频域中等间隔排列，提供了众多频率精准的谱线。利用光频梳进行激光波长测量具有显著的优势：光频梳可以实现光学绝对频率测量，把长度单位“米”直接溯源至时间单位“秒”；测量范围宽，在光频梳宽带光谱范围内均可进行波长测量与量值传递；测量精度高，较易实现 10^{-11} 以上的不确定度水平。通过 1550nm 近红外光纤光频梳的光谱扩展和非线性频率转换，获得了超过 532nm~2200nm 的超宽光谱范围，建立了光波长标准装置，测量不确定度优于 2×10^{-13} ($k=2$)，可为各种精密测量光源提供波长校准服务。



Name: Chenglin Gu 顾澄琳

Organization: East China Normal University 华东师范大学

Biography:

顾澄琳，华东师范大学精密光谱科学与技术国家重点实验室，研究员，博士生导师。本科毕业于天津大学光学工程专业，2013年获得天津大学博士学位，2014年至2016年在香港中文大学精密仪器与自动化超快光学实验室从事博士后研究。2016年11月加入华东师范大学。目前主要从事飞秒光学频率梳技术及其在光梳分子光谱技术应用研究。近年来在Nature communication, Optica、Photonics Research、Optics Letters等专业期刊发表SCI学术论文80余篇。入选上海市浦江人才计划，主持航天计量前端技术、国家重点研究计划课题等多项国家项目。

Title:

光学频率梳光谱技术及应用

Optical Frequency Comb Spectroscopy Technology and Its Applications

Abstract:

光梳光谱技术具有超高分辨率、高灵敏度以及宽带探测能力等诸多优势。然而高相干的光梳光源的实现仍然是制约其应用发展的重要技术问题。另一方面，光梳光谱的拓展特别是长波红外的实现对于其在生物化学中的应用极为重要，但是波长转化的非线性过程中的噪声积累对于其相干性影响严重。在本次报告中，主要介绍光梳光谱技术的发展以及我们在基于超快光纤激光器的高分辨率双光梳光谱方面的最新进展。我们提出了一系列噪声抑制和相干控制技术，实现了主动和被动锁定技术的超低相位噪声的高互相干双光梳技术，实现了痕量分子的并行传感及其相关应用，例如有毒有害气体检测、高温测量以及手性分子构型分析等，并且我们将光梳光谱范围拓展至了中红外以及长波红外波段。



Name: Liheng Shi 施立恒

Organization: Tsinghua University 清华大学

Biography:

施立恒，清华大学精仪系博士后。2023 年获得清华大学博士 学位。主要研究领域为光频梳精密测量，包括对微纳结构的 三维成像、对非合作目标位姿的动态检测等，已发表 SCI 论 文 12 篇，申请/授权国家发明专利 7 项。曾获中国光学工程 学会第三届“金燧奖”金奖、第 17 届北京发明创新大赛发 明创新奖银奖。

Title:

基于飞秒脉冲对准的快速全场三维成像

Abstract:

光学频率梳具有宽光谱、高相干性和频率可溯源的特点，使得可以在较 大的视场和垂直范围内进行精确的脉冲扫描。基于此特性，我们开发了一个 基于扫描光频梳重复频率的相干扫描干涉仪。在该系统中，使用一个中心波 长为 1558 nm，带宽为 46 nm 的光频梳作为光源，发射重复频率 f_r 为 63.804 MHz 的脉冲列。当光程差正好等于脉冲间隔的整数 m 倍时，来自不同干涉臂 的第 m 个脉冲与第 0 个脉冲重叠并干涉。如果 f_r 发生变化，能在每个像素得 到一个互相关干涉图。使用相机记录重复频率扫描过程中的全场干涉条纹 变 化，即可根据互相关脉冲峰值重建目标表面的三维形貌。然而，受采样定理限制，这种扫描的步长通常小于光源中心波长的 $1/8$ 。另一方面，面阵检测器受通信吞吐率的限制，不能兼顾高像素和高帧率。为 了提高测量速度，一种传统方法是降采样。但相机收集的干涉信号对比度会 随着扫描速度的增加而降低。在本文中，我们展示了两种不影响干涉对比度 的降采样方法。第一种是同时曝光，其原理是控制扫描过程，使得在每个需 要采样的点，都有一个用于曝光的静止状态。这保证了曝光过程中由于相位 移动而造成的对比度损失，但对伺服响应提出了更高的要求。因此我们开发 了一种相位补偿技术，通过声光调制器来降低载波频率，从而在不改变原始 扫描机制的情况下仍能获得高对比度的干涉信号。基于我们优化的频域分析 算法，我们可以在微米级扫描间隔下实现纳米级测量重复性，实现对 大范围 区域内的高效纳米级三维测量。



Name: Jie Chen 陈杰

Organization: Taiyuan University of Technology 太原理工大学

Biography:

陈杰，太原理工大学副教授、博导，获批山西省优青。主持国家自然科学基金 2 项（面上和青年）、山西省青年基金和横向课题 10 余项。以第一作者或通信作者在 *Advanced Photonics*、*Optics Express* 等上发表论文 15 余篇。在 CLEO 和 FIO 等国际会议上作邀请报告/口头报告 6 次。以第一发明人申请国家发明专利 6 项，成果转化 1 项。所提出的多维度脉冲复用的双光频频梳光源及精密测量系统被美国工程院院士等多位国际知名学者在期刊和综述论文上给予积极评价，成果被 *SPIE Newsroom*、*EurekAlert!* 和 *Phys.org* 等国际主流学术媒体报道，引起国内外同行的关注。

Title:

多维度脉冲复用的单腔双光频梳生成及其光谱学测量研究

Abstract:

双光频梳等前沿光学技术在实现高精度、快速测量方面展现了不可替代的优势，但传统的双光频梳技术在光谱学测量等应用领域面临着功耗、可靠性、体积上的瓶颈。基于此，我们揭示了光纤腔内光谱滤波机制下脉冲演化动力学规律和稳定宽谱锁模脉冲产生问题，实现了一种能够可控生成多种锁模孤子态的光纤光源结构；提出在单一光纤激光器腔内同时引入波长复用、偏振复用和方向复用三种脉冲复用传输机制，实现了低复杂度、高互相干性的双/多光频梳生成；开展了基于单腔双光频梳光源的自适应采样太赫兹光谱测量方法研究，将传统单腔双光频梳太赫兹光谱分辨率提升了 2~3 个数量级。在此基础上，探索将双光频梳技术应用于温室气体监测和太赫兹梳齿分辨的气体光谱学测量等领域。



Name: Lin Ling 凌琳

Organization: South China University of Technology 华南理工大学

Biography:

凌琳，华南理工大学物理学博士二年级学生，导师为杨中民教授和韦小明教授，主要研究方向为高重频光纤激光技术及双光梳应用。目前以第一作者在 *Optics Express* 中发表论文 1 篇，以合作作者在 *Light: Science & Applications*、*Optics Letter* 等国际知名期刊发表论文 10 篇。申请中国发明专利 5 项（授权 1 项），国际专利 3 项。2022 年荣获硕士生国家奖学金。2021 年在中国国际“互联网+”大学生创新创业大赛中荣获银奖。2024 年在全国光学与光学工程博士生学术联赛中荣获全国百强三等奖和最佳人气奖。

Title:

高性能 GHz 重频锁模光纤激光及双光梳应用

Abstract:

通过探索由高掺杂少模增益光纤和单模光纤在全光纤超短腔中构建的多模干涉介导的光谱滤波效应，展示了一种新型的 GHz 高重复频率单腔双光梳系统。该系统基于 GHz 重复频率的双波长锁模光纤激光器构建，激光器以约 1.0 GHz 的基频运转工作，异步双色脉冲的重复频率差为 148 kHz，在自由运行状态下实现了仅为 101.7 mHz 的频率波动，表现出优异的稳定性。得益于异步双色脉冲串之间的重复频率差较大，使得 GHz 双光梳的刷新时间短至 6.75 μ s，使其成为研究不可重复瞬态现象的有力工具。为了验证并展示其实用性，该双光梳系统成功捕获了气球和鞭炮爆炸产生的冲击波，并对冲击波引发的应变进行了定量分析。本研究中的 GHz 全光纤单腔双光梳系统在保持高测量精度的同时，显著提高了采集速度和光谱带宽，并凭借其高鲁棒性和紧凑设计的特点，有望作为测量工具应用在许多新兴研究领域，尤其是冲击波、湍流和化学反应等动态事件的探测与分析。

Session 6 JAN. 13-14.2025

Exhibition Center Hall C1

Atomic and Molecular Spectroscopy

原子分子精密光谱



Name: Hongxin Zou 邹宏新

Organization: National University of Defense Technology 华中科技大学

Title:

China Space Station Optical Clock and Its Evaluation of The Relativistic Redshift

Abstract:

The China Space Station launched the Mengtian Laboratory Module in October 2022. The Cold Atomic Optical Clock is one of its crucial experimental systems and also the world's first Cold Atomic Optical Clock to be launched into space. The Cold Atomic Optical Clock consists of five individual components: a vacuum physics system, an optical system, an electronic control system, ultra-stable laser, and a femtosecond optical comb. The optical clock will play a significant role in the tests of fundamental physics. However, orbital motion and gravitational potential lead to the relativistic redshift (RRS), which introduces systematic errors in frequency measurements. Based on perturbation force models and orbital ephemeris data, we calculated the trajectory of the China Space Station (CSS), and evaluated the RRS of a strontium optical lattice clock aboard. The uncertainty of the RRS is estimated to be 3.3×10^{-17} , and the instability reaches 3.57×10^{-19} at 104 s, which is comparable to the overall uncertainty and instability of the state-of-the-art ground-based optical clock. Therefore, according to our assessment, the evaluating method for the RRS of the optical clock in the CSS is feasible and effective, and the results can serve as a reference for dynamic frequency correction of spaceborne optical clocks.



Name: Zhenxiang Zhong 钟振祥

Organization: Hainan University 海南大学

Biography:

钟振祥 博士，研究员，博士生导师。2003 年本科毕业于中国科学技术大学近代物理系，2009 年中科院武汉物理与数学研究所获原子分子物理博士学位。随后留所工作至 2022 年，历任助理研究员（2009-2013），副研究员（2013-2018）及 研究员（2018-2022）。2022 年 12 月调入海南大学理论物理中心。主要研究少体原子分子精密谱理论和计算，包括氢分子离子精密谱、反质子氢和类氢两电子体系；致力于通过精密谱研究检验束缚态 QED 理论、测量基本物理常数及探索 原子核结构信息。获得国家自然科学基金的连续资助。于 2017 年加入中科院青年创新促进会。

Title:

少体精密谱理论与计算

Abstract:

原子分子精密光谱研究历经百年，氢原子光谱研究在近现代物理学的发展过程中起到重要的推动作用。随着理论方法和实验技术的发展，许多微小的物理效应能够清晰地 在光谱的细微移动中体现出来，使我们可以窥探其中的物理。少体原子分子精密谱研究在检验基本理论、测量基本物理常数和原子核 结构参数、探索新物理等方面具有重要的科学意义。报告人将从氢分子离子、类氢体系以及反质子氢等体系的精密谱研究入手，介绍少体原子分子精密谱 的理论研究历程和现状，讨论质子-电子质量比和精细结构常数的光谱测量结果；介绍以质子电荷半径之谜为代表的原子核结构参数光谱研究；讨论以反 质子氢为代表的光谱研究在基本理论发展中的作用。

Name: Hua Guan 管桦

Organization: Institute of Precision Measurement Science and Technology Innovation, CAS
中国科学院精密测量科学与技术创新研究院

Biography:

管桦，中国科学院精密测量科学与技术创新研究院研究员，博士生导师。主要从事离子光钟和离子精密光谱研究。中国科学院青年创新促进会优秀会员，国家基金委优青，湖北省杰青，主持湖北省创新群体项目和国家基金委重点等等项目。获 2018 年度中国计量测试学会科技进步一等奖：高精度钙离子光钟（排名第二），2022 年获得湖北省物理学会首届“杰出青年科技创新奖”，荣获 2022 年中国科学院第三届“科苑名匠”荣誉称号（排名第二）。发表 SCI 论文 70 余篇。

Title:

Progress on Ni^{12+} Based Highly Charged Ion Clock

Abstract:

Highly charged ions (HCIs) have promising clock transitions with potential accuracy below 10^{-19} . Furthermore, they are sensitive to fine structure constant α and can be used to explore new physics beyond the standard physical model^{1,2,3}. We utilized the Shanghai-Wuhan Electron Beam Ion Trap (SW-EBIT)⁴ to perform a high-precision measurement of the M1 transition of Ni-HCI. Our approach involved an improved calibration scheme for the spectra, utilizing auxiliary Ar⁺ lines for calibration and correction. Our final measured result of the M1 transition wavelength demonstrate a four-fold improvement in accuracy compared to our previous findings⁵, reaching sub-picometer level accuracy⁶. In addition, High energy HCI bunches were slowed down⁷ to the ion trap and cooled in a room temperature ion trap by means sympathetic cooling through the laser-cooled Be⁺ ions. The Ni-HCIs temperature were decreased to hundred millikelvin level from megakelvin.

Name: Jun Jiang 蒋军

Organization: Northwest Normal University 西北师范大学

Biography:

蒋军，西北师范大学教授，研究方向为原子结构、碰撞和精密光谱理论，参与主持国家自然科学基金、甘肃省青年基金等多个项目。荣获甘肃省自然科学奖，三等奖；甘肃省高校科技进步一等奖；甘肃省高校科技进步一等奖；甘肃省高等学校科学研究优秀成果，一等奖；甘肃省自然科学三等奖等多项奖项。

Title:

镉和铟原子的三能级魔幻囚禁



Name: Xin Tong 童昕

Organization: Institute of Precision Measurement Science and Technology
Innovation, CAS 中国科学院精密测量科学与技术创新研究院

Biography:

中国科学院精密测量科学与技术创新研究院研究员，博士生导师，精密测量物理研究部副主任，中科院 BR 计划入选者；1995-2000 中国科学与技术大学，化学物理系，理学学士；

2000-2005 英国约克(The University of York)大学，物理化学专业，理学博士； 2005-2008 英国曼彻斯特大学(The University of Manchester)，光子科学所，助理研究员； 2008-2012 瑞士巴塞尔大学(University of Basel)，物理化学所，高级助理研究员。长期致力于以囚禁离子为体系的精密测量物理领域的研究工作。在国际知名期刊《自然·物理》(Nature Physics)、《物理评论快报》(Physical Review Letters)等刊物上发表论文 40 余篇，拥有 8 项授权发明专利。担任“简单原子体系精密测量”、“精密测量物理与基本物理常数”以及“可控冷分子离子”等国际会议的咨询委员。主持了多个重要研究项目，包括科技部国家“物态调控”重点研发计划课题、国家自然科学基金委“少电子原子分子精密谱”重大项目课题、基金委“精密测量物理”重大研究计划重点支持项目，以及中国科学院“基于原子的精密测量物理”、“钍核光钟物理与关键技术”战略性科技先导专项等。

Title:

基于冷分子离子 HD^+ 振转光谱的精密测量

Abstract:

由一个质子、一个氘核以及一个电子构成的氢分子离子“ HD^+ ”，是最为简单的异核双原子分子。它拥有丰富的振转跃迁谱线，这些谱线能够进行精确的计算与测量。通过对比 HD^+ 振转光谱的实验测量结果与理论计算数据，我们不仅能够精确确定物理常数，对量子电动力学理论进行检验，还开启了对超越标准模型新物理的探索之旅。当前， HD^+ 振转跃迁频率的确定精度已达到 10^{-12} 量级，基于此，获得了目前精度最高的质子与电子质量比，其相对精度达到 20 ppt (1 ppt = 10^{-12})。本报告将对 HD^+ 振转光谱的研究现状以及理论背景展开介绍，阐述基于 Be^+ 离子协同冷却 HD^+ 分子离子的高精度振转光谱测量方法。这一方法涵盖了 Be^+ 离子与 HD^+ 分子离子的产生及囚禁过程、 HD^+ 外态的冷却与内态的制备方式、双组分库仑晶体中 HD^+ 数量的确定方法，以及 HD^+ 振转跃迁的探测手段。最后，报告将展望能够进一步提升频率测量精度的前沿光谱技术，以及同位素氢分子离子振转光谱在未来研究中的广阔发展前景。



Name: Yufei Ma 马欲飞

Organization: Harbin Institute of Technology 哈尔滨工业大学

Biography:

马欲飞，哈尔滨工业大学航天学院教授，从事激光光谱技术研究。担任中国光学工程学会光谱技术及应用专委会副主任，担任《Opto-Electronic Advances》(IF=15.3)、Elsevier

《Photoacoustics》(IF=7.9)、《Optics Express》等 9 个国际知名 SCI 检索学术期刊领域主编/副主编/编委，作为负责人主持国家自然科学基金重点、国家自然科学基金优青、国家载人航天预研、JkW 基础加强计划、华为公司委托项目等 30 余项。以第一作者/通讯作者在《Light: Science & Applications》、《Opto-Electronic Advances》、《Applied Physics Reviews》等国际知名期刊上发表论文 100 余篇，获中国光学工程学会自然科学二等奖、军队科技进步二等奖、教育部学术新人奖等多项奖励等。

Title:

高性能石英增强激光光谱气体传感

Abstract:

针对常见半导体激光源输出波长短、功率低、调谐范围窄的问题，本论文提出了以宽带可调谐单纵模固体激光器作为激励源，并以此开展了石英增强光声光谱 (QEPAS) 气体传感技术的研究工作。同时，基于固体激光器光学谐振腔的开放性，设计了内腔 QEPAS 气体传感系统，将音叉探测单元放置在了激光器谐振腔内，在提高系统集成度的同时，也利用了腔内的高功率密度，改善了系统探测性能。最后，针对 QEPAS 技术中的核心探测元件，设计了多款新型石英音叉，有效降低了其共振频率、增大了叉股间隙，实现了压电转换效率的提高和光学噪声的降低。



Name: Liyan Tang 唐丽艳

Organization: Institute of Precision Measurement Science and Technology
Innovation, CAS 中国科学院精密测量科学与技术创新研究院

Biography:

唐丽艳，中国科学院精密测量科学与技术创新研究院研究员，博士生导师。2005 年本科毕业于华中师范大学物理系，2010 年获中国科学院武汉物理与数学研究所理学博士学位。毕业后留所工作至今。长期从事精密原子结构理论与外场响应性质研究。主要在原子结构理论方法构建、基本物理理论检验、新一代光钟发展、少电子原子精密谱研究等方面做出系列原创性的研究工作，为国内外精密测量物理的发展起到了重要的理论推动作用。目前在国际核心期刊 *Science*, *Phys. Rev. Lett.*, *Phys. Rev. A*, *J. Chem. Phys.* 等发表学术论文近 50 篇，主持国家自然科学基金委、中科院先导 B、以及湖北省科技项目多项。

Title:

原子电磁极化性质的理论研究与应用

Abstract:

光与原子相互作用一直是科学研究的核心主题之一。在外场环境下，深入探究原子的电磁极化性质对于量子态的调控、基础物理理论的验证以及高精度光钟的开发等多个精密测量与技术领域具有重大意义。本报告聚焦于原子电磁极化性质的高精度计算与应用，具体将介绍基于 He 原子电偶极极化率的计算，我们提出一种利用氦原子幻零波长来验证量子电动力学 (QED) 理论的新方案；同时，基于 Sr 原子磁偶极极化率的计算结果，我们揭示了负能态在磁极化率中的关键作用，并成功解决了 Sr 光钟多极极化率在理论与实验间长期存在的符号不一致问题，消除了限制光钟精度进一步提升的主要瓶颈。

**Name:** Ke Chen 陈珂**Organization:** Dalian University of Technology 大连理工大学**Biography:**

陈珂，大连理工大学副教授，博士生导师，大连市高端人才、青年科技之星，光纤光声气体传感团队负责人，担任中国光学工程学会光谱技术及应用专业委员会委员。面向国家在能源安全监测领域的重大需求，与国家电网、华为等单位合作开展光纤传感与激光光谱技术的应用基础研究，促进了光纤光声气体传感技术在智能电网故障预警、煤矿生产安全监测和环境气体监测中的应用和产业化推广。2020-2024 连续 5 年入选“全球前 2% 顶尖科学家”榜单，获得中国产学研合作创新成果一等奖、重庆市科技进步二等奖。工作 9 年来，共主持国家级项目 3 项（近 3 年获批 2 项国家自然科学基金），省级项目 3 项，大连市高层次人才创新支持计划项目 1 项，技术转让/开发项目 30 余项；开发了 50 余套激光气体检测仪器、光纤传感解调仪器，在国家电网多个变电站开展了现场应用；以第一/通讯作者在 *Analytical Chemistry* 等期刊上发表 SCI/EI 论文 102 篇(中科院一区论文 36 篇，ESI 热点论文 3 篇，ESI 高被引论文 16 篇)；已申请和授权发明专利 55 项，其中第一发明人专利 27 项。

Title:

光纤光声气体传感技术及应用

Abstract:

光纤光声传感器具有灵敏度高、感测距离远、本质安全和抗电磁干扰等诸多优点。报告人在近几年设计了多种新型高灵敏度光纤声波传感器，其信噪比比传统的电学麦克风提高了 1-2 个数量级；提出了基于绝对腔长测量的光纤法布里-珀罗声波传感器的解调方法，包括光谱解调法和光学互相关解调法，实现了声波信号的高灵敏、高稳定和大动态范围探测；将光纤声波传感器用于光声信号测量，提出了干涉型光纤声波锁相探测方法，设计了新型的光纤悬臂梁增强型光声光谱气体检测仪器。提出了用于远距离气体测量的微型扩散式单光纤光声传感器，气室容积仅为 1 微升，气体采样无需气泵和气阀，光声激发光和探测光均采用光纤传输。在工程应用方面，突破了微弱光声信号探测难度大、现场电磁/振动/噪音干扰大、单点测量成本高等关键技术瓶颈。光纤光声气体传感技术在环境气体监测、煤矿和石化工厂的安全监测、变压器油中溶解气分析等领域具有较好的应用前景。



Name: Huadan Zheng 郑华丹

Organization: Jinan University 暨南大学

Biography:

郑华丹，暨南大学物理与光电工程学院（理工学院），副教授、博士生导师，暨南双百英才杰出青年支持计划第一次层次人选。本科、硕士、博士毕业于山西大学量子光学与光量子器件国家重点实验室。主要从事激光光谱技术的理论与实验研究。共发表学术论文 100 余篇，其中以第一或通讯作者发表论文约 50 篇，被引用 3000 余次，入选斯坦福大学全球前 2% 顶尖科学家榜单；以第一发明人申请中国发明专利 11 件、国际 PCT 专利 1 件；在国内外学术会议上作主旨和邀请报告 10 余次。主持国家重大国防军工项目 1 项、国家自然科学基金项目 2 项、国家创新中心产学研横向项目 1 项。研究成果在中央军委科学技术委员会、捷克科学院获得典型应用。荣获中央军委四季青勋章、中央军委源创杯全国最高奖、全国光学优秀博士学位论文奖、中国光学学会王大珩光学奖。编写研究生教材 1 本、本科生教材 1 本，荣获全国大学生挑战杯优秀指导教师、全国大学生创新年会优秀指导教师、全国大学生光电设计竞赛优秀指导教师。

Title:

音叉增强光声光谱测声器及应用

Abstract:

音叉增强光声光谱是一种新型高灵敏气体传感技术，因其体积小、灵敏度高和抗干扰能力强，近年来在军事国防、环境监测以及医学诊断等领域展现出广阔应用前景。本报告重点介绍了该技术的核心器件——光谱测声器的最新研究进展，包括自主研发的自定义音叉晶振和微型声学谐振腔等关键部件。这些新型结构针对不同应用需求进行了优化设计，既丰富了音叉增强光声光谱传感器的总体结构，又显著提高了检测灵敏度。最后，报告还展示了音叉增强光声光谱技术在多种应用场景下的最新成果与发展趋势，为进一步提升气体传感性能和实现产业化奠定了重要基础。



Name: Lunhua Deng 邓伦华

Organization: East China Normal University 华东师范大学

Biography:

2007 年在安徽光学精密机械研究所获得博士学位。自 2009 年起，在华东师范大学先后担任博士后、助理研究员和副研究员。研究领域包括：瞬态粒子激光光谱学：利用高灵敏度和高选择性的吸收光谱测量系统，研究非稳态分子、离子以及自由基分子的激发和反应过程。气相分子浓度的高灵敏度和高选择性探测技术：使用可调谐激光吸收光谱技术，测量环境中的痕量气体分子浓度。此外，还使用红外光源在等离子体环境中对痕量自由基分子进行高选择性和高灵敏度的测量。

Title:

激光等离子体辅助研究大气 CO₂ 高效环保转化路径

Abstract:

地球正面临 CO₂ 浓度持续上升的严峻挑战。将大气中的 CO₂ 转化为 CO，是降低其浓度并带来经济效益的有效途径。等离子体技术辅助 CO₂ 转化，展现出工业化应用潜力。然而，捕集的 CO₂ 中常含大气残留物，转化过程可能产生有害气体。当前放电等离子体技术检测这些有害产物时灵敏度不足，限制了转化机制的理解及抑制策略的制定。为此，我们采用超短脉冲激光生成光丝等离子体，构建精确控制的反应腔反应器。结合中红外激光吸收光谱与瞬态粒子浓度测量技术，精确监测反应及中间产物，深入探究关键产物形成过程与条件，揭示机理。我们的目标是提供高效的 CO₂ 至 CO 转化方案，同时最大限度减少有害气体生成，推动大气环境向低碳、可持续方向迈进，为应对全球气候变化贡献力量。



Name: Zejiang Deng 邓泽江

Organization: East China Normal University 华东师范大学

Biography:

邓泽江，华东师范大学精密光谱科学与技术国家重点实验室副研究员。2021 年获华东师范大学博士学位。长期从事光频梳和原子分子光谱的研究工作。主要工作集中于双光梳光谱测量技术和原子多维相干光谱测量技术，利用高分辨的光学频率梳多维相干光谱技术研究热原子的多体相互作用。发表 SCI 相关论文 30 余篇。

Title:

光频梳多维相干光谱揭示 Dicke 态原子关联增强

Abstract:

光频梳是时频域精密操控的锁模激光器，在时域是飞秒脉冲，在频域是频率间隔固定的频率梳齿。光学频率梳与多维相干光谱技术的结合，可以极大的提高多维相干光谱的测量速度和光谱分辨率。将多维相干光谱的分辨率从 10 吉兆赫兹提高到百兆赫兹，从而实现超精细能级可分辨的热原子多体相互作用的动力学过程的测量。我们利用光频梳多维相干光谱技术研究了铷原子 D2 线的单量子、双量子和三量子二维相干光谱，实现了区分两种天然同位素（ ^{87}Rb 和 ^{85}Rb ）的超精细能级耦合，揭示了由偶极-偶极相互作用的集体超精细共振。其次，利用光学布洛赫方程求解光频梳多维相干光谱的线型，揭示了 Dicke 态原子随着原子数目的增加，偶极偶极相互关联增强，原子热运动速度接近的现象。光频梳二维相干光谱技术高分辨的特性将会成为未来研究原子分子等超快动力学基本物理过程的重要技术手段。

Session 8 JAN. 13-14.2025

Exhibition Center Hall C1

Spectroscopic Sensing and Applications
光谱遥感及应用





Name: Lianbo Guo 郭连波

Organization: Huazhong University of Science and Technology
华中科技大学

Biography:

郭连波，华中科技大学软件学院教授/博导、武汉光电国家研究中心激光部副主任，激光光谱与智能感知团队负责人，现任中国光学工程学会 LIBS 专业委员会常务委员、中国光学工程学会第一届光谱技术及应用专业委员会青年工作组组长，中国光学学会激光光谱学专业委员会委员及激光加工专业委员会委员，湖北省仪器仪表学会常务理事、湖北省青年科技协会理事。入选重庆巴渝学者教授，武汉市 3551 创新创业领军人才，苏州市姑苏创新创业领军人才等。担任 Atomic Spectroscopy 等国际期刊编委，及 ACS sensor、OE 和 OL 等国际期刊审稿人。主要从事 LIBS、激光探针多模态智能感知等研究。先后主持和参与国家重点研发计划、国家重大科学仪器设备开发专项、国家自然科学基金面上项目等 20 多项。以第一/通讯作者在 Adv. Func. Mater., Infor. Fusion, Anal. Chem. 等期刊上发表 SCI 论文 100 多篇；授权发明专利 15 件，其中国际专利 2 件。主编激光诱导击穿光谱中文专著 2 部、参编 LIBS 英文专著 1 部；获中国电子学会科技进步奖一等奖，中国光学工程学会首届 LIBS 青年科学家奖。

Title:

多模态融合激光探针技术

Abstract:

激光诱导击穿光谱（以下简称为“LIBS”）随“好奇号”和“祝融号”探索火星，与“蛟龙号”揭秘深海，被称为“未来化学分析巨星”。本团队围绕 LIBS 技术的基础、新方法、仪器研制和应用展开全链条攻关研究。在此基础上，针对目前 LIBS 单一指标检测的局限，提出基于激光等离子体图像-光谱融合、激光光谱-超声融合等多模态融合探测新方法与新技术、即激光探针技术，该激光探针技术的多模态融合感知是未来 LIBS 发展的必然趋势，也是激光探针技术向多功能、高稳定和多参数同时检测的最佳解决方案。研究表明，下一代 LIBS 进阶技术、即多模态融合激光探针具有快速、高集成、多功能和高稳定等独特的优点，在现场快速检测领域具有非常广阔的应用前景。

Name: Hailiang Shi 施海亮

Organization: Hefei Institute of Physical Sciences, CAS
中国科学院合肥物质科学研究院

Biography:

施海亮，男，博士，副研究员，硕士研究生导师。2007年毕业于河海大学，获摄影测量与遥感硕士学位；2012年毕业于中科院研究生院，获光学博士学位。现主要从事高光谱遥感探测机理、光电遥感信息处理、遥感数据定量化、目标光谱特性等方面的研究。研发了我国多颗卫星载荷的地面数据处理系统，并在地基、机载以及星载干涉型高光谱仪器数据应用方面突破了多项关键技术，对提高国产卫星数据产品质量发挥了重大作用。作为课题负责人承担了国家自然科学基金、高分地面系统专项、科技部重点研发计划课题等多项国家级科研项目。此外，还承担了多项横向合作项目。担任 APPLIED OPTICS、光学学报、中国激光等多个国内外期刊审稿人，以及国家自然科学基金外审专家等职务。

Title:

超分辨空间外差干涉光谱技术及其碳监测应用



Name: Guotao Yang 杨国韬

Organization: National Space Science Center, CAS
中科院国家空间科学中心

Biography:

杨国韬，中科院国家空间科学中心研究员、博导。率领团队与合作者研发成功全固态全天时钠层风温激光雷达、钙原子离子 OPO 激光雷达、子午工程漠河金属层激光雷达、中巴钠钾激光雷达等一系列具有国际领先或先进水平的中高层大气激光雷达，利用自主研发激光雷达的数据发表 SCI 论文 70 多篇；荣获国家技术发明奖二等奖 1 项；主持基金委重大仪器专项（自由申请）一项。

Title:

全固态激光雷达对电离层 f 区金属离子的探测研究

Abstract:

全固态激光发射技术具有结构牢固、能量稳定、寿命长、系统稳定可靠等诸多优点，是激光雷达重要的技术发展方向。采用光参量振荡与放大技术（OPO/OPA），我们在延庆台站建成了可探测金属钙原子离子的全固态 OPO 激光雷达，该系统的探测阈值明显优于国际同行通常采用的染料系统，发现了被前人忽略的背景钙离子层，并且激光雷达首次探测到了高达 300 km 的 F 区钙离子层。在延庆系统的基础上，我们在漠河建设了超高功率口径积的金属层激光雷达综合探测系统，其中钙原子离子探测激光能量可达 90mJ 以上，配合漠河激光雷达的超大口径组合型望远镜，实现了金属钙原子离子层的超高灵敏度探测（探测阈值可达 0.02 个/cm³@1km1h），优于国外染料系统两个量级。并且发现了多次低密度的 F 区钙离子事件、金属层对磁暴事件的剧烈响应等具有重要科研价值的现象。F 区钙离子的发现，说明激光雷达有成为电离层重要研究手段的潜力。



Name: Liang Mei 梅亮

Organization: Dalian University of Technology 大连理工大学

Biography:

梅亮，大连理工大学，教授，博士生导师，入选国家级青年人才，辽宁省“兴辽英才”计划青年拔尖人才、大连市高端人才等。主要从事激光光谱、激光雷达、光电感知技术及其应用研究，担任中国光学学会、中国环境科学学会、中国光学工程学会等分委员会委员。近年来，在 *Laser and Photonics Review*, *OL/OE*, *Analytical Chemistry*, *Photoacoustic* 等期刊发表学术论文 100 余篇，申请及授权发明专利 20 余项。主持中组部人才项目、国家重点研发计划青年项目、国家自然科学基金面上/青年基金等。研制的沙氏激光雷达在 30 余个省市环保部门应用，实现成果转化与批量应用，并获中国光学工程学会技术发明二等奖。

Title:

大气温湿度差分吸收激光雷达研究进展

Abstract:

当成像系统的物面与光学透镜所在平面不平行时，如果像面、物面及透镜所在平面三者相交于一条直线——即满足沙氏成像原理（Scheimpflug principle），则成像系统依然可对物面清晰成像，并实现理论上的无穷远景深。基于沙氏成像原理而发展起来的沙氏激光雷达（Scheimpflug lidar, SLidar）采用连续波二极管激光器作为光源、图像传感器作为探测器，在大口径光学系统的条件下，以角度分辨的方式实现目标信息的距离分辨探测，并具备盲区小、结构紧凑、低维护、高性价比等特色，广泛应用于大气环境监测、三维成像、荧光（高光谱）激光雷达、昆虫生态学研究等领域。针对当前气象气候研究、天气预报模型对高密度、高时空分辨率温湿度廓线数据的迫切需求，课题组基于沙氏激光雷达方法，提出了连续波差分吸收激光雷达（DIAL）温湿度探测新方案，以距离分辨的气体吸收谱线精确反演温湿度廓线，结合沙氏成像原理和全半导体架构光源巧妙克服现有方法对脉冲光源的苛刻要求。这一方案将有效支撑高密度温湿度廓线地基观测网络建设，为星载温湿度激光雷达的发展提供新的解决方案和技术储备，服务气象气候前沿研究和天气预报重大需求。本报告将聚焦连续波温湿度 DIAL 的基本原理及其最新研究进展。



Name: Wei Chen 陈巍

Organization: Shenzhen Institute of Advanced Technology, CAS
中国科学院深圳先进技术研究院

Biography:

陈巍，男，博士，正高级工程师，博士生导师，中国科学院青年创新促进会会员，深圳市高层次人才，南山区领航人才，深圳市仪器仪表协会专家委员会成员，科技部重点领域研发计划课题负责人。主要从事特种成像、光谱分析以及多种探测手段交叉融合的光电检测技术，以实际应用为牵引，研发面向工业、海洋领域的光电传感器和仪器，实现成果转移转化。承担多项重大任务，部分成果已转移到企业，取得良好的经济效益；授权专利 40 余项，发表论文 20 余篇。

Title:

宽波段红外光谱气体成像识别

Abstract:

基于成像光谱技术的工业气体泄漏成像检测技术新思想，针对传统气体探测只能实现单点单一气体探测的缺点，采用宽波段中远红外成像和多光谱分析技术，开发了一种宽波段红外光谱气体成像识别检测系统，实现了气体泄漏成像观测和成分分析。该系统包含宽波段红外光学成像系统、子波段滤波系统，图像处理与输出系统等模块。针对红外图像中气体痕迹弱、对比度低以及无明显轮廓特征等特点，提出一种 YOLO 目标识别与传统图像差分相结合的气体自适应目标检测及分割算法。同时还提出一种气体编码方法，根据检测结果对泄漏气体进行编码，与有毒有害气体数据库进行编码匹配，对泄漏气体种类进行判定。该系统可快速拍摄扩散气体“云图”，对于评估其扩散态势、定位泄漏源提供了全新的技术手段，成功实现多气体成像探测和成分分析。其可以广泛应用在化工园区气体泄漏监测、企业排放、轮船排放等大气污染防治领域，为应用单位或执法部门提供有效的远距离快速监控手段。



Name: Daping Luo 罗大平

Organization: East China Normal University 华东师范大学

Biography:

Daping Luo received his Ph.D. in Physics from the East China Normal University (ECNU) of in 2019. His research interested include high power fiber lasers in the pulsed and frequency comb technology. Since 2019, he has been continually working at the East China Normal University, where he extended his research interests to optical frequency comb generation and application research. In 2022, he got an associate researcher position at the State Key Laboratory of Precision Spectral Science and Technology, East China Normal University. He further developed the dual-comb spectral measurement technology, which was applied to the magnetic field, electric field, temperature field and gas flow field measurement. For the past five years, a total of 60 academic papers of his works has been published in international journals such as Nat. Commun., Photonics Res., Appl. Phys. Lett. and Opt. Lett.

Title:

光频梳及双光频梳光谱

Abstract:

The optical frequency comb is a highly coherent laser source. By using two coherent frequency combs, dual-comb spectroscopy allows a sample's spectral response to be measured on a comb tooth-by-tooth basis rapidly and without the size constraints or instrument response limitations of conventional spectrometers. This presentation focuses on the development of optical frequency combs and the investigation of spectroscopic capabilities. It provides an overview of the research group's work in fiber-based optical frequency combs and high-precision time-frequency control approaches. Moreover, we will delve into the application of optical frequency comb spectroscopy technology within the context of exhaust gas analysis from aviation engines, dual-comb spectroscopic gas flow velocity measurements, optical activity detection of paramagnetic gas molecules and chiral molecules in the liquid phase, as well as optical frequency comb-based encoding imaging.

Name: Jun Zhang 张俊

Organization: Institute of Semiconductors, CAS 中国科学院半导体研究所

Biography:

张俊，男，博士，研究员，博士生导师。现任半导体超晶格国家重点实验室副主任，兼任半导体声子物理与器件课题组长。国家高层次人才计划入选者。先后担任国家高层次人才计划答辩专家组成员、国家自然科学基金委、科技部重点研发专项、广东省高层次人才计划、广州市“创新创业领军人才计划”、福建省高层次人才计划等项目评审专家。现为中国物理学会光散射专业委员会委员，中国电子学会青年委员会半导体专业委员会委员，《光散射学报》编委。

取得的重要科研成果及所获奖励：

张俊博士在低维量子材料中光与物质相互作用研究方面做出了一系列成果，已在国际学术期刊上发表学术论文 60 多篇，其中在影响因子大于 6 的杂志上发表文章 40 多篇，包括 1 篇《Nature》(封面)、2 篇《Nature Photonics》、一篇《Nature Communications》、7 篇《Nano Letter》、9 篇《ACS Nano》；撰写英文专著 1 章；授权专利 4 项。张俊博士多次受邀在国际学术会议上做邀请报告和担任专题主席，目前是美国物理学会 (APS)、美国光学协会 (OSA) 和美国化学学会 (ACS) 的会员，是多个国际期刊的审稿人。他的研究工作被《Nature Photonics 7, 348 - 349 (2013)》、《Nature Photonics 7, 262 (2013)》、《NPG Asia Materials》、《IOP Physics World》、《Phys Org》等报道多次。张俊博士的研究成果包括：1) 利用声子辅助反斯托克斯荧光上转换能够带走材料中热能（声子）的原理，在实验上首次观察到了激光制冷半导体的现象，相关成果发表在《Nature 493, 504; 2013》（封面）、《Optics Express, 21, 19302; 2013》、《Laser Focus World, 49, 53; 2013》、《Nano Lett. 14, 4724; 2014》、《Nature Photonics, 10, 115-121; 2016》上。这一工作被认为是继激光冷却固体技术的重大突破，被认为是向无制冷剂全固态光学制冷器的实现迈出的重要一步。2) 利用可分辨边带拉曼冷却技术，首次实现了半导体中单个光学声子模式的激光冷却和加热，为固体中声子的量子调控开辟了新的方向，相关成果发表在 Nature Photonics, 10, 600 - 605, (2016)。同期的 Nature Photonics 在 News & Views 中对我们的工作做了介绍 Nature Photon. 10, 566 - 567 (2016)。3) 首次利用化学合成方法合成了不同层数的拓扑绝缘体 Bi₂Se₃ 和 Bi₂Te₃，并完整报道了其不同层数的拉曼光谱和折射率，提出利用拉曼光谱的 Fano 共振来探测拓扑绝缘体表面态电-声子耦合的设想 (Nano Lett., 11, 2407, 2011)；4) 实现了可见光波段波长连续可调的超材料 (Metamaterials)，得到了其晶格表面等离激元极化子的色散、耦合和负折射特性 (ACS Nano 8, 3796, 2014)；利用该材料共振波长对其表面媒介折射率极其敏感的特性和共振增强的表面增强拉曼散射特性，实现同时对蛋白质和化学分子的浓度和成分的鉴定，其检测灵敏度达到 10-15 mol/L，并设计和验证了全光学 DNA 逻辑门操，以及 DNA 的构象和亲和性的灵敏检测。

Title:

半导体中自旋-电荷-晶格相互作用



Name: Chen Ge 葛琛

Organization: Institute of Physics, CAS 中国科学院物理研究所

Biography:

中国科学院物理研究所研究员，国家优秀青年科学基金获得者，中国科学院青年创新促进会优秀会员。师从杨国桢院士和金奎娟院士在中国科学院物理研究所获得博士学位。致力于氧化物人工微结构精控制备、物态调控与原型器件研究，近几年来特别针对神经形态智能光电研究中面临的关键难题开展了系统工作。在包括 *Nat. Mater.*、*Nat. Commun.*、*Sci. Adv.*、*Phys. Rev. Lett.*、*Adv. Mater.*、*J. Am. Chem. Soc.*等期刊发表论文 100 余篇。相关研究工作被 *Nature Electronics* 期刊整版亮点报道，入选了“中国芯片科学十大进展”。

Title:

氧化物光电计算与器件物理

Abstract:

大数据和物联网的快速发展对计算系统的信息处理能力提出了更高的要求。受人脑启发的新型系统期望能够将感知、存储、计算功能融于一体，从而大幅度提升整体效率，智能计算相关研究近年来备受关注，已成为当前的研究热点之一。氧化物材料因为电荷、轨道、晶格、自旋之间的耦合效应，具有一系列丰富的物理性质，蕴含着塑造人工类脑功能和器件的可能。本报告将以高质量的氧化物外延薄膜材料为研究载体，面向光电智能计算需求介绍我们近期在这一方向上的进展。研究了紫外光致二氧化钒非易失相变新现象，基于此现象提出了感知、存储、计算融合的智能光电器件，演示了图像识别应用；探索了多种氧化物人工微结构的光电效应，揭示了光电协同调控的新机理，实现了物理存储池计算和突触功能的可重构；通过界面工程实现了氧化物微结构人工调制，电场驱动的界面原子重构诱导了光电功能重构，实现了光电传感内计算；最后简要讨论目前受到业界广泛关注的铅基铁电薄膜相稳定机理，我们使用激光法首次制备出了高质量自支撑铅基铁电薄膜，研究了反常铁电物理。



Name: Hu Shao 邵虎

Organization: Institute of Precision Measurement Science and Technology
Innovation, CAS 中国科学院精密测量科学与技术创新研究院

Biography:

邵虎，副研究员，硕士生导师。长期从事钙离子、镱离子、镱离子光钟及精密谱测量工作。本科毕业于西北师范大学物理系，毕业后被保送到中国科学院武汉物理与数学研究所攻读硕士和博士学位。博士毕业后在德国联邦物理技术研究院（PTB）开展交流学习和从事博士后研究工作，2021年加入中国科学院精密测量院。在 Physical Review Letter 等杂志发表学术论文 20 余篇，主持和参与了基金委青年基金、国家重点研发计划、基金委重大研究计划、科技创新 2030 等项目。

Title:

基于镱离子光钟体系的跃迁矩阵元测量及应用

Abstract:

基于镱离子光钟体系，我们发展了一种高精度测量原子跃迁矩阵元的普适实验测量技术。通过改变激发脉冲的作用时间增加量子搁置几率，而搁置几率的获取是通过测量从激发态向基态跃迁的辐射光子。本实验选取的激发态向基态跃迁的光子对激光的强度、失谐量以及磁场的变化不敏感，这是高精度测量矩阵元的关键。此外，我们采用了激发强度交替变化的脉冲和背景光子实时修正的方案进一步降低探测误差，结合功率稳定技术在镱离子光钟体系上第一次实现了电偶极和电四极跃迁矩阵元的测量，测量相对精度达到了 $E-3$ 至 $E-4$ 水平。高精度的原子跃迁矩阵元可为发展高精度的原子结构理论提供参考，也可用来评估光钟的黑体辐射、评估相应跃迁宇称不守恒幅度的大小，以及检验 QED 理论等。由高精度的跃迁矩阵元确定的光钟动力学极化率，可应用于光和温度的传感、发展新型的异核多离子光钟，拓宽光钟的应用前景。实验中采用的背景光子实时探测方法可应用于提取背景中微弱信号、短脉冲信号探测和图像处理中背景强度随时间变化情况。



Name: Biao Zhong 钟标

Organization: Technical Institute of Physics and Chemistry, CAS
中国科学院理化技术研究所

Biography:

钟标，中国科学院理化技术研究所项目研究员，博士生导师，中国科学院“率先行动”引才计划（B类），中科院稳定支持基础研究领域青年团队成员。2014年毕业于华东师范大学光学专业获得理学博士学位，从2006年以来，一直从事固体材料激光冷却的研究工作。在国际上首次发现 $\text{Yb}^{3+}:\text{LuLiF}_4$ 晶体优越的激光冷却性能，该晶体是能够被激光冷却到低温学温度的两种晶体之一，也是目前为止能用下降法生长的最好的激光冷却晶体。目前为止，共发表学术论文30多篇。获得中国博士后特别资助基金项目，国家自然科学基金青年基金项目，国家重点创新项目。博士后期间访问美国洛斯阿拉莫斯国家实验室和新墨西哥大学固体材料激光冷却联合实验室。多次受邀在固体材料激光冷却国际学术会议上做口头邀请报告。

Title:

无振动低温光学制冷器

Abstract:

随着激光稳频技术的发展使得激光能够作为基础物理的精确探测工具和全光型时间尺度的光学振荡器。目前最先进的光学振荡器是NIST的叶军教授小组和德国PTB合作研制的工作在零热膨胀系数点的低温单晶F-P腔。上述团队采用两种方式来控制单晶硅F-P腔的温度，一种是采用灌装液氮的方式，另一种是采用GM制冷机的方式。第一种制冷方式存在开放性以及液氮损耗的问题，第二种制冷方式尽管克服了开放性问题，但是仍存在振动以及不可搬运的问题。设计具有低振动噪声和温度波动在有限热噪声极限范围内的低温恒温器是一项极具挑战性的工作。目前为止，高精度光钟的可搬运性取决于窄线宽激光器的可搬运性，而窄线宽激光器的可搬运性取决于低温参考腔的低温制冷设备。与绝大多数低温恒温器不同，低温光学制冷器是全封闭的且在运行过程中不产生任何噪音。此外，低温光学制冷器能够提供足够的冷量使得低温单晶硅F-P参考腔维持在124K工作。因此无振动低温光学制冷器的引入将彻底解决可搬运高精度光钟最后的痛点问题

Name: Yi Gao 高怡

Organization: Shanghai Jiao Tong University 上海交通大学

Biography:

高怡，现任上海交通大学副教授，博士生导师。于 2009 年至 2013 年在德国埃尔朗根-纽伦堡大学攻读博士学位，并于博士毕业后在英国剑桥大学从事博士后研究，积累了丰富的国际科研经验。自 2017 年起加入上海交通大学，专注于航空与能源领域的燃烧诊断与优化研究。

高怡教授长期从事激光精细成像和光谱技术的研究，尤其在航空发动机、燃气轮机燃烧室内燃烧过程的可视化与污染物生成机理研究方面做出了重要贡献。她的研究成果为提升燃烧效率、降低污染物排放提供了重要理论依据和技术支持。主持和参与了多项国家级科研项目，包括国家自然科学基金重点项目和航空发动机重大专项等，并在国际知名期刊上发表论文数十篇。她曾多次受邀在国际燃烧与动力领域的重要会议上作特邀报告。

Title:

多物理场同步光学成像技术及相关应用进展



Name: Kun Liu 刘锟

Organization: Anhui Institute of Optics and Fine Mechanics, CAS
中国科学院合肥物质科学研究院

Biography:

刘锟，中国科学院合肥物质科学研究院研究员，博导，中科院安徽光机所基础科学研究中心副主任，中国科学院青年创新促进会会员，中国光学工程协会光谱技术及应用专业委员会委员。主要从事高灵敏光谱检测技术及应用研究，提出了离轴石英音叉光声光谱、多通道共振增强光声光谱、永磁型法拉第磁旋转光谱、小型化光学多通吸收增强等创新性光谱检测技术。主持国家自然科学基金、ZF 项目、国家重点研发项目课题、安徽省重点研发项目、中科院科研仪器研制项目课题等多个科研项目，研发了面向双碳、公共安全、深海资源勘探等领域应用的高性能光谱分析仪器。在 *Opt. lett.*、*Sens. Actuators B*、*Rew. Sci. Instrum.*、*Anal. Chem.* 等国际期刊上发表论文 50 余篇，申请发明专利 10 余项。

Title:

光学腔增强吸收光谱高灵敏探测技术

Abstract:

为应对温室气体浓度增加导致的全球变暖等气候问题，我国于 2020 年宣布了“双碳”目标，国家陆续出台顶层设计文件，为双碳目标提供政策支撑。碳监测技术及设备是碳核算、制定碳减排政策、评估减排效果、应对气候变化国际谈判及碳交易的必要支撑。针对我国缺乏高精度碳监测技术及设备问题，开展了基于激光光谱的温室气体高精度测量技术研究，发展了光学腔增强吸收光谱高灵敏探测技术，攻克了光学腔吸收作用增强、噪声抑制、温度及压力控制等关键技术，实现大气温室气体（CO₂、CH₄、N₂O）的高精度测量，并研发了大气温室气体探测装备，为我国双碳目标建设提供高精度的先进碳监测技术及设备支撑。



Name: Chuanliang Li 李传亮

Organization: Taiyuan University of Science and Technology 太原科技大学

Biography:

李传亮教授、博士生导师，应用科学院副院长，山西省精密测量与在线检测装备工程研究中心主任，法国国家科学研究中心和美国路易斯维尔大学访问教授。入选山西省“优秀青年学术带头人”、山西省青年“三晋英才”。担任国际分子光学研讨会(ISMS)的 Miller 奖评委、中国光学学会激光光谱学专委会副秘书长，山西省光学学会理事，山西省物理学会理事。目前主要从事激光光谱技术、光电测量和传感技术方面的研究。主持国家自然科学基金、山西省重点研发计划、山西省自然科学基金等省部级课题 10 余项。在《Anal. Chem.》、《NDT & E International》、《Opt. Letters》、《Opt. Express》、《Phys. Chem. Chem. Phys.》、《J. Chem. Phys.》、《Measurement》等 SCI 期刊上发表第一和通讯作者论文 30 多篇、出版《高灵敏光谱技术在痕量检测中的应用》专著 1 部，授权发明专利 5 项。

Title:

基于近红外双光梳光谱技术的痕量气体检测

Abstract:

由于双光梳光谱具有高分辨率、绝对频率精度、快速采集时间、宽带宽覆盖和高信噪比等优势，已经被广泛应用于光学钟、分子光谱学、计时和测距等领域。然而，由于近红外波段分子的横截面通常比中红外范围弱约 1000 倍，因此基于近红外双光梳光谱技术的痕量气体检测通常针对的是高浓度气体。本报告基于近红外双光梳光谱技术，实现微量气体 C₂H₂ 的低浓度测量。采用多通道长气体吸收池以延长光程，从而提高传感器的测量灵敏度。通过插值法进行信号后处理，减少梳齿噪声并实现更平坦的双梳光谱输出。选择 6526.53 cm⁻¹、6529.17 cm⁻¹ 和 6531.78 cm⁻¹ 的吸收线，评估传感器的灵敏度和瞬态特性，实验结果与 Voigt 函数拟合良好。通过在 200 ppm C₂H₂ 浓度下进行 2.5 小时的观察确认系统稳定性，结果表明，系统稳定性优于 2.305×10⁻²。通过 Allan 方差分析表明，最佳积分时间为 597 秒，对应的吸光度检测极限为 6.15×10⁻⁴，浓度检测极限为 350 ppb。通过测量乙炔的九条吸收线，展示了基于近红外双光梳光谱的多峰测量能力，偏差范围从 0.059% 到 12.496% 不等。

Name: Gang Zhao 赵刚

Organization: Shanxi University 山西大学

Biography:

赵刚，2018年毕业于山西大学原子与分子物理专业，瑞典于默奥大学联合培养博士生，美国国家标准与技术研究院（NIST）博士后，现工作于量子光学与光量子器件国家重点实验室、山西大学激光光谱研究所，主要从事腔增强光谱、中红外光谱、气体传感等领域的研究。目前已发表学术论文 60 余篇，申请/授权国家发明专利 20 余项。主持各类科研项目 10 余项，总经费 800 余万元。

Title:

腔增强精密光谱及其应用

Abstract:

本文介绍我们在高效激光-腔频率锁定、多激光-腔耦合、腔模频率精密控制和腔增强光谱噪声抑制、中红外腔增强光谱等技术方面的研究，通过对系统中关键部件和参数的动态调控，达到稳定激光频率和光谱信号、提升系统应用性和小型化的目的，然后我们将介绍以上技术在吸收光谱和拉曼光谱上的应用，最终实现在分子精密光谱和高灵敏气体检测的应用。

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Exhibition Center Hall C1

Terahertz Science and Technology
太赫兹科学与技术





Name: Yuncai Wang 王云才

Organization: Guangdong University of Technology 广东工业大学

Biography:

王云才，教授、博导，享受国务院政府特殊津贴。主要研究领域为硬件保密通信、微波光子学与毫米波/太赫兹器件等。先后承担科技部国际合作项目、国家自然科学基金重点项目、国家重大科学仪器研制项目等；发表学术论文 200 余篇，获发明专利授权 70 余件；科技成果获教育部技术发明二等奖 1 项，省技术发明一等奖 2 项、自然科学二等奖 2 项、技术发明二等奖 2 项；为省模范教师及学术技术带头人；领导的团队入选省科技创新重点团队，七次被评为省级研究生教育优秀导师。

Title:

从保密通信到噪声系数：高熵信号的应用

Abstract:

光学混沌作为一种高熵信号，具有高带宽、大幅度等固有特征，在雷达探测、光纤测量及传感、保密通信及噪声系数测量等众多工程实践中获得了成功应用，并获得了广泛关注。这里，将重点介绍本团队近年来在高速保密通信及高频器件噪声系数测量等领域取得的一些进展。尤其是，提出一种多光束拍频产生高超噪比、超宽带太赫兹噪声的光子学实现方法，成功构建了频率范围覆盖 90 GHz ~ 390 GHz、超噪比 ≥ 40 dB 的噪声发生器，填补了我国 110 GHz 以上固态噪声发生器的技术空白，刷新了太赫兹噪声源工作频率的国际记录，有助于推动毫米波及太赫兹等相关技术发展。

Name: Dayong Wang 王大勇

Organization: Beijing University of Technology 北京工业大学

Biography:

王大勇，北京工业大学教授，博士生导师。近年来对数字全息显微成像、太赫兹成像、高分辨率光学成像、微波光子技术等的方法和应用系统有较深入研究，发表学术论文 100 余篇，获授权发明专利 20 余项；2007 年入选北京市高校拔尖创新人才计划，2005 年获北京市科技进步三等奖，2017 年获军队科技进步二等奖，2023 年获北京市麒麟科技创新奖。承担国家自然科学基金国际合作重点项目及面上项目、JKW 创新项目等课题。美国光学学会（OSA）会员，国际光学工程学会（SPIE）会员，中国光学学会全息与光信息处理专业委员会常委，中国光学学会光电技术专业委员会常委，中国仪器仪表学会光机电一体化专业委员会理事，全国高等学校光学教学研究会副理事长。

Title:

Terahertz Imaging with The Binary Diffractive Lens and The Evanescent Wave

Abstract:

High-resolution, high-quality terahertz(THz) imaging has become a great potential and highly promising technology in the field of imaging due to its penetrating, safe, and nondestructive properties. Due to the inherent long wavelength of THz, the diffraction effect of the imaging system, and the relatively lack of optical components, THz images have low resolution and blurred image edges, thus limiting their practical applications, improving the resolution of THz images is one of the current hot research topics. In this paper, we first introduce a THz binary diffractive lens (BDL) based on photosensitive standard resin for super-resolution imaging by subwavelength focusing the illumination beam and pointsweeping the samples. A converging beam with a waist diameter of 0.65mm and a lateral imaging resolution of 1mm achieved at an incident THz frequency of 278.6 GHz. To realize wide-field imaging, we propose a THz-based rotational coherent scattering(ROCS) superresolution imaging technique. THz wave propagates axially along the high-resistance siliconhemispherical lens and is converted to quasi-parallel wave. When the hemispherical lens is tilted and the angle of tilt is greater than the critical angle, the total internal reflection (TIR) occurs at the silicon-air interface, resulting in the evanescent waves illumination on the sample. The sample is tightly adhered to the hemispherical lens plane and the scattered light is received by a subsequent imaging system. Rotating hemisphere lens measurements of sample intensity images under different azimuthal illumination are superimposed directly and generates a incoherent image with higher resolution and contrast. The experimental results show that with an incident THz wavelength of 118 μm and the numerical aperture of 0.6 of the THz camera lens, the imaging resolution reaches 100 μm when superimposing 12 intensity images with 30 azimuthal intervals, realizing wide-field subwavelength imaging. Considering that rotating the hemispherical lens several times during the ROCS experiment is not only inconvenient to operate, but also the possible displacement of the sample and the error in the rotation angle can negatively affect the results. In order to reduce the number of required single-azimuth illumination intensity images, a deep-learning based THz ROCS superresolution imaging method is proposed, combining transfer learning with a small amount of experimental data and a large amount of simulation data to complete the training of the Unet network, the 70 μm periodic metallic grating can be reconstructed from only six intensity images with 60° azimuthal intervals, and the imaging resolution and contrast are further improved.



Name: Junqi Liu 刘俊岐

Organization: Institute of Semiconductors, CAS 中国科学院半导体研究所

Biography:

刘俊岐，男，中国科学院半导体所研究员、中国科学院大学岗位教授，国家级领军人才。从事红外及太赫兹半导体光子芯片研究，曾研制出亚洲第一支 GaAs 基中红外量子级联激光器；发展了表面等离子体分布反馈理论，研制出垂直面发射量子级联激光器，关键技术指标保持记录；研制出高功率太赫兹量子级联激光器成为国际第二个展示单管峰值功率突破 1W 的单位，实现太赫兹量子级联激光器 频率完全覆盖 2.5~5.2 THz；研制出首支室温高速中红外量子级联激光器，完成激光通信工程验证；突破近余辉带电子输运机制，研制出甚长波红外量子级联激光器。迄今发表学术论文 200 篇，获授权发明专利 40 余项，获北京市技术发明二等奖。

Title:

量子级联激光器及其光谱学应用

Abstract:

随着应用需求越来越迫切，太赫兹频率的上限已由传统定义的 10 THz 扩展到了 100 THz（中红外）。量子级联激光器（QCL）通过能带工程的方式将材料结构化，利用耦合量子阱中的子带间跃迁和电子再循环实现激光增益，波长可以覆盖宽的太赫兹光谱范围。在持续发展基础设计理论和创新材料制备技术的基础上，量子级联激光器的模式调控及其光谱学应用也已经发展成为重要的领域。本报告重点介绍量子级联激光器研制方面的最新成果，并针对其在光谱学方面的应用做出展望。



Name: Zhen Tian 田震

Organization: Tianjin University 天津大学

Biography:

田震，天津大学英才教授，博士生导师。现任天津大学精密仪器与光电子工程学院副院长，天津大学光学工程学科负责人，国家优秀青年科学基金获得者，天津市杰出青年科学基金获得者。中国光学学会激光光谱专委会委员，中国仪器仪表学会图像科学与工程分会副主任委员，中国生物物理学会太赫兹生物物理分会理事，天津市光学学会监事，中国超材料学会理事，美国光学学会会员。曾获教育部自然科学一等奖、天津市青年科技奖等奖项。在 *Nature Communications*、*Advanced Materials* 等刊物上发表论文 100 余篇，目前总引用次数 7000 多次，H 因子 44。主要研究方向为太赫兹光子学、微纳光子学、光声效应等。

Title:

太赫兹光声与应用

Abstract:

太赫兹波段介于红外波与微波之间，是电磁频谱中最后亟待开发的波段，尤其在下一代无线通信、无损检测、生物医学方面具有重要潜在应用。低能量的太赫兹波不会产生电离效应，可清晰安全地进行成像，可以作为超声波、核磁共振、红外成像等技术的重要补充，可避免对人体造成电离伤害的可能，凸显了太赫兹波较高的安全性。同时，太赫兹波对氢键、范德华力和经典中红外光谱检测不到的非键（疏水）相互作用等弱共振非常敏感，有望成为生物电磁研究的新手段。但利用太赫兹波进行无损检测会面临金属及高电导性的复合材料的高反射和强衰减，进行生物医学应用也会面临生物体系的强吸收，上述情况是太赫兹波在无损检测和生物电磁领域进一步应用的最大瓶颈。为了克服这些限制，我们开发了系列太赫兹辐射源以及太赫兹光声技术，有望无损的进行内部探伤，同时在进行生物医学检测测试过程不需要侵入性取样或化学标记，从而提供了一种在体方法来实时测定生物组织尤其是血液中的生物分子浓度。该方法为太赫兹无损检测和生物医学应用提供了新的潜在解决方案。



Name: Quanyong Lu 陆全勇

Organization: Beijing Academy of Quantum Information Sciences
北京量子信息科学研究院

Biography:

Quanyong Lu received his doctoral degree from Institute of Semiconductors, Chinese Academy of Sciences in 2010. He went to Center for Quantum Devices, Northwestern University as postdoctoral researcher and then Research Assistant Professor from 2010 to 2020. He was a Senior RD-chip Engineer in Applied Optoelectronics Inc. in 2020-2021. He now is a professor of Beijing Academy of Quantum Information Sciences (BAQIS) since November 2021.

He has demonstrated the first continuous wave THz semiconductor source based on on-chip difference frequency generation, the first room temperature semiconductor THz comb, the highest power mid-IR single mode laser, and the highest power mid-IR laser array, and high brightness THz quantum cascade laser. His current research is focused on quantum light sources and systems, including quantum cascade lasers, frequency comb, terahertz laser sources, and other quantum light sources.

Title:

High Brightness Surface Emitting Terahertz Quantum Cascade Laser

Abstract:

2024 marks the 30 year anniversary of quantum cascade laser (QCL) which is becoming the leading semiconductor laser source in the mid-infrared (mid-IR) and terahertz (THz) ranges. Since the first demonstration, QCL has undergone tremendous development in terms of the output power, wall plug efficiency, spectral coverage, wavelength tunability, and beam quality. Owing to its unique intersubband transition and fast gain features, QCL possesses strong nonlinearities that makes it an ideal platform for nonlinear photonics like terahertz (THz) difference-frequency generation and direct frequency comb generation via four-wave mixing when group velocity dispersion is engineered. In this talk, I will present our recent progress on QCL research, including high-brightness surface emitting THz QCL, mid-IR QCL frequency combs, and major challenges facing QCL in the future.



Name: Yue Wang 王玥

Organization: Xi'an University of Technology 西安理工大学

Biography:

Professor Wang graduated from Harbin Institute of Technology in 2011. From 2015 to 2016, he was a Research Scholar with the College of Engineering, Boston University, Boston, MA, USA. He is currently a Professor with the Department of Applied Physics, and a High level Talent, Xi'an University of Technology. In 2024, He was approved as a leading young talent in Shaanxi Province. From 2020, he served as the Director of the Youth Innovation Team for Terahertz Micro Nano Materials, Device Physics and Applications. He has authored 100 articles in international peerreviewed journals. His research interests include the terahertz pulse spectroscopy of carbon-based nano-materials, antenna and propagation, surface plasmon polaritons, terahertz metamaterial and applications, and BICs at Terahertz region. He was selected as one of World's top 2% of scientists in 2023 and 2024.

Title:

Study on The Sensing Characteristics of Modified Carbon Nanotube Thin Film Metas

Abstract:

Carbon nanotubes have unique physical and chemical properties such as large surface area, fast Electron transfer, good biocompatibility, and modifiable functionalization. The metasurface constructed by carbon nanotubes has important application value in terahertz biological and chemical sensing fields. On the one hand, this report introduces the flexible terahertz plasma resonance transmission characteristics based on carbon nanotube metasurfaces; On the other hand, considering the risks posed by the excessive use of pesticides to human health and biodiversity, the preparation and characterization of carbon nanotube films and the design of a metasurface terahertz sensor were completed by utilizing the extremely sensitive nature of surface plasmon enhanced resonance transmission peaks to changes in dielectric environment. The detection of the concentration of substances on the opposite side was achieved, with a minimum detection quality of 10 ng. The proposed carbon nanotube thin film metasurface devices have potential application prospects in terahertz sensing, imaging and other functional devices.

Name: Hui Yan 颜辉

Organization: South China Normal University 华南师范大学

Biography:

颜辉，教授、博士生导师，华南师范大学物理学院副院长，国家杰出青年基金获得者，国家优秀青年基金获得者，广东省珠江学者特聘教授。全国近代物理研究会常务理事，量子光学专业委员会委员，光量子科学与技术专业委员会委员。本科毕业于武汉大学，博士毕业于中国科学院武汉物理与数学研究所。主要从事冷原子物理实验研究，具体研究方向包括：（1）量子计算与量子模拟；（2）量子网络与量子存储；（3）量子精密测量。已发表SCI论文65篇，其中Nature Photon. 4篇，Phys. Rev. Lett. 12篇，Nature Commun. 1篇。

Title:

里德堡原子太赫兹成像

Abstract:

太赫兹同时拥有激光的指向性和微波的穿透性，在安防、通信、无损检测、生物成像等众多领域具有重要应用前景。里德堡原子由于极大的电偶极矩，可以应用于微波和太赫兹的高灵敏度测量。我们利用里德堡原子实现了可溯源、高灵敏度的微波和太赫兹测量。进一步将太赫兹转化为可见光，并通过对可见光成像来还原太赫兹图像，从而实现快速、高灵敏的太赫兹成像。在此基础上，我们研发了国际首台里德堡原子太赫兹相机。基于里德堡原子的太赫兹成像有望突破传统基于电子学的太赫兹成像瓶颈，在无损检测、医学影像等领域有着广阔的应用前景。

Name: Jinqing Yu 余金清

Organization: Hunan University 湖南大学

Biography:

余金清，男，1984年11月生，教授，博士生导师，岳麓山工业创新中心（省实验室）常务副主任。余金清博士毕业于电子科技大学/中物院激光聚变中心/帝国理工大学，先后在加州大学圣地亚哥分校和北京大学从事博士后研究。研究兴趣包括：激光与等离子体相互作用物理、超短超强激光脉冲与等离子体相互作用产生高能粒子束，激光产生强辐射源及应用。在新型粒子加速与辐射、激光太赫兹源、计算物理等领域取得了一系列进展，在 PRL, APL, PPCF, CICP, POP, LPB 等期刊发表期刊研究论文近 60 篇。

Title:

激光等离子体的高效强场可调谐太赫兹辐射源研究

Abstract:

在强场太赫兹辐射研究领域，开发高效率、强场和频率可调的辐射源一直是科学界的重点和难点。尽管近年来该领域取得了显著进展，如何提高太赫兹辐射的产生效率、增强辐射强度，并实现频率和偏振的灵活调控，依然面临诸多技术挑战。针对这些难题，我们研究了多种物理机制，显著提升了太赫兹辐射的效率、强度和频率，空间偏振可调性，为高效强场太赫兹源的开发提供了新技术路径：（1）提出了激光与锥靶的相互作用，利用锥靶的聚焦效应显著提升了相干渡越辐射的产生效率，成功获得了高强度的太赫兹辐射；（2）基于等离子体 wiggler 的实验方案，通过表面电荷分离场对电子振荡的约束，实现了中心频率可调的强场太赫兹辐射，拓宽了辐射源的调谐范围；（3）提出了一种基于激光与气体靶相互作用产生具有空间偏振依赖性的强场庞加莱太赫兹束，为实现各向异性非线性调控提供了新的可能性。这些进展不仅为强场太赫兹科学的发展注入了活力，也为未来在通信、成像和材料分析等领域的应用奠定了重要基础。



Name: Jianqiang Gu 谷建强

Organization: Tianjin University 天津大学

Biography:

谷建强，天津大学，教授，博导。从事太赫兹光谱、光电导天线和太赫兹超材料的研究。近年来专注于太赫兹近场频率梳、太赫兹液晶弹性体超表面和新型光电导天线等方向。在知名期刊上发表 SCI 论文 100 余篇，论文被引用上千次，其中多篇被选为封面文章和 ESI 文章。主持国家自然科学基金 重大科学仪器研制项目（自由申请），优秀青年科学基金项目等，获得教育部自然科学一等奖（排名第三），入选天津市人才特支计划青年拔尖人才，天津市“131”创新型人才培养工程第一层次人才，斯坦福大学 2023 全球前 2% 顶尖科学家。

Title:

亚波长空间分辨的异步采样太赫兹光谱技术及其应用

Abstract:

随着太赫兹光谱学的深入研究和广泛应用，对频率分辨率和空间分辨率的需求迅速上升。学界迫切需要兼容远场、近场，且具有极高空间和光谱分辨率的新型太赫兹光谱技术，本报告将展示近期报告人团队将异步采样与光电导探针相结合，来满足对分辨率的更高要求，并开展的应用研究。通过加入 PID 反馈，成功将两台飞秒激光器的重复频率差锁定，并分别激发了宽带 THz 源和光电导探针，实现了对 THz 时域近场的异步采样探测。虽然光电导探针的探测截面仅为 $100\ \mu\text{m}^2$ 量级，系统仍实现了 37 dB 的动态范围，1.7 THz 的频率范围，100 MHz 的频率分辨率以及 $5\ \mu\text{m}$ 的空间分辨率。以该系统对泄漏导模谐振进行了近、远场表征。得到的近场电场振幅和相位分布与模拟结果高度吻合，可跨越模拟、实测频率之间的差别，作为模式判定的直接判据。重要的是，探针在远场区测得的谐振 Q 值和 FoM 全面优于 4F 异步采样系统下测得的结果。此处报道的 THz 光谱新技术，为更深入、原位的表征高 Q 值 THz 频段谐振提供了强有力的工具，将推动 THz 声子、激子、等离激元、EIT、BIC 等高 Q 值谐振的研究和相关应用。

Name: Haiqing Liu 刘海庆

Organization: Hefei Institutes of Physical Science, CAS 中国科学院合肥物质科学研究院

Biography:

刘海庆，中国科学院等离子体物理研究所研究员，博士生导师。主要从事托卡马克装置等离子体物理实验、等离子体物理诊断、等离子体约束和输运物理等方面的研究工作。目前的研究重点是 EAST 托卡马克装置远红外激光干涉仪诊断、EAST 托卡马克等离子体物理实验，如粒子输运、电流输运、长脉冲高约束 H 模等。近五年来主持完成国家磁约束聚变专项和国家自然科学基金面上项目等多项课题，发表 SCI 收录论文 70 余篇。现任国际等离子体激光诊断会议科学委员会委员，国际托卡马克物理活动组织激光诊断专家组组长。安徽省青年科技奖获奖者。2018 年中国科学院杰出科技成就奖获奖者。

Title:

太赫兹激光诊断技术及太赫兹光主动成像技术应用



Name: Huanjun Chen 陈焕君

Organization: Sun Yat-sen University 中山大学

Biography:

陈焕君，中山大学电子与信息工程学院，教授，博导。长期致力于极化激元效应及其新型光电功能材料与器件的研究，关注低维结构激元效应及机制、激元结构构筑与电磁场调控、光电探测材料及器件，围绕“材料制备-物理效应研究器件应用”开展全链条研究，在SCI期刊已发表120篇文章，他引8000余次（SCI）/11000余次（Google），H指数51（SCI）/56（Google），研究成果被Nature, Science, Nat. Materials, Nat. Photonics, Nat. Nanotechnology, Nat. Communications, Nat. Rev. Mater., Sci. Adv.等重要学术期刊引用。

Title:

极化激元二维晶体微纳结构的太赫兹光场调控及探测

Abstract:

极化激元是电磁场与材料中电性或磁性元激发耦合形成的杂化模式，可将电磁场高度聚焦至材料体内或表面，极大地促进纳米尺度下电磁场与物质的相互作用，在发展纳米光子/光电器件方面具有独特的优势。近年来的研究表明，范德华二维原子晶体及其微纳结构，在中远红外至太赫兹谱段能够支持多种极化激元模式。特别是，一些具有较低对称性的二维晶体，在特定晶面存在面内各向异性、乃至符号相反的介电函数分量，这使得它们可以支持具备面内各向异性传输特性的极化激元模式。这些模式往往工作于中远红外乃至太赫兹谱段，为该谱段的高性能光电微纳器件的研制提供了新材料基础。在本次报告中，我将结合我们研究团队近年来关于二维原子晶体微纳结构结构的极化激元光场局域与调控研究的一些进展，汇报范德华二维晶体的各向异性极化激元及其纳米尺度光场调控研究现状，并对相关的潜在应用进行展望。



Name: Lin Wang 王林

Organization: Shanghai Institute of Technical Physics, CAS
中国科学院上海技术物理研究所

Biography:

王林, 博士, 研究员, 基金委优青, 红外科学与技术国家重点实验室学术带头人, 中科院青促会会员、美国科学促进会 AAAS 会员、中国电子学会会员。围绕新一代空间天文、雷达通讯、深空探测等重要应用对太赫兹辐射探测的重要需求, 聚焦太赫兹光电材料与器件机理性瓶颈问题, 从事低维材料量子态多维度操控的室温太赫兹探测与集成化应用研究, 曾获中科院院长特别奖、中科院优博、启明星研究员等人才计划。以第一、通讯作者在 Nat. Commun.、Sci. Adv.、Advanced Materials、Light、NL 等期刊发表 SCI 论文 70 余篇, 他引 3000 余次, 在国内外重要会议作邀请报告 30 余次。主持国家自然科学基金、中科院先导 B 课题、重点研发课题等项目 20 余项, 作为指导老师培养博士生 7 名、硕士 5 名, 研究生多次获中科院院长奖、优博奖, 毕业去向包括高效、高新企业、央企等, 就业率 100%。目前担任 Research、Fundamental Research、EcoEnergy、Exploration 等 SCI 刊物编委。

Title:

量子态几何性质的非线性霍尔太赫兹探测效应研究

Abstract:

红外与太赫兹光电技术经历了跨代发展, 当前朝着低功耗、高灵敏、高集成的高端三代方向发展, 在拓展极制性能的基础上以智能化、多功能为特色的普适应用方向发展。随着人类活动的拓展, 深空探测、高速通讯、空间态势感知等重大需求与传统太赫兹光电极端条件束缚, 亟需突破传统以能带理论为框架的光电技术在太赫兹频率面临着本征物理(暗电流、噪声等)极限束缚。为此探索定态波函数基础之上的非平衡态物理效应所带来的光电新原理是实现光电转换突破传统准平衡极限的必要措施, 而这需要对波函数微观层面的作用规律、操控规律、器件形式等形成创新链。针对此, 本报告将聚焦量子态位相、动量等维度的拓扑微观特征及其电磁非线性非平衡物理过程, 探索量子位相对宏观光电效应的多重影响, 包括非线性霍尔效应、反演对称的本征光电导效应等, 探讨以量子态本征维度非平衡电磁作用下太赫兹光电响应调控与信噪分离规律及其在低功耗、集成化、高速等方面的应用前景。



Name: Ya Zhang 张亚

Organization: Tokyo University of Agriculture and Technology
东京农工大学

Biography:

Dr. Ya Zhang

2006.7 Tsinghua University, Bachelor of Engineering

2008.7 Tsinghua University, Master of Engineering

2014.9 University of Tokyo, PhD(Engineering)

2014.10-2018.3 University of Tokyo, Postdoc research

2018.4-Now Tokyo University of Agriculture and

Technology, associate Professor.

Title:

Terahertz Quasi-Mim Metamaterial Perfect Absorber for Integrating with Thin-Film

Abstract:

THz thermal detectors using Microelectromechanical-system (MEMS) resonators have attracted great interests owing to their good sensitivity, rapid response, and room-temperature operation. Metal-insulator-metal (MIM) metamaterial absorber is promising for improving the detection sensitivity of MEMS detectors. However, the MIM absorber generally features a multilayer structure with a thickness of several micrometers, which is thicker than MEMS detectors. Moreover, the internal strain induced by the multi-layer structure may severely degrade the mechanical property of MEMS beam, leading to a low quality(Q) factor and thereby a low detection sensitivity. Here, we present a perfect THz absorber with a quasi-MIM structure to enhance the THz absorption coefficient of MEMS thermal detectors. High-resistivity silicon substrate is etched to form a groove structure. Thin aluminum (Al) films are then deposited on both etched and non-etched areas, serving as the plasmonic resonator and the MIM ground, respectively. The silicon between the two metal layers acts as the dielectric structure instead of introducing extra dielectric materials. Comparing to conventional MIM structures, our quasi-MIM absorber has reduced thickness and very low internal strain, making it highly compatible with MEMS thermal detectors. Both simulation and experimental results show that the quasi-MIM absorber can achieve a near-perfect THz absorption (>98%). Furthermore, the absorption frequency is widely tunable, from sub-THz to over 10 THz, by altering its geometry. While our prototype uses a silicon substrate, the design is adaptable to other materials, such as GaAs and SiN, broadening its application range. These results confirm that the quasi-MIM absorber achieves exceptional THz absorption with a thin, compact structure, making it an excellent candidate for enhancing the sensitivity of MEMS-based THz detectors.

Name: Huabing Wang 王华兵

Organization: Nanjing University 南京大学

Title:

高温超导太赫兹探测器

Abstract:

The terahertz (THz) waveband is of immense interest in astronomy as it encompasses significant energy generated following the Big Bang, offering critical insights into processes invisible in other bands, such as the earliest stages of planet, star, and galaxy formation. Superconducting kinetic inductance detectors (KIDs) have emerged as a formidable contender in the field of THz astronomy, attributed to their exceptional sensitivity and scalability [1,2]. In this study, we introduce a novel class of KIDs incorporating a lumped element (LE) superconducting resonator design, with inductors fabricated on β -Ta film and capacitors on α -Ta film. We characterize the noise of the hybrid α -Ta/ β -Ta LEKIDs, achieving an optical noise equivalent power (NEP) of 4.8×10^{-19} W/Hz^{1/2}, demonstrating high sensitivity (Fig.1). Additionally, the LEKIDs exhibited robust stability across multiple thermal cycles. The combination of high sensitivity and robust stability makes the hybrid LEKIDs promising for the stringent demands of astronomy and other applications at THz waveband.

Name: Hui liu 刘辉

Organization: Nanjing University 南京大学

Biography:

南京大学物理学院教授，博士生导师，南京大学物理学院副院长，固体微结构物理国家重点实验室副主任。2003 年南京大学博士毕业；2004-2005 年美国加州大学伯克利分校博士后；2008 年德国斯图加特大学访问学者；2009 年香港科技大学访问学者；2011 年入选教育部“新世纪优秀人才支持计划”；2012 年入选南京大学登峰人才计划 B 层次；研究成果入选中国光学杂志社评选的 2013 年“中国光学重要成果”；2014 年获得杰出青年基金资助；2015 年获得中国光学学会王大珩光学奖；2015 年获得江苏省光学科技奖；2019 年获得中国光学学会光学科技奖一等奖；2022 年获得江苏省科学技术奖一等奖，2023 年获得国家教学成果一等奖等。主持承担科技部纳米科技专项课题，自然科学基金重大项目课题。

Title:

基于铌酸锂非线性光子晶体的光生太赫兹源

Abstract:

随着社会信息化的高速发展，人们对无线通信系统高传输速率的需求与日俱增。而太赫兹作为更高的频段，被认为是下一代 6G 高速通讯的关键技术。但是目前人们迫切需要室温连续高效的非线性光生太赫兹源。基于太赫兹差频产生，我们提出了铌酸锂非线性光子晶体和太赫兹行波管混合波导，克服从光波到太赫兹波转换中的两个主要瓶颈：相位失配和太赫兹损耗，从而实现光波到太赫兹的高转换效率。我们的结果证明了混合波导太赫兹源的可行性，为太赫兹通信系统提供了集成、低功耗、窄线宽和噪声低等优势。



Name: Tianwu Wang 王天武

Organization: GBA branch of Aerospace Information Research Institute, CAS
广东大湾区空天信息研究院

Biography:

Tianwu Wang is the researcher of Aerospace Information Research Institute, Chinese Academy of Sciences (AIRCAS) and the Supervisor of Doctorate Candidates at University of Chinese Academy of Sciences. He received his Ph.D. degree in Technical University of Denmark (DTU) and worked as a postdoctoral researcher in University of Alberta in Canada. He was awarded by the high-level researcher program of Chinese Academy of Sciences. He developed the first THz scanning tunneling microscope in China. His research interests include time resolved THz spectroscopy, near field THz spectroscopy (THz SNOM, THz-STM), and ultrafast dynamics of 2D materials.

Title:

Atomic Scale Terahertz Spectroscopy with Thz-Stm

Abstract:

Terahertz (THz) wave is between microwave and far-infrared, THz time-domain spectroscopy has become a powerful non-contact method to study physics, material science, biomedical science, et al. Due to the diffraction limit, the spatial resolution of THz imaging in far field is normally limited to be hundreds of micrometers. THz scanning tunneling microscope (THz-STM) has been developed as a novel technique, with both sub-picosecond temporal resolution and atomic spatial resolution. With a scanning metal tip, the resolution can be down to sub-nanometer scale. In the talk, I will present our recent progress on high spatial and temporal THz scanning tunneling microscope, especially, sampling THz waveforms under the metal tip at tunneling condition, which enables THz spectroscopy down to atomic scales.

Name: Liyuan Liu 刘力源

Organization: Institute of Semiconductors, CAS 中国科学院半导体研究所

Biography:

Liyuan Liu received the B.S. and Ph.D. degrees in electrical engineering from Electronic Engineering Department, Institute of Microelectronics, Tsinghua University, Beijing, China, in 2005 and 2010, respectively. In 2012, he finished his Postdoctoral training at Tsinghua Univ. and joined the State Key Laboratory of Superlattices and Microstructures, Institute of Semiconductors, Chinese Academy of Sciences, Beijing, as an Associate Professor, where he became a Professor in 2018. His current research interests are high speed CMOS image sensors, SPAD based 3-D image sensors, CMOS terahertz image sensors, smart processors for edge computing and design of monolithic vision chip. Prof. Liu is a member of IEEE. He serves as vice chair of IEEE SSCS Beijing Chapter. He was a TPC Member for the IEEE Asian Solid-State Circuits

Title:

Cmos Terahertz Image Sensors

Abstract:

Terahertz imaging is promising and has potential applications in non-invasive detection, security check, material analysis et.al. CMOS terahertz detector and image sensors take use of self-mixing principle to detect terahertz signal far beyond MOS device f_T . THz image sensor in CMOS is very suitable for large array and mass integration with readout circuits or even post digital processing circuits. In this talk we report design issues in implementation of CMOS terahertz detectors and imaging sensors. We will introduce the principle of terahertz detection using CMOS. Then we talk about design of terahertz detector, including design of antenna, matching network, notch filter. The simulation model of Terahertz detector is very important for accurately predicting the performance and will be discussed in the talk. Low noise readout design method will be presented. We show several silicon implementation of detectors and image sensors with different resolution. The talk ends with perspective on future trends in development of CMOS terahertz sensors.



Name: Yingdong Wei 卫英东

Organization: Shanghai Institute of Technical Physics, CAS 上海科技大学

Biography:

卫英东，男，本科就读于吉林大学物理学院，上海科技大学博士研究生，中国科学院上海技术物理研究所联合培养。聚焦于低维拓扑材料新奇物象研究和高性能红外太赫兹宽广谱光电探测器及其成像研究。

Title:

低维拓扑量子材料太赫兹探测

Abstract:

低能光子探测技术在天文观测、生物医学和 6G 通讯等领域有关键应用，但受限于经典物理理论框架，低能光子探测难度大，低温功耗等因素限制其进一步发展。基于拓扑量子理论不断发展，几何、拓扑、自旋和相关之间的量子相互作用所产生的丰富的涌现现象为低能光子探测提供广阔平台。狄拉克外尔半金属在太赫兹探测中起到关键作用，第二类狄拉克半金属具有沿某些动量方向高度倾斜的狄拉克锥，对应于太赫兹频段的低能电子态，因此是研究太赫兹光电子器件应用的理想选择，并且异质结结构可对本身的奇异量子效应进一步增强。几何受限二维晶格-Kagome 六角晶格同样引人注目，Kagome 晶格在其电子结构中自然具有狄拉克费米子、平带和范霍夫奇点。狄拉克费米子编码拓扑结构，平坦带有利于磁性等相关现象，范霍夫奇点可以导致远程多体秩序的不稳定性，从而实现和发现一系列具有奇异性质的拓扑现象。本研究中基于第一类和第二类外尔半金属异质结器件，明显增强光电响应，实现宽光谱探测，具有 242 kV/W 的响应率。基于 Kagome 材料也实现 0.02-0.34 THz 宽广谱探测突破，具有 $4.6e-23$ A²/Hz 噪声电流的优异性能。



Name: Yaxin Zhang 张雅鑫

Organization: University of Electronic Science and Technology of China
电子科技大学

Biography:

张雅鑫，电子科技大学教授，博导。国家级人才计划、教育部新世纪优秀人才、四川省学术与技术带头人。国家重大专项重点方向专家、中国光学工程学会青工委副主任、中国电子学会青年科学家太赫兹专委会副主任委员、中国通信学会太赫兹专委会副主任、中国电子学会首届太赫兹分会秘书长等。作为自然科学基金重点项目、重点研发计划项目、重大专项重点项目、国家实验室重点项目负责人。发表包括 *Nature Photonics* 主页推荐论文、*Nano letters* 和 *Optica* 封面论文，以及系列 *IEEE Trans.*等在内的 SCI 论文 100 余篇。

Title:

A Transmitted Intelligent Surface Based on Pb Phase Using 2Deg and Its Aystem Application Technology

Abstract:

In recent years, THz technology has become a research focus due to its prominent role in future communication and sensing systems. One of the main challenges in this field is the need to achieve real-time manipulation of THz wavefronts. Here, we design a transmission-type intelligent surface based on PB phase, which is composed of metal microstructures and 2DEG composite materials. By changing the bias voltage and coding sequence, it simultaneously possesses amplitude and phase modulation capabilities. In the experiment, the modulation efficiency of this metasurface reaches up to 93.2%, with a 3dB relative bandwidth of 22.97%, and a dynamic switching speed of up to 500 MHz. It achieves scanning of $\pm 60^\circ$ wide-angle beams in the 0.22 THz band, with a scanning accuracy of 1° . The THz wireless communication system based on this device realizes uninterrupted transmission of 1 Gbps video within $\pm 50^\circ$ and multi-target perception and perception-communication integration within $\pm 45^\circ$. This technology will open up new possibilities for THz communication and sensing.

Name: Zhensheng Tao 陶镇生

Organization: Fudan University 复旦大学

Biography:

Zhensheng Tao is a professor and Ph.D. supervisor in the Department of Physics at Fudan University. He completed his undergraduate and master's studies in the Department of Physics at Fudan University. In 2014, he obtained his Ph.D. from Michigan State University, USA, and subsequently conducted postdoctoral research at JILA, University of Colorado Boulder. His primary research interests focus on ultrafast optics and ultrafast light-matter interactions. He has published over 40 papers in journals such as Science, Physical Review Letters (PRL), Light: Science & Applications, and Science Advances. He has received several academic honors, including the Shanghai "Oriental Scholar" Distinguished Professorship, the Humboldt Research Fellowship, and the "XiDe Young Professor" Award from the Department of Physics at Fudan University.

Title:

Programmable Spintronic Emitters for Structured Terahertz Wave Generation

Abstract:

Structured light, particularly in the terahertz frequency range, holds considerable potential for a diverse range of applications. However, the generation and control of structured terahertz radiation pose major challenges. In this work, we demonstrate a novel programmable spintronic emitter that can flexibly generate a variety of structured terahertz waves. This is achieved through the precise and high resolution programming of the magnetization pattern on the emitter's surface, utilizing laser-assisted local field cooling of an exchange-biased ferromagnetic heterostructure. Moreover, we outline a generic design strategy for realizing specific complex structured terahertz fields in the far field. Our device successfully demonstrates the generation of terahertz waves with diverse structured polarization states, including spatially separated circular polarizations, azimuthal or radial polarization states, and a full Poincaré beam. This innovation opens a new avenue for designing and generating structured terahertz radiations, with potential applications in terahertz microscopy, communication, quantum information, and light-matter interactions.

Name: Huabin Wang 王化斌

Organization: Chongqing Insitute of Green and Intelligent Technology
中国科学院重庆绿色智能技术研究院

Title:

原子力显微镜及其与太赫兹联用的生物物理表征技术

Abstract:

原子力显微镜（AFM）是一种广泛应用于生物分子及细胞检测的研究工具，新的 AFM 应用技术一直在不断发展。报告人将主要介绍研究团队近期围绕 AFM 发展和应用 开展的三方面的工作。首先，利用 AFM 超分辨成像技术，观察了分子手性对 Tau 蛋白自 组装行为的影响。接着，发展了 AFM 成像与力学测量方法相结合的技术，研究了 A β 寡聚 体和碳点对神经细胞结构及力学特性的影响，推进了 AFM 力学生物学方法。最后，将 AFM 与太赫兹（THz）光谱技术结合，实现了单个蛋白分子的 THz 成像和光谱检测，并 进一步建立了 THz 亚表面生物探测方法。上述工作有效促进了 AFM 及其联用技术在生物 物理研究中的应用，对推动生物物理学的发展起到了积极作用。

Name: Su Xu 徐速

Organization: Jilin University 吉林大学

Biography:

徐速，吉林大学电子科学与工程学院教授，主要研究太赫兹片上器件和特种电磁器件的设计方法与制造技术，承担国家自然科学基金、创新特区、华为预研等纵/横向课题，第一发明人申请/授权发明专利 10 余项，担任国际 SCI 期刊 *Progress in Electromagnetics Research* 等期刊的 Associate Editor、《光子学报》“片上光学传感”专题组稿专家、中国复合材料学会电磁复合材料分会委员。

Title:

太赫兹硅基片上可调器件

Abstract:

太赫兹波段是介于微波和红外之间的缝隙波段，因其丰富的频谱资源、较低的光子能量和较微波更好的分辨能力，在 6G 通信、灵敏传感、先进探测等领域均展现了巨大的潜力。太赫兹系统正朝着小型化发展；对应地，太赫兹器件的片上化和集成化是太赫兹功能系统小型化、片上化的前置条件和硬件基础。硅材料在太赫兹波段具有介质损耗低、传输效率高等优势，是实现太赫兹片上器件的可选材料之一。目前，宽带、低损耗、可调节的全硅片上器件，是领域内的研究方向之一。本人将在报告中汇报团队最近在太赫兹全硅片上器件方面取得的实验进展，包括片上信道时-频编织的灵活复用器件和单双刀掷开关。



Name: Yiwen Sun 孙怡雯

Organization: Shenzhen University 深圳大学

Biography:

孙怡雯，教授，博士生导师。长期致力于无标记生物检测与成像的太赫兹光谱技术研究与应用。先后主持并承担5项国家自然科学基金项目。发表包括 *Photonics Res.*, *ACS Photonics*, *Adv. Optical Mater.*, *APL Photonics* 等期刊论文 80 余篇。获中国发明专利 7 项授权，4 项 PCT 专利获国际检索报告，5 项软件著作权获授权登记。曾任中国光学学会生物医学光子学专业委员会青年委员及副秘书长，现为中国光学学会生物医学光子学专委会常委委员，中国生物物理学会太赫兹生物物理分会委员，中国生物医学工程学会生物医学光子学分会委员，JIOHS 期刊青年编委，*Energy Reviews* 杂志编委，生物医学工程学杂志青年编委等。

Title:

蛋白分子-石墨烯共组装超分子结构电子转移机制的太赫兹探测

Abstract:

利用分子之间相互作用及自组装特性，探索分子间识别、传递和调控机制是目前功能性材料研发和检测方法研究的一大挑战。通过利用无序蛋白质和天然石墨烯的独特性质，我们开发了一种无序蛋白质-石墨烯共组装系统。该系统通过扩散反应过程和从无序到有序的转变，生成了具有可调控特性的参杂型石墨烯表面材料。结合太赫兹全反射探测方法和分子动力学模拟，揭示了该超分子材料形成的基本机制，并确立了设计和调控的关键原则，为开发高灵敏度、高选择性的传感技术和功能性器件提供了广阔的应用前景。



Name: Fei Fan 范飞

Organization: Nankai University 南开大学

Biography:

范飞，南开大学现代光学研究所教授，博士生导师，长期从事微纳光子器件和太赫兹光子技术的研究。主持国家自然科学基金等国家省部级项目共 8 项，以通讯或第一作者在 Optica、Adv. Func. Mater.、Adv. Science、Laser. Photon. Rev.、Adv. Opt. Mater.、Photon. Res. 等顶尖光电期刊上发表论文 110 篇，被引 4100 余次，H 因子 36，授权发明专利 12 项。获得天津市自然科学二等奖（排名 2/8）、第一批天津市青年科技人才、天津市青年人才托举工程、天津市创新人才推进计划青年科技优秀人、中国仪器仪表学会金国藩青年学子奖等奖励和称号。担任天津市光电传感器与传感网络重点实验室副主任等职务。

Title:

Chiral Wavefront Manipulation Based on Terahertz Liquid Crystal Metadevice

Abstract:

This report mainly discusses terahertz chiral wavefront construction and dynamic manipulation of liquid crystal integrated metasurfaces:

1. Far field in the free space:

- (1) Tunable chiral field construction of liquid crystal and metasurface biaxial anisotropy.
- (2) Coupling between the chiral field and helical geometric phase metasurface to achieve flexible transitions between vector beam and vortex beam with different topological charges.

2. Near field on chip:

- (1) Chirality-dependent unidirectional focusing of SPWs.
- (2) Broadband excitation based on on-chip propagation phase matching.
- (3) Liquid crystal tuning for dynamic energy distribution.

Name: Min Zhu 朱敏

Organization: Southeast University/ Purple Mountain Laboratories 东南大学/紫金山实验室

Title:

超宽带光子太赫兹通信系统：光生、光载、光检测

Abstract:

太赫兹通信被普遍认为是未来 6G 移动通信系统的核心组成部分。报告提出了一种超宽带光子太赫兹通信系统架构，通过与光纤通信系统深度融合，突破了超宽带太赫兹信号多维调制、超宽带光与太赫兹之间的灵活转换，以及光纤太赫兹混合信道的非线性损伤抑制等方面的应用瓶颈，实现大容量光生太赫兹信号，灵活转化一体融合的光载太赫兹传输，以及高灵敏度的太赫兹信号光检测技术，解决超高容量 6G 太赫兹实时无线通信难题。基于上述架构和关键技术，完成了世界上首个 100 ~ 500 GHz 光子太赫兹 Tbps 量级实时无线传输通信实验，实现了 200Gbps 以上光子太赫兹信号在 320GHz 载频上 200 米长距离传输，创造出目前世界上太赫兹无线通信的最高实时传输记录和最高容量-距离积，通信速率较 5G 提升 100 倍。还从集成化、移动性、高可靠性等方面，对超宽带光子太赫兹通信系统的未来发展方向及关键技术进行展望。



Name: Dongwen Zhang 张栋文

Organization: National University of Defense Technology 国防科技大学

Biography:

Dongwen Zhang received the Ph.D. degree in physics from the National University of Defense Technology, Changsha, China, in 2008. He is currently a Professor with the Department of Physics, National University of Defense Technology. His research interests include strong field physics, photon-based THz technology, time-resolved THz spectroscopy of ultrafast phenomena, and high-harmonic generation spectroscopy in condense matter.

Title:

Thz Conductivity of Warm-Dense Au

Abstract:

Terahertz (THz) waves offer a distinctive diagnostic method for detecting high energy density matter. However, realizing the THz time-domain spectral (THz-TDS) diagnosis of matter states under extreme conditions in large high-energy density devices remains a significant obstacle. To address this requirement, we designed and implemented an optical pump-THz single-shot detection system driven by a strong femtosecond laser. In the experiment, The LiNbO3 wafer with the diameter of 3 inches generated THz radiation with pulse energy of 1 milli-Joule and electric field of 10 MV/cm. The strong THz pulse was employed to measure the transient THz conductivity of 30 nm thick freestanding gold foils pumped by a 400 nm laser pulse. THz conductivity evolution of warm dense Au is measured with single-shot THz TDS. It' s found that electron-ion coupling factor is nonsensitive to electron temperature and Drude model is not applicable to the THz conductivity of nonequilibrium warm dense Au.

Name: Xuecou Tu 涂学凑

Organization: Nanjing University 南京大学

Biography:

涂学凑，南京大学教授级高工，登峰人才计划入选者，江苏省电磁波先进调控技术重点实验室副主任。主要从事微纳光子芯片及其制造研究。入选国家青年人才，江苏省杰青/优青。成果获省部级奖 2 项；第一或通讯作者发表 *Nature* 等论文多篇，他引 1000 余次，入选 ESI 高被引论文 4 篇；授权中国发明专利 30 余件。本次报告主要汇报在太赫兹器件微纳制造与性能测试取得的进展。

Title:

微纳制造与太赫兹光电集成器件

Abstract:

太赫兹探测器是成像和通信的关键传感接收前端，其灵敏度和集成度直接影响系统的性能。本报告从提高太赫兹与物质的相互作用结构出发，简要介绍常用提高太赫兹探测器灵敏度的微纳结构及其制备工艺；重点报告集成微纳结构的太赫兹探测器的研究成果（*Nature Communications*, 15, 5542 (2024)），报告如何通过 MEMS 技术制备 Tamm 腔，及其电磁波调控机理，实现高效耦合的太赫兹探测器。



Name: Xueqian Zhang 张学迁

Organization: Tianjin University 天津大学

Biography:

张学迁，男，博士，天津大学精仪学院光学工程，教授。主要从事太赫兹光子学波前调控方面的研究。共发表论文 110 余篇，谷歌总引 9300 余次，H 指数 48；其中，以第一和通讯作者身份在 Nat. Commun.、Sci. Adv.、Adv. Mater.和 Adv. Photon.等期刊上发表论文 54 篇；承担国家自然科学基金重点、面上和青年项目，荣获教育部自然科学一等奖、广西自然科学二等奖，入选中国科协“青托工程”项目，中国仪器仪表学会金国藩青年学子奖学金，中国光学学会全国光学优博论文，中国光学工程学会全国光学工程学科优博论文提名，天津大学科技创新领军人才培育计划-“攀登计划”，天津大学北洋学者-青年骨干教师等荣誉。

Title:

Nonlinear Photonic Terahertz Functional Emitters

Abstract:

太赫兹 (THz) 技术在通讯、光谱成像及传感等领域具有重要的应用前景。在传统 THz 系统中，产生和调控通常是两个分立的过程，分别由辐射源和调控器件来完成。近来研究表明，利用非线性超表面可将 THz 产生和调控功能进行融合，即非线性光子学太赫兹功能性辐射源。在前期研究中，我们基于非线性超表面实现了对太赫兹辐射相位、振幅和手性产生的控制，本报告将介绍我们在此方面取得的最新进展，包括基于手性非线性超表面的太赫兹辐射振幅、相位和偏振同步调控器件，以及光子学太赫兹相控阵天线等。未来有望与光通信相融合，如将光携带的调制信息通过非线性过程传递到产生的 THz 载波上，并通过微结构同步调控 THz 波的空间传输模式，从而实现无线通讯。



Name: Zuanming Jin 金钻明

Organization: University of Shanghai for Science and Technology
上海理工大学

Biography:

金钻明，男，教授，博士生导师。国家自然科学基金委优秀青年科学基金获得者，上海高校青年东方学者，“晨光计划”，上海市青年科技启明星计划，“曙光计划”。以第一/通讯作者在 *Nature Physics*, *Light: Sci. & Appl.*, *Laser & Photonics Reviews*, *Advanced Functional Materials* 等期刊发表高水平论文 40 余篇，合作发表包括 *Science* 论文 80 余篇，累计引用 1800 余次，出版学术专著《太赫兹光谱在自旋电子学中的应用》，教材《激光原理基础与拓展》。朱亦鸣，国防领域国家级人才、国家万人计划“中青年科技创新领军人才”、国家百千万人才、青年长江学者、国家基金委优秀青年科学基金、国务院特殊津贴获得者、上海首届杰出人才。以实用化的太赫兹成像系统和成谱系统为主线，作为太赫兹团队负责人带领团队成功申请到“国家基础科学中心-太赫兹科学技术前沿（合作）”，“太赫兹波谱与影像技术省部共建协同创新中心”，“国家 111 太赫兹精准生物医学技术创新引智基地”，“上海市太赫兹波谱与影像技术协同创新中心”，“上海理工-莫斯科大学太赫兹技术创新国际联合实验室”。承担国家及地方课题项目二十余项。以第一作者或通讯作者在 *SCI* 杂志发表论文 100 余篇(其中光电领域一区论文的共 50 余篇)，其中包括 *ESI* 论文 9 篇。累计授权发明专利 40 余项，其中 12 项被转让或授权使用，累计转让经费近 4000 万。先后获得教育部高等学校科学研究优秀成果奖（科学技术）奖技术发明一等奖（排 1），上海市青年科技杰出贡献奖，上海市技术发明一等奖（排 1），中国发明协会发明创新奖一等奖（金奖）（排 1），中国专利奖优秀奖（排 2），中国产学研合作促进会中国产学研合作创新奖等。

Title:

太赫兹超快物理、器件及瞬态光谱研究及应用

Abstract:

上海理工大学，太赫兹技术创新研究院，上海市现代光学系统重点实验室，光学仪器与系统教育部工程中心，太赫兹光谱与影像技术协同创新中心，上海 200093）太赫兹波泛指频率在 0.1~10 THz 范围内，介于微波和红外线之间的电磁波。本报告将从以下四个方面进行阐述：1）利用太赫兹脉冲实现了自旋分辨的电子密度和亚皮秒尺度电子散射时间的非接触准确测量，解决了自旋输运参数无法实测的难题；2）阐明并利用超快退磁效应、反常霍尔效应、反常能斯特效应、逆自旋霍尔效应实现了电子自旋在亚皮秒尺度的全光超快操控并诱导宽频太赫兹辐射；3）提出大尺寸、多层铁磁异质结级联放大方法，实现了低成本、纳米级厚度、光场参数灵活调控的强太赫兹辐射源；4）利用光抽运太赫兹探测技术研究钙钛矿材料和拓扑量子材料中光生载流子和极化子等在皮秒时间尺度上的超快动力学过程及在太赫兹波段的光电导特性。



Name: Min Hu 胡旻

Organization: University of Electronic Science and Technology of China
电子科技大学

Biography:

胡旻，男，电子科技大学，博士，教授，博导，电子科技大学电子学院太赫兹科学研究中心负责人，教育部重点实验室副主任，入选四川天府青城菁英计划，国际红外毫米波太赫兹协会国际委员会委员、电子学会太赫兹分会副主任委员。长期致力于自由电子太赫兹辐射源、太赫兹近场显微镜和太赫兹成像系统方面的研究。近年来先后主持和承担了包括国家科技部重点研发计划、国家自然科学基金委重点项目、面上项目在内的多个国家级太赫兹项目。在 *Nature Photonics* 等国内外学术期刊发表 SCI 论文 100 余篇，授权发明专利 50 余项。获四川省自然科学一等奖、技术发明三等奖各 1 项。

Title:

太赫兹纳米波谱的实现与应用

Abstract:

作为电磁波谱中全新的频段，太赫兹在诸多领域有着巨大的潜在应用，但是受到了分辨率的限制。太赫兹超分辨技术，包括微米超分辨和纳米超分辨为太赫兹的应用推广带来了新希望。本报告将介绍太赫兹近场光学系统的相关技术，特别是介绍太赫兹频段近场系统成像成谱不同于其他频段的特点。报告还将介绍太赫兹近场系统发展历程，以及在材料分析、生物医学、半导体检测等领域的应用情况及瓶颈限制。报告还将针对太赫兹近场系统面临的信噪比、天线谐振效应、波矢频谱等瓶颈问题进行分析探讨，指出解决这些问题方法。最后，报告将展示太赫兹近场系统的未来发展前景。



Name: Xiaokai Pan 潘晓凯

Organization: Shanghai Institute of Technical Physics, CAS
中国科学院上海技术物理研究所

Biography:

中国科学院上海技术物理研究所，在读博士生，凝聚态物理专业，主要研究课题为：基于低维拓扑材料的太赫兹相干探测研究；基于高电子迁移率晶体管（HEMT）的太赫兹阵列芯片研究

Title:

基于低维拓扑材料的太赫兹外差混频研究

Abstract:

当前太赫兹探测技术依赖非本征调控手段，由于受到输出电容、电子饱和速度、临界电场以及工作原理等因素的限制，存在探测性能极限，亟需发展新材料、新原理与新器件，突破室温太赫兹探测瓶颈。非线性霍尔效应为具有宽带响应的无线整流器提供了一种新的替代机制，它可以克服热电压阈值和电子转换时间的限制，并具有超越量子效率极限的潜力。此外，这种机制理论上不受传统混频器截止频率的影响，也为太赫兹外差混频探测研究提供了新的选择。外差混频探测器通过被测太赫兹信号与低噪声本地相干太赫兹信号的混频，将被测信号下转换为微波射频波段的中频信号后进行检测，可以有效提升探测灵敏度，同时还能够同步获得太赫兹波的幅度、相位和频率信息，因此成为太赫兹雷达、通信和波谱成像等应用的核心器件。

Session 10

JAN. 13-14.2025

Exhibition Center Hall C1

Biomedical Photonics

生物医学光子学





Name: Ling Fu 付玲

Organization: Hainan University 海南大学

Biography:

付玲，1999 年获华中理工大学光电仪器与技术专业学士学位，2002 年获华中科技大学物理电子学硕士学位，2007 年在澳大利亚斯威本科技大学获得博士学位（学位论文被评为该校最高等级）。

付玲教授在生物医学光学领域的主要贡献包括活体显微光学成像原理与技术，行为动物成像，以及临床应用等。研究领域包括飞秒脉冲传输、微型光学器件和活体光学成像等，开展了共聚焦/非线性光学显微成像研究，推动了高分辨活体成像技术的进步。她的多学科工作将光电子基础研究转化为生物医学应用。9 色双光子成像技术能对异质性肿瘤演进的时空动态过程进行长时程观测；显微方法和高灵敏度、集成的多通道光纤光度计成功应用于小鼠记忆环路和神经元编码的研究；光学活检技术和仪器已被 300 多家医院用于单细胞分辨率的胃肠疾病诊断。

付玲教授发表了许多高质量的论文，其中以第一作者或通讯作者身份在国际期刊上发表了 60 多篇论文，拥有 40 多项授权专利，在全球范围内发表了 40 多次特邀演讲。入选教育部新世纪优秀人才（2008），3551 光谷人才计划（2013），基金委优青（2015），美国光学学会会士 OPTICA Fellow（2019），国际光学工程学会会士 SPIE Fellow（2021），国家重大人才工程（2023）。

付玲教授参与过两个国家级人才培养特区的建设，为很多国际会议和期刊服务。特别是，2016 年担任美国光学学会第 100 周年大会的程序主席，自 2019 年起担任西部光子学会议（Photonics West）中神经成像和传感会议的共主席。自 2008 年，她担任 Journal of Innovative Optical Health Sciences（亚太地区唯一的同行评议生物光子学期刊）的主编助理，在 6 家国际期刊担任高级编辑、副编辑等职务。她的照片曾登上 Faces of OPTICA（2021）和 Optics and Photonics News（2021）等学术宣传刊物，旨在鼓励更多女性加入科学、技术和工程界。

Title:

活体光学显微成像与生物医学应用 In Vivo Optical Microscopic Imaging and Biomedical Applications



Name: Changfeng Wu 吴长锋

Organization: Southern University of Science and Technology
南方科技大学

Biography:

吴长锋教授，入选国家青年人才、科技创新领军人才，先后获得国家自然科学基金优秀青年项目、国家自然科学基金重点项目（2项）、国家重点研发计划、深圳市孔雀团队等项目资助。研究方向为光学分子探针和生物成像技术，迄今发表SCI论文200余篇，SCI引用15000多次，H因子63，近五年连续入选“爱思唯尔”中国高被引学者榜单。担任南科大生物医学工程系教学副主任，讲授《生物医学光学》、《生物医学光学实验》、《生物医学工程概论》、《高级显微学》等课程。获得深圳市“先进教育工作者”、南方科技大学“杰出教学奖”。

Title:

基于有机半导体的分子探针与光学成像研究 Organic Semiconductor Based Molecular Probe and Optical Imaging



Name: Feifan Zhou 周非凡

Organization: Hainan University 海南大学

Biography:

周非凡，教授、博士生导师，海南大学生物医学工程学院 副院长，国家海外高层次人才青年项目获得者，SPIE FELLOW。从事光学技术在肿瘤诊疗和神经免疫调控中的应用基础研究。在 Nature Communication、Brain Behavior and Immunity、Clinical Cancer Research 等国际知名学术期刊上发表 SCI 论文 50 余篇，被引 5000 余次，入选 2021-2023 年度全球 2 %高被引科学家。主持科技部脑科学与类脑研究”重大项目青年项目、国自然科学基金、省重点研发计划等 10 余项。现任国际光学工程学会(SPIE)Photonics West “Biophotonics and Immune Responses” 分会主席，中国光学学会生物医学光子学专业委员会常务委员，海南省生物医学工程学会理事长。

Title:

脑膜淋巴管光学监测与调控 Optical Monitoring and Control of Meningeal Lymphatic Vessels

Abstract:

脑膜淋巴管 (meningeal lymphatic vessels, mLVs) 已被证明参与 β -淀粉样蛋白 (amyloid β -protein, A β) 清除，因而被认为是阿尔茨海默病 (Alzheimer's disease, AD) 的潜在调控靶点。然而，如何利用光学成像与调控技术改善 mLVs 功能，进而缓解 AD 仍是一个巨大挑战。在这项研究中，基于 mLVs 的浅表空间分布，利用光声成像和荧光成像观察评估 mLVs 的结构与功能，并开发相应的光学调控策略调节 mLVs 引流能力，最终实现 AD 相关病理和认知的改善，为神经退行性疾病的干预提供了一种潜在的调控策略。



Name: Sihua Yang 杨思华

Organization: South China Normal University 华南师范大学

Biography:

杨思华，国家优秀青年科学基金获得者、广东特支计划科技创新青年拔尖人才、广东省高等学校优秀青年教师（培养计划）；目前研究领域是显微光声成像技术、光声内窥镜技术及其应用仪器开发；超短脉冲（微波）热弹冲击波治疗技术及其医学应用研究。2016 年获广东特支计划科技创新青年拔尖人才、广东省高等学校优秀青年教师（培养计划）。主持国家科技部“863”青年科学家专项、国家自然科学基金重点项目（合作）、面上项目、广东省自然科学基金重点项目、广东省产学研项目、广州市产学研重大项目等；发表研究论文 120 多篇，代表性论文有 Journal of the American College of Cardiology, Physical Review Letter, Nano Lett, IEEE TMI, Nanophotonics, Small, Theranostics, Optics Letter, Appl Phys Lett 等，H-index 23；主编教材《Biomedical Photoacoustics》1 本；授权国家发明专利 27 项（第一发明人）。在光声成像技术方面曾获中国产学研合作创新奖（2021 年）、广东省百名博士博士后创新人物（2021 年）、教育部高等学校科学研究优秀成果奖二等奖（2013 年）、广东省科学技术奖(发明类)二等奖（2009 年）、美国医学物理学会“Sylvia Sorkin Greenfield Award”奖（2008 年）、中国光学重要成果奖（2008 年）。

Title:

解析组织构型偏振敏感光声矢量吸收矩阵显微术

Deciphering Tissue Configuration in via Polarization-Sensitive Photoacoustic Vectorial Absorption Matrix Microscopy



Name: Lei Xi 奚磊

Organization: Southern University of Science and Technology
南方科技大学

Biography:

奚磊，南方科技大学生物医学工程系教授，博士生导师，主要研究方向为生物医学成像，从事以光声成像技术为核心的多模式、多功能、多参数成像技术在基础和临床应用中的研究。分别于2007年、2010年、2012年获得华中科技大学光信息科学与技术学士学位、美国佛罗里达大学生物医学工程硕士和博士学位。2012年底至2014年11月份在佛罗里达大学继续博士后研究工作。2014年11月加入电子科技大学担任物理电子学院教授、博士生导师，建立了多功能光学影像实验室(www.mfoil.org)。2018年2月入职南方科技大学。迄今共发表SCI论文100余篇。目前，拥有美国授权发明专利1项、中国授权发明专利13项。以项目负责人身份主持国家自然科学基金重点项目、优秀青年基金项目、科技部重点研发课题等。

Title:

高通量光声成像 High-Throughput Photoacoustic Microscopy

Abstract:

本报告将从速度、视场、深度和多模态四个维度介绍课题组在高通量光声成像中的研究工作。



Name: Jiao Li 李娇

Organization: Tianjin University 天津大学

Biography:

李娇, 天津大学, 副教授, 博导, 拥有生物医学工程学博士学位, 自 2007 年起从事生物医学光子学领域研究工作, 主要涉及光学/光声测量系统、先进成像理论及医学应用研究等, 在 *Light: Science & Applications*, *Optica*, *Advanced Photonics* 等国内外著名学术期刊发表论文 50 余篇, 授权发明专利 5 项, 主持国家自然科学基金项目 3 项, 天津市自然科学基金 1 项, 校企合作项目 1 项。曾在德国慕尼黑工业大学和加利福尼亚大学洛杉矶分校进行访学。

Title:

组织光学定量光声成像

Multispectral Quantitative Optoacoustic Imaging of Tissue Optics



Name: Kangwen Yang 杨康文

Organization : University of Shanghai for Science and
Technology 上海理工大学

Biography:

杨康文，上海理工大学副教授，特聘博导，香港大学电气与电子工程系访问学者，上海理工大学志远学者，“乘风计划”获得者。担任中国光学学会第三届生物医学光子学专委会青年委员，先后承担国家自然科学基金面上项目、青年项目，国防科技创新特区项目，中国博士后科学基金面上项目等。国际学术兼职包括 Optics Letters、Optics Express、《中国激光》等期刊的审稿人。研究方向为光纤超快光源及其在生物医学无标记成像方面的应用，包括高功率光纤激光器、光纤飞秒光学频率梳、双色同步飞秒激光器等方面的研究。已发表 SCI 第一作者论文 20 余篇，研究成果发表在 Photonix、Opt. Letters、Opt. Express、IEEE Photon. Technol. Lett. 等光电子学期刊；已授权美国发明专利 2 项，中国发明专利 10 余项。

Title:

高速全谱相干拉曼散射光谱技术

High-Speed Full-Spectrum Coherent Anti-Stokes Raman Spectroscopy



Name: Minbiao Ji 季敏标

Organization: Fudan University 复旦大学

Biography:

季敏标，男，1982 年出生于浙江省台州市。2005 年获北京大学物理系学士；2011 年获美国斯坦福大学物理系博士学位，之后在哈佛大学从事博士后研究（2011-2014），发展相干拉曼成像技术并将其应用到肿瘤的无标记探测。2014 年入职复旦大学物理系担任研究员和博士生导师。2015 年入选中组部青年专家和上海市“青年科技启明星计划”。季敏标的研究方向集中在非线性光谱学在物理、化学和生物医学等交叉学科中的应用，研究课题包括利用新型光谱显微成像技术研究生物医学问题，以及新材料的光电子特性研究等。迄今发表 SCI 论文 60 余篇，包括 Science, Science Translational Medicine, Science Advances, Nature Communications 等。并承担科技部重点研发计划“数字诊疗装备”青年专项、基金委面上项目、上海市科技创新行动计划等多项科研项目。担任中国生物医学光子学专委会常务委员，中国激光杂志社青年编委，上海市物理学会青年工作者委员会副主任等职务。

Title:

受激拉曼病理成像与诊断

Stimulated Raman Histopathology and Diagnosis



Name: Pu Wang 王璞

Organization: Beihang University 北京航空航天大学

Biography:

王璞，北京航空航天大学生物与医学工程学院教授、北京生物医学高精尖中心研究员，博士生导师，入选国家级青年人才项目。本科毕业于复旦大学物理系，2009年至2014年博士就读于普渡大学生物医学工程学院，师从于非线性成像专家程继新教授。长期致力于非线性拉曼显微镜的开发以及在先进材料、单细胞代谢的表征方案，以及光致超声器件在生物医学中的应用。以第一/通讯作者发表在 *Nature Photonics*, *Science Advances*, *Light: Science & Applications*, *Advanced Science*, *Laser & Photonics Reviews*, *Nano Letters* 等顶级期刊，主持国家自然科学基金等多项国家级科研项目。

Title:

泵浦探测显微成像设备以及应用

Pump-Probe Microscopic Imaging: Instrumentation and Application



Name: Liqing Ren 任立庆

Organization: Yulin University 榆林学院

Biography:

任立庆, 男, 中共党员, 现为榆林学院能源工程学院副教授, 硕导, 榆林市高分辨太赫兹振动成像重点实验室主任, 入选第二届“榆溪学者”优秀青年人才计划, 曾以博士后身份加入以色列魏兹曼科学研究所 Yaron Silberberg 院士课题组, 主要从事相干拉曼散射光谱与显微成像相关方面的研究, 主持国家自然科学基金项目、陕西省科技资源共享平台项目、陕西省教育厅青年创新团队项目、榆林市科技局产学研项目等课题, 研发了太赫兹波段第一套高分辨振动谱成像显微系统, 并开发了第一个电子共振相干反斯托克斯拉曼散射系统, 荣获陕西省自然科学优秀学术论文三等奖, 发表高水平科研论文 30 余篇, 申请发明专利 8 件 (已授权 2 件), 指导学生荣获第九届中国国际互联网+大赛全国总决赛铜奖, 指导学生荣获第八届互联网+大赛陕西赛区银奖, 并指导学生荣获 2023 年“挑战杯”陕西赛区二等奖等。

Title:

电子共振相干反斯托克斯拉曼散射光谱与显微术 Electronic-Resonance Coherent Anti-Stokes Raman Scattering Spectroscopy and Microscopy

Abstract:

Advanced optical microscopy techniques, such as fluorescence and vibrational imaging, play a key role in science and technology. Both the sensitivity and the chemical selectivity are important for applications of these methods in biomedical research. However, there are few bioimaging techniques that could offer vibrational sensitivity and selectivity simultaneously. Here, we demonstrate electronic-resonance coherent anti-Stokes Raman scattering (ER-CARS) spectroscopy and microscopy with high sensitivity and high selectivity by using lock-in detection. With this ER-CARS strategy, we observed the low-wavenumber Raman spectra of various infrared dyes in solution at ultralow vibrational frequencies (from ~ 20 to 330 cm^{-1}) using a sharp edge filter and impulsive CARS excitation at low input power. We demonstrate low-frequency ER-CARS imaging of cells stained with infrared dyes using only 200 mW of input power, fundamentally mitigating photobleaching issues. We also show the application of ER-CARS in the detection of nonfluorescent molecules. Finally, we demonstrate the chemically selective capabilities of ER-CARS microscopy by imaging tissues stained with two different infrared dyes. These ER-CARS spectroscopy and microscopy results pave the way toward ultrasensitive Raman imaging of biological systems and present a pathway toward highly multiplexed selective imaging.



Name: Lixue Shi 施立雪

Organization: Fudan University 复旦大学

Biography:

施立雪博士 2014 年于北京大学化学与分子工程学院取得学士学位，获北京大学优秀毕业生；2019 年博士毕业于美国哥伦比亚大学化学院，获哥伦比亚大学优秀博士毕业生 Pegram 奖；2019-2022 年在哥伦比亚大学继续从事博士后工作。于 2022 年 11 月入职复旦大学生物医学研究院担任青年研究员、博士生导师。课题组主要研究方向为基于振动光谱的生物成像技术的开发和应用，致力于将空间组学拓展到蛋白质和代谢分子水平上，为解释复杂生物体系中的基因表达提供新维度。研究成果以第一作者（含并列）在 *Nature Biotechnology*, *Nature Methods*, *Nature Photonics*, *Nature Communications*, *Advanced Science* 等学术期刊上发表重要论文 7 篇，入选麻省理工评论杂志 2022 年亚太区“35 岁以下科技创新 35 人”。

Title:

受激拉曼散射成像技术助力三维空间生物学

Stimulated Raman Scattering Imaging Techniques for 3D Spatial Biology

Abstract:



Name: Hao Sun 孙浩

Organization: Nikon Precision Shanghai Co., Ltd
尼康精机（上海）有限公司

Biography:

2024年毕业于南京医科大学，硕士研究生学历。

现任职于尼康精机（上海）有限公司，医疗健康事业部，解决方案开发课。

Title:

百年光学，求实创造

Abstract:

今年尼康迎来首台显微镜发售 100 周年，尼康与华东师范大学（前身大夏大学）皆拥有百年历史，都承载着光荣传统。在此次华师大主办的超快科学与量子感知国际会议上，尼康将展现自身风采，与各界携手共进。

尼康作为全球知名的光学仪器制造商，拥有深厚的技术底蕴和卓越的创新能力。自创立以来，始终致力于光学技术的研发与应用，为科研、医疗等众多领域提供高品质的产品和服务。

尼康生物显微镜产品线丰富多样，涵盖了从基础教学到高端科研的不同需求。基础款显微镜操作简便，价格亲民，为教育领域提供了优质的教学工具；高端研究级显微镜则具备超高分辨率、出色的成像质量和先进的功能，满足了生命科学前沿研究对微观世界精细观察的严苛要求。

同时，尼康还提供丰富的 OEM 配件，可根据客户的特殊需求进行定制，提升显微镜的性能和适用性。

在解决方案开发业务方面，尼康针对不同行业的具体需求，整合先进技术，提供个性化的解决方案。竭诚为用户提供专业的技术支持和完善的服务。

一百年来，尼康始终坚守对品质的执着追求，在光学显微镜领域不断探索创新。从最初的基础型号到如今的高端智能产品，尼康的每一步发展都体现了对技术的不懈钻研和对用户需求的深刻理解。

未来，尼康将继续秉持求实创造的理念，为全球用户提供更优质的光学显微镜产品和解决方案，推动微观世界观察技术的持续进步。在量子光学等前沿领域碰撞出更多创新火花，实现合作共赢，共同续写辉煌篇章。

Session 11

JAN. 13-14.2025

Exhibition Center Hall C1

Photon Detection and Computational Imaging

光子探测与计算成像





Name: Shixiang Xu 徐世祥

Organization: Shenzhen University 深圳大学

Biography:

Shixiang Xu, a professor of Shenzhen University, completed his PhD in 1998 from Shanghai Institute of Optics and Fine Mechanics, China. Currently, he serves as a member of Laser Professional Committee, high-speed photography Professional Committee of Chinese Optical Society. He was awarded Shanghai Pujiang talent Fund. In 2023, He has gained the First Prize of Shanghai Technical Invention. Up to date, has gained about 20 funds at National, provincial and ministerial-level. He has published more than 190 papers in peer-reviewed journals, such as Nat. Communications, Laser Photon. Rev. et. al., and authorized more than 30 patents. His research interests include ultrashort pulse laser, ultrafast imaging, terahertz optics, and manipulation of light field.

Title:

Mid-Infrared Opa Imaging Pumped by Femtosecond Laser

Abstract:

The underdevelopment of mid-infrared (MIR) components and detectors greatly limit the spatial resolution and sensitivity of MIR imaging. This talk presents some efforts on overcoming these limitations by via non-degenerate optical parametric amplification (OPA) in order for MIR illumination but with visible recording. It includes two main parts. The first actualizes MIR detail enhanced imaging via non-degenerate OPA pumped by a femtosecond vortex pulse. This design renders MIR illumination into a visible image by nonlinear wavelength-conversion, together with a high OPA gain, large spatial bandwidth, and remarkable sensitivity. Our experiments show that the design can realize MIR imaging with a spatial resolution of up to 114-line pairs per millimeter and a two-dimensional spatial bandwidth product of up to 62900, over a spectral region tunable from $2.0 \mu\text{m}$ to $3.0 \mu\text{m}$. Equally important, this setup has simultaneously achieved excellent imaging sensitivity of 25 photons at room temperature. In the second part, in order to maximize the OPA gain and spatial resolution, we induce oblique illumination by total internal reflection with a ZnSe prism in a MIR idler imaging. This arrange allows to correct distortions of type-I phase-matching OPA imaging in both horizontal and vertical directions, while to suppress low-frequent noises by Fourier frequency shift. The experimental results show the SWIR imaging can work with a spatial resolution beyond 228 line-pairs per milli-meter for a spectral range from 2.0 to $2.6 \mu\text{m}$.



Name: Chao Zuo 左超

Organization: Nanjing University of Science and Technology 南京理工大学

Biography:

左超，南京理工大学紫金卓越教授、南京理工大学智能计算成像实验室（SCILab: www.scilaboratory.com）学术带头人、南京理工大学智能计算成像研究院院长、首席科学家。研究方向为计算光学成像与光信息处理技术。发表 SCI 论文 200 余篇，其中 40 余篇论文被选作 *Light*、*Optica* 等期刊封面论文，20 余篇 ESI 高被引/热点论文，论文被引超过 18000 次。教育部长江学者特聘教授，国际光学工程学会/美国光学学会/英国物理学会会士（SPIE/Optica/IOP Fellow），*Photonix*、*Optics Letters*、*Optics and Lasers in Engineering*、*IEEE Transaction on Computational Imaging* 等期刊编辑，连续入选科睿唯安全球高被引科学家。

Title:

深度学习赋能超快结构光三维成像与测量

Abstract:

随着光电信息技术的快速发展，三维成像与传感已成为光学计量和信息光学领域的最重要的研究方向之一；结构光投影技术因其非接触、高分辨、高速和全场自动化等优点，成为目前最具代表性的三维成像技术之一。近年来，随着光电子器件和数字处理单元的飞速发展，人们也随之对条纹投影轮廓术提出了更高的期许——既要“精度高”，又要“速度快”。尽管二者似乎天生就是一对矛盾体，仅采用一幅投影图案实现高精度三维重建一直是结构光 3D 成像的终极目标。本报告会向大家展示深度学习与光学测量的结合将如何为结构光三维成像这一“传统”领域带来新的“生机”。相比较传统方法，深度学习在条纹分析、相位展开、高速测量等方面展现出令人惊叹的性能以及强大的应用潜力。在此基础上，我们发展出一系列基于深度学习的“单帧”高精度无歧义结构光三维成像技术，穷有望填补 3D 成像和 2D 传感之间的速度“鸿沟”，为高速瞬态物体的高精度三维成像开辟新途径。



Name: Weitao Liu 刘伟涛

Organization: National University of Defense Technology 国防科技大学

Biography:

Wei-Tao Liu is now a professor of physics, who received his PhD degree on 2009. He is selected as excellent talent of new century and his thesis was nominated as national excellent thesis. He is a member of committee of experts on computation imaging, CSOE. He is also a member of council of Hunan province physics society. Focused on quantum imaging, quantum measurement, and photonic entanglement, his group published more than 50 papers on peer-reviewed journals such as Phys.Rev.Lett. and Optics. They also achieved the first prize of natural science, by Hunan Province.

Title:

Progress on Practical Ghost Imaging

Abstract:

Based on second-order correlation of light field, ghost imaging provides a novel way for information acquisition. Towards its practical application, we considered several issues, including the conflict between the requirement on a large number of samplings and the limited time for moving objects, the influence by scattering and the atmospheric turbulence. By inventing pseudo-thermal source of high refreshing rate, relaxing the requirement on sampling, updating reconstruction algorithms, the performance of our ghost imaging system is greatly improved.



Name: Yi Xu 徐毅

Organization: Guangdong University of Technology 广东工业大学

Biography:

徐毅，广东工业大学“百人计划”特聘教授，主持国家自然科学基金优秀青年基金等纵向科研项目10余项，在Nature Photonics, Physical Review Letters, Nature Communications等专业学术期刊上发表学术论文90余篇，任中文核心期刊《光学学报》的青年编委。

Title:

透过散射介质的定量光场成像

Abstract:

透过散射介质实现高保真度的光学信息重建具有重要应用。传输矩阵可为光散射系统的输入与输出信息之间建立联系。然而，目前测量传输矩阵和输出端复振幅光场存在实验噪声，尚未有通过逆传输矩阵直接恢复输入波前复振幅信息的相关报告。与该领域基于统计方法和理论近似的经典方法不同，我们精确地测量了散射系统的传输矩阵和输出光场的复振幅，实现了通过毛玻璃和多模光纤的数据并行传输。我们进一步将物理模型与深度学习融合形成自监督的神经网络，实现了透过散射介质的高保真相位成像。与现有传输矩阵和深度学习方法对比，所提出方法的复杂度低、复用维度高、保真率接近完美，相关结果有望拓展应用于各类多入多出光传输系统。



Name: Lingdong Kong 孔令东

Organization : Shanghai Institute of Microsystems and Information Technology, CAS 中国科学院上海微系统与信息技术研究所

Biography:

孔令东，中国科学院上海微系统与信息技术研究所助理 研究员。2022 年在南京大学超导电子学研究所获得博士学位，获 2023 年江苏省优秀博士学位论文；2024 年 7 月起任 助理研究员。研究领域专注于超导纳米结构和器件以及单光 子探测应用。面向光量子信息和极端灵敏光学传感的科技前 沿，发展了超导纳米线条的电热、光谱和结构调控技术，提 出了单根超导纳米线条上直接空间分辨、光谱分辨和光子数 分辨的新方法，实现了多种新型超导单光子探测器。发表 SCI 论文 12 篇，一作/通讯包括 Nature Photonics×2、Advanced Photonics、Nano Letters×2 等。

Title:

基于超导纳米线的单光子成像阵列

Abstract:

单光子的时间和空间探测推动了单光子成像、荧光寿命分析、极限光通 信和量子信息处理的进步。超导纳米线单光子探测器（SNSPD）在效率、抖 动、速度等方面展现了突出的优势。但是，受限于低温环境，大规模的 SNSPD 阵列读出存在困难。现有的读出结构典型地单独利用降维（行列读出）、编 码以及特征复用（时间、频率）的方法，在进一步减低读出复杂度、提升像 素规模上存在挑战。我们结合了降维和特征复用的策略，设计了一种基于时 间-幅度二维特征联合复用的成像器件，仅用两个读出端口，就可以读出 1024 个空间位置。进一步地，通过一维线性阵列的三维电热集成，实现了 321×321 的像素分辨率。该成像器件具有扩展性强、像素读出保真度高的特点。



Name: Labao Zhang 张蜡宝

Organization: Nanjing University 南京大学

Biography:

张蜡宝，南京大学教授、博导，入选教育部青年长江学者、江苏中青年学术带头人、南大青年五四奖章和登峰计划等。张蜡宝教授于 2010 年获南京大学博士学位后留校工作至今，期间多次赴欧洲和日本著名高校从事合作研究；长期专注于超导单光子探测及应用技术研究，攻克了从器件到材料的全部关键技术；以第一或通信作者在 *Nature* 子刊、国家科学评论、*Nano Letters* 等重要期刊发表论文百余篇，获授权发明专利 16 项(含国际专利 2 项)。近年来，主持或参与科技创新 2030 重大项目、国家重大科研仪器研制项目(部委推荐)、国家重点研发计划、国家自然科学基金重点项目等重大科研任务。

Title:

大光敏面高速度超导单光子探测器及应用

Abstract:

超导纳米线单光子探测器(SNSPD)具有灵敏度高、速度快、噪声低等特点。然而，由于纳米线是 SNSPD 器件的核心部件，同时具有光敏元件和电感元件的作用，增加光敏面积不仅会大幅度降低器件成品率，而且会增加器件电感，降低探测速度和时间精度。为了解决这一器件本征矛盾，我们提出了旋转对称的多元器件结构，同时降低了动态电感和片上信号延迟，提升了探测速度和时间精度；开发了晶圆级高质量超导薄膜和微纳米加工工艺，研制出兼容多模光纤耦合的大光敏面高速度高效率器件。同时，通过开发低能隙超导材料和设计新结构，研制 SNSPD 器件在近红外-中红外波段量子效率超过 90%，在长波红外波段量子效率超过 50%。成果应用到月地激光测距、空间碎片探测和近地空间环境探测等重大工程中。



Name: Guangwei Deng 邓光伟

Organization: University of Electronic Science and Technology of China
电子科技大学

Biography:

邓光伟，教授，博导，入选教育部国家青年人才。长期从事量子计算及量子精密测量方面的研究工作，主持科技部重点研发计划青年、自然科学基金重点联合及重大研究计划、科技委 173 重点课题等项目 10 余项，在 PRL、PNAS、Nature 子刊、Science 子刊、Optica 等各类学术期刊发表论文 60 余篇，申请发明专利 10 余项。担任《激光技术》编委、《Chinese Optics Letters》青年编委、《电子科技大学学报》量子信息专栏编委，中国光学学会-光量子科学与技术专业委员会委员和中国计算机学会-量子计算专委会 会常务委员。

Title:

光声量子态探测及应用

Abstract:

基于光机电系统 (Electro-opto-mechanical Systems) 的声学高性能器件在新型声学信息处理、光声通信、光声精密测量等领域具有广泛的应用前景。随着光机电器件的尺寸不断减小，其非线性及量子特性变得愈加显著，这些特性为光、声（机械）、电等物理维度的量子态调控提供了新的研究平台。本报告基于腔光力系统、光机电系统，主要涉及内容有：1) 基于光声相互作用的声学量子态构筑及探测方法；2) 基于光机电系统的机械模式共振耦合、参量耦合、参量锁定，以及基于机械模式节点的集成光声量子器件架构；3) 基于光机电相互作用的新型功能器件，如量子增强的加速度计、陀螺仪等惯性传感器件。



Name: Yanli Shi 史衍丽

Organization: Yunnan University 云南大学

Biography:

史衍丽，女，博士，中共党员，研究员，博士生导师。云南省中青年学术技术带头人，云南省有突出贡献的优秀专业技术人才。中国物理学会女物理工作委员会委员，《红外与激光工程》编委、《红外技术》、《红外与毫米波学报》编委。

Title:

InGaAs/InP Based Short Wavelength Infrared Detectors

Abstract:

InGaAs/InP short-wave infrared detectors are currently the most widely used infrared detector in the range of 0.9-1.7 μ m, which use InGaAs absorb materials matched with the InP substrate lattice, through the design of band structure, high-quality epitaxial material structures can be obtained to made the high performance PIN type, avalanche photodiode (APD) and single-photon avalanche diode (SPAD) photodetectors, these chips have high quantum efficiency and low dark current when operating at room temperature or near room temperature, so InGaAs/InP short-wave infrared detectors are applied to optical fiber communication, spectral detection, process manufacturing, Shortwave infrared imaging, biomedicine, etc.



Name: Hao Li 李浩

Organization : Shanghai Institute of Microsystems and Information
Technology, CAS 中国科学院上海微系统与信息技术研究所

Biography:

长期从事超导单光子探测技术及应用研究，具有丰富的超导 及光电器件研究经验。发明了多层超导纳米线单光子探测器 件，成功实现近极限效率（98%）超导单光子探测器。研制 的高性能器件应用于量子信息、卫星激光测距。合作应用成 果多次创造光纤量子密钥分发和光量子计算世界纪录。作为 项目负责人承担了国家基金委、上海市、中国科学院等科研 任务。已发表学术论文 120 余篇，申请专利 50 项。

Title:

光子数可分辨单光子探测超导单光子探测器

Abstract:

超导纳米线单光子探测器（SSPD）是利用超导纳米线吸收光子后产生的 热点效应实现光子探测的器件，已在量子信息及微弱光检测等领域发挥了重 要作用。本文将介绍基于超导纳米线实现的近极限效率单光子探测器以及最新器 件及应用方面的进展。重点介绍光子数可分辨单光子探测器，在高效率单光 子探测效率的基础上，利用三明治结构超导纳米线、热点调控、空分复用等 技术，实现高效率光子数可分辨单光子探测器。测量结果表明可实现最优单 光子探测效率大于 95%，光子数分辨率大于 30 的单光子探测器。该成果将 为光量子计算、精密测量、单光子雷达等应用提供重要支撑。



Name: Fang Wang 王芳

Organization: Shanghai Institute of Technical Physics, CAS
中国科学院上海技术物理研究所

Biography:

王芳，研究员，博士生导师，国家优秀青年基金获得者。2022 年在中国科学院上海技术物理研究所完成博士后研究工作并留所任职。主要从事航天用红外探测器微弱信号探测、长波红外探测器光电联合调控新机制等方面的研究。以第一、通讯作者在 *Nature Materials*、*Nature Electronics*、*Nature Communications*、*Science Advances* 等期刊发表论文 25 篇，总引用 4000 余次，h 因子 31。承担国家自然科学基金、国家重点研发计划课题、先导专项课题等 10 余项。目前是 *Opto-Electronics Review*、*Journal of Infrared and Millimeter Waves* 等期刊编委。曾获中国科学院“百人计划”B 类人才、上海市巾帼创新未来之星、上海市青年科技启明星计划等奖励。

Title:

微弱信号红外探测器

Abstract:

微弱信号探测一直是光电领域追求的极致灵敏极限，并且不断在量子通信、医疗行业疾病诊断、军事防务检测定位等方面发挥着越来越重要的作用。弱信号的光子能量很小，对于可见光和红外波段，单个光子的能量约为 10-19J，而且不可避免的噪声干扰使得探测更加困难。实现红外微弱信号探测的核心是提高红外探测器的信噪比，其关键就是噪声暗电流抑制和信号光电流提高。本次报告汇报我们通过操控光电联合局域场，促进红外探测器噪声暗电流抑制和信号光电流提高，进而实现高灵敏探测需求。



Name: Zhiyuan Zhou 周志远

Organization: University of Science and Technology of China
中国科学院大学

Biography:

周志远，中国科大物理学院副教授，博士生导师。长期从事量子非线性光学研究，至今以第一作者或通信作者在国内外期刊上发表论文 70 余篇。Google Scholar 引用 3000 余次；授权发明专利 4 项。在国内外重要学术会议做口头报告 10 余次，主要获奖包括：中国光学学会光学科技一等奖、安徽省自然科学奖一等奖。受邀与国内外非线性光学与量子光学同行共同撰写 2 篇 roadmap 综述论文 2 篇。担任《量子电子学报》和《Chip》期刊青年编委。

Title:

量子频谱迁移中红外探测研究进展

Abstract:

中红外波段近些年逐渐成为研究的焦点和热点领域，其在物质分子鉴定和检测、自由空间光通信和远距离目标识别和探测等方面应用广泛。尽管近红外波段光场的产生与探测技术发展已相对成熟，但中红外波段光场制备与探测因受限于材料工艺和探测器技术，发展相对滞后。通过量子频谱迁移探测技术将中红外光场频谱迁移到硅探测器的探测波段可以有效解决中红外波段高灵敏的探测问题。本报告主要介绍我们基于量子频谱迁移探测实现中红外波段光场的相干和非相干成像、通过级联二阶非线性过程在中红外波段观察到合成四波混频现象、基于该技术实现中红外单光子的探测，并用于制备和表征了中红外纠缠光子，以及光子间的 HOM 干涉，为中红外波段量子光学和量子分子光谱的发展奠定了重要的基础。



Name: Yaning Li 李雅宁

Organization: Beijing Institute of Space Mechanics and Electricity, China
Academy of Space Technology 中国空间技术研究院北京空间机电研究所

Biography:

李雅宁：北京大学未来技术学院博士，中国空间技术研究院 北京空间机电研究所工程师，主要从事结构光照明超分辨显微成像技术，微光遥感成像技术，超大口径望远镜技术等研究。

Title:

超宽动态范围微光遥感成像与目标检测

Ultra-Wide Dynamic Range Imaging and Target Detection for Low-Light Remote Sensing

Abstract:

In response to the unique physical characteristics of the twilight-night low light remote sensing imaging conditions, such as strong stray light interference caused by artificial light sources at night or the reduction of natural reflection light from the ground due to Earth's atmospheric radiation, both of which can cause an increase in the scene dynamic range and weaken the contrast of effective signals. Effective imaging of low-brightness natural light sources (moonlight or starlight) at night requires that the space remote sensing system has the ability to acquire ultra-wide dynamic range ($\sim 100\text{dB}$) of light field information. The effective number of quantization bits of high-performance image sensors is generally no greater than 14bit, which means that a single imaging cannot meet the above requirements. At the same time, conventional target detection and recognition networks are basically based on 8bit images and are not applicable to ultra-wide dynamic range data. This project proposes a method of ultra-wide dynamic range continuous light field acquisition and inversion based on high-performance planar frame imaging, by establishing the Remote Sensing Ultra-wide Dynamic Range Image Reconstruction Network (RSUDR), and conducting research on the fusion of low dynamic range image sequences with multi-exposure parameters, to achieve the missing information supplementation of under/overexposed regions in low-light scene images. Our main idea is to inject visual attention into multi-scale convolutional networks, in order to obtain region information from images respectively. On the other hand, facing the detection difficulty of low-contrast targets in ultra-wide dynamic range, a method of dark and small target detection and recognition in ultra wide dynamic images based on YOLOv8 is proposed, by pre-processing the original image with dynamic range slicing to extract low emissivity target and region information, achieving the enhancement of low-contrast targets and separation of background information. This paper simulates the imaging chain link and atmospheric model to construct a simulated data set for daytime images and conducts the setup and shooting of high dynamic range low-light actual scenes to verify the high dynamic range image reconstruction and target detection and recognition method based on multi-exposure image sequences, achieving the realization of ultra-wide dynamic range continuous light field information non destructive inversion and target detection rate exceeding 96%



Name: Zhenwu Nie 聂镇武

Organization: National University of Defense Technology 国防科技大学

Biography:

聂镇武，国防科技大学硕博连读研究生。研究领域主要为 散射成像与关联成像。发表 SCI 论文 1 篇，获第三届国际 计算成像会议优秀口头报告。

Title:

Experiment Comparison on Image Sharpness Metrics in Feed-Back Wavefront Shaping

Abstract:

Imaging through scattering media has been fully developed in recent years. Wavefront shaping has received wide attention in the fields of biomedical imaging, optogenetics, and optical communication with its advantage in light field control. Recently, image-guided wavefront shaping has changed the invasive imaging way compared with the traditional wavefront shaping technique. However, with the increasing complexity of the imaging scene, the selection of suitable image evaluation metrics greatly affects the quality of images. In this presentation, for the commonly used image evaluation metrics, the theoretical derivation and experimental verification of different metrics in the noisy imaging conditions were analyzed. We concluded that the image gradient metric has the best convergence and the image variance metric has the strongest noise-resistance. With the help of the image gradient metric, we have realized the imaging through the scattering medium across the 9-fold memory effect range by choosing the ROI appropriately. In addition, we also realized image reconstruction under extremely low SNR where the noise is stronger than the signal up to 6dB.

Session 12

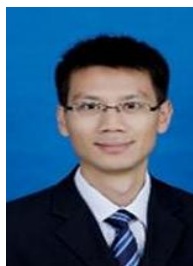
JAN. 13-14.2025

Exhibition Center Hall C1

Infrared Photonics and Devices

红外光子学与器件





Name: Qiang Zhao 赵强

Organization: Nanjing University of Posts and Telecommunications
南京邮电大学

Biography:

赵强，南京邮电大学副校长，电子与光学工程学院、柔性电子（未来技术）学院院长，有机电子与信息显示国家重点实验室副主任、教授、博导，国家杰出青年科学基金获得者、国家“万人计划”青年拔尖人才、教育部“长江学者奖励计划”青年学者、全国高校黄大年式教师团队负责人，主 报告人简 介 要从事有机与柔性光电子领域研究。近年来在 Nat. Commun.、Sci. Adv.、Adv. Mater.等期刊发表高质量论文 100 余篇，研究成果多次被 Nature、Nature Asia、Chemical & Engineering News、Phys.org、Science Daily 等作为研究亮点 进行专题报道，获国家自然科学奖二等奖、教育部自然科学 奖一等奖、江苏省科学技术奖一等奖、江苏省青年科技杰出 贡献奖等。电子邮箱：iamqzhao@njupt.edu.cn

Title:

柔性智能感知材料与器件

Abstract:

面向人民生命健康是引领国家科技事业发展的新指针之一，而柔性智能 感知材料与器件作为近年来快速发展的前沿领域，展现出巨大的应用潜力。 集智能传感、信号读取和通信传输等多重功能于一体的柔性智能感知器件， 是实现柔性传感与探测的重要保障。然而，当前该领域仍面临诸多挑战，如 与人体共形贴合度不足、功能单一化以及集成度低等问题，难以满足智慧医 疗对人体多种生理信号长期、实时、稳定监测的迫切需求。本报告将重点 阐 述我们在柔性智能感知材料与器件领域的最新研究成果。具体而言，我们针 对柔性半导体在“分子结构设计-材料物性调控-制备工艺开发-器件功能耦合” 中的关键科学问题与技术难题，从分子设计的源头入手，系统地建立了柔性 半导体光学和电学性质的调控方法，发展了适应柔性半导体材料的高精密印 刷电子技术，成功构建了柔性 x 射线探测器、多功能传感器及射频核心元器 件，探索了传感与探测-信号读取-通信传输一体化的柔性智能感 知器件在长 期、实时、远程健康监测等方面的应用。



Name: Huihui Lu 卢惠辉

Organization: Jinan University 暨南大学

Biography:

卢惠辉，暨南大学光电工程系主任、教授、博士生导师，暨南大学电子研究所所长，国家级一流本科专业（光电信息科学与工程）负责人。2012年博士毕业于法国国家科学研究中心。从事光波导集成技术与微纳光电器件的相关研究，在 *Light*, *Nano Letters*, *Laser Photonics & Reviews* 等权威期刊发表高水平代表论文 60 余篇。主持国家级科研项目 8 项，获批广东省“特支计划”和省杰出青年基金。

Title:

微纳结构铌酸锂薄膜赋能的光子器件

Abstract:

铌酸锂薄膜光子器件凭借优异的光学性能，在光电器件和集成中日益重要，本报告通过研究微纳结构铌酸锂薄膜来增强光子器件的性能或补充其性能，研究集中于电光调制、电场传感、可调谐光子器件和光电探测。通过光子晶体波导提升电光调制效率、微纳结构提升电场探测的灵敏度、通过准连续束缚态结构提升可调光子器件的性能、通过纳米结构的二维材料于铌酸锂的异质集成构建光电探测功能，实现宽波段、多功能的高性能探测。



Name: Yuanmu Yang 杨原牧

Organization: Tsinghua University 清华大学

Biography:

杨原牧，清华大学精密仪器系长聘副教授、博士生导师。2011年获天津大学学士学位，2015年获美国范德堡大学博士学位。2015-2017年，在美国Sandia国家实验室从事博士后研究。长期围绕新型平面超构光学元件开展研究。作为负责人，先后主持了国家自然科学基金面上项目、重点项目、北京市科技计划等。在Nature Photonics、Nature Physics等高水平期刊共发表论文50余篇，谷歌学术引用6000余次，入选爱思唯尔“中国高被引学者”。担任Advanced Devices & Instrumentation、Advanced Photonics等6本国内外高水平期刊编委或青年编委，40余次在SPIE Photonics West等国际会议做邀请报告。获得中国仪器仪表学会“金国藩青年学子奖”、福布斯中国（科学领域）“30岁以下30人”、清华大学“学术新人奖”等奖励荣誉。

Title:

基于超构表面的多维成像与精密测量

Abstract:

传统相机仅能感知目标场景的光强，与此同时会丢失掉场景偏振、光谱、相位等重要信息。为了获取多维光场信息，通常需要利用更加笨重且昂贵的光学仪器。超表面是一种具有亚波长特征尺寸的新型平面光学元件。它有望突破传统光学元件在光场调控精度和维度上的局限，对构筑下一代小型化、多功能光学仪器具有潜在的重要意义。近年来，报告人提出利用超表面替代传统相机镜头或滤光片，构造对场景偏振、光谱、深度敏感的成像系统点扩散函数或滤光片穆勒矩阵，将多维光场信息编码在相机传感器上，结合特定计算成像算法恢复，实现多维光场感知。申请人拟汇报基于超表面的单目偏振深度四维相机、快照式复振幅光场相机、片上光谱椭圆偏仪等相关工作。

Name: Yi Zou 邹毅

Organization: ShanghaiTech University 上海科技大学

Biography:

邹毅，上海科技大学研究员，博士生导师，独立课题组负责人，2014年毕业于美国德克萨斯大学奥斯汀分校电子与计算机工程系，获博士学位。2017年7月起任职于上海科技大学信息科学与技术学院。主要从事集成光子学的研究，在硅基中红外和近红外传感领域取得了多项重要研究成果，目前已在 *Laser & Photonics Reviews*, *Applied Physics Reviews*, *Nano Letters*, *ACS Photonics*, *Photonics Research*, *Physical Review Letters*, *Advanced Materials* 等光学类一流期刊发表学术论文 70 余篇，获得 2300 余次引用。担任 *Photonics West* 会议技术委员会成员，以及基金委、科技部、欧洲地区自然科学基金和香港大学教育资助项目评审工作。

Title:

片上光波耦合调控

Abstract:

硅基光子学因其具有低损耗，高集成度，低成本，且与微电子芯片行业的 CMOS 制备工艺兼容的特性而备受学界和业界的关注。大量的相关研究陆续展开，其工作光谱范围从近红外一直延伸到中红外区间，涵盖了从通信到传感到计算的一系列应用。在片上器件中，具有半波长间距、低串扰、宽带宽以及灵活路由能力的高密度波导阵列对于集成光子学至关重要。然而，由于介质波导的模式约束较弱，以及密集波导间的相互作用增强，实现这一性能具有显著挑战。在本次报告中，我将主要介绍我们课题组在提升硅基光子器件的集成度方面的研究进展。我们通过形态工程方法，在硅平台上展示了由 64 个波导组成的半波长间距高密度波导阵列，在 1480 nm 至 1550 nm 波段实现了 -30 dB 的串扰抑制。该波导阵列在 90 度弯曲时几乎没有附加插入损耗。这种方法能够灵活地路由大规模高密度波导阵列，大幅降低芯片面积，从而实现高密度光子集成电路。同时，我也将介绍该技术在超大视场片上集成光学相控阵（OPA）以及超高密度空分复用（SDM）方面的应用。



Name: Hongtao Lin 林宏焘

Organization: Zhejiang University 浙江大学

Biography:

林宏焘，博士，浙江大学电子工程系副系主任，国家高层次人才青年项目获得者和浙江省特聘专家。林宏焘研究员 2010 年于中国科学技术大学本科毕业，此后于 2015 年在美国特拉华大学获得材料科学与工程博士学位。2015 年到 2018 年期间，曾在美国麻省理工学院材料系进行博士后研究。他在一些高影响力期刊上已发表超过 90 余篇论文，其中包括 *Nature Photonics*, *Light: Science & Applications*, *Optica*, *Nature Communication* 等刊物。他的课题组正致力于研究硫基光电子及硅基异质光子集成技术的研究。谷歌学术引用超过 6,500 余次，H 指数高达 40。成果入选美国光学学会旗舰期刊 *OPN* 所评 “Optics in 2018”，“2023 中国光学十大进展”（应用研究类）等。*Frontier of Optoelectronics* 及《红外与激光工程》青年编委会成员。

Title:

中波红外硫基/硅基集成光电子器件

Abstract:

中波红外波段（2-20 微米）作为战略性频段，在物质检测、红外成像及自由空间光通信等领域被广泛关注。利用半导体技术发展红外光电子器件及芯片将极大降低系统体积、功耗及成本，将作为一项变革性技术在传感、通信领域具有重大应用前景。在这个报告中，我们将简要介绍下我们在硫基-硅基光电子器件在中波红外物质传感，有源器件集成，以及超材料红外透镜的一些进展。



Name: Fangfang Wang 王芳芳

Organization: Shanghai Institute of Technical Physics, CAS 中国科学院上海技术物理研究所

Biography:

本人主要从事 II 类超晶格红外探测器的研制工作。研究方向包括超晶格红外探测材料性能与器件性能相关性研究、器件制备工艺与器件性能相关性研究、基于超晶格材料的量子结构高温红外探测器研制、基于光子结构的多维集成红外探测器研制等。

Title:

高温及偏振集成超晶格红外探测器

Abstract:

随着科学技术的不断进步，红外/光电探测器技术的发展日新月异，更新换代从未停止过。近年来，为进一步提高系统应用的空间、时间、能量、光谱的分辨率，红外光电探测器在现有的三代红外探测器的基础上，继续挑战红外辐射强度的探测能力极限，向着超大规模、甚长波、多色、数字化、APD、高温等方向发展。同时，人工微结构、人工智能和神经形态计算等技术研究逐渐兴起，推进了红外辐射光学调控、片上智能化与传统红外光电探测器的芯片级集成发展。许多极具前沿前瞻性的新概念、新技术、新器件，如雨后春笋般地应运而生。

本文主要报道了基于 InAs/GaSb II 类超晶格材料的高温带间级联红外探测器和偏振集成红外探测器的研究。在高温带间级联超晶格红外探测器研究方面，我们主要通过级数和吸收区厚度等结构参数的优化来提高探测器的探测率，通过分子束外延技术生长了不同级数的带间级联结构的红外探测器材料，通过掩膜生长、光刻、刻蚀等工艺完成了带间级联结构超晶格红外探测器的制备。测试结果表明，对于一级和三级带间级联探测器，从 220 K 温度开始器件的响应率都开始降低，而十级器件由于吸收区厚度较短，在高温下响应率基本不变，相比于一级器件，十级器件的响应率受扩散长度的影响较小。在 300 K 下，一级、三级、五级和十级正入射器件的 ROA 分别为 0.018、0.047、0.099、0.29 $\Omega \cdot \text{cm}^2$ ，探测率分别为 4.5×10^8 、 4.9×10^8 、 7.6×10^8 、 $8.0 \times 10^8 \text{ cm} \cdot \text{Hz}^{1/2}/\text{W}$ 。我们研制的中心距 30 μm 、面阵规模 320×256 和中心距 15 μm 、面阵规模 640×512 的带间级联结构超晶格红外探测器在 150 K 下均获得了清晰成像。在偏振集成红外探测器研究方面，我们建立了整体结构设计仿真模型，突破了高消光比金属偏振光栅制备、偏振片与探测器集成等关键工艺技术，实现了长波线列偏振集成探测器件消光比大于 50:1，并完成了成像测试。初步实现了分焦平面器件制备，消光比大于 10:1。



Name: Pengfei Wang 王鹏飞

Organization: Northeast Normal University/Harbin Engineering University
东北师范大学/哈尔滨工程大学

Biography:

东北师范大学物理学院 特聘教授，美国光学学会会士（Optica Fellow），主要从事中红外光纤激光器、红外特种光学玻璃材料和海洋传感光学器件等领域研究。在 *Nature Communications* 等国际学术期刊和重要国际会议上发表学术论文 300 余篇，其中被 SCI 收录 200 余篇，文章累计被引用 7000 余次，H-index=43。爱尔兰都柏林理工大学荣誉教授。主持国家自然科学基金委杰青、重点项目，科技部重点研发计划等国家级项目。Elsevier 期刊 *Infrared Physics & Technology* 副编辑、*Journal of Lightwave Technology* 副编辑、*Applied Optics* 专栏编委、*Scientific Reports* 和 Springer 期刊 *Optical and Quantum Electronics* 编委，《光学学报》网络版编委、《中国激光》、《红外与激光工程》青年编委。中国硅酸盐学会特种玻璃分会理事、中国光学学会纤维光学与光子集成专业委员会委员、全国光学和光子学标准化技术委员会委员，工信部电子科技委委员。

Title:

氟化物玻璃中红外光纤激光器最新研究进展

Abstract:

3-5 μm 中红外波段在环境监测、灾害预警、资源勘探、国民健康等领域展现出巨大潜力和旺盛需求。基于稀土掺杂氟化物光纤的中红外光纤激光器，因结构紧凑、散热优异、光束质量高而成为研究热点。近年来，氟化物玻璃材料在成分优化、制备工艺及性能表征方面取得显著进展，为高功率稳定输出和远距离传输等应用奠定了坚实基础。本报告将重点介绍汇报人团队自主研发的新型稀土掺杂氟化物玻璃材料及其在构建高性能中红外光纤激光器中的应用，涵盖激光器的设计原理、性能优化及测试结果等内容。同时还将展望中红外光纤激光技术未来在更高功率、更宽光谱范围及更紧凑系统设计等方面的发展前景，并讨论其在医疗诊断、材料加工、安全监控和空间通信等领域的潜在应用价值。



Name: Guanhai Li 李冠海

Organization: Shanghai Institute of Technical Physics, CAS
中国科学院上海技术物理研究所

Biography:

李冠海，研究员，博士生导师。中国科学院上海技术物理研究所红外物理国家重点实验室（红外科学与技术重点实验室）学术带头人。国家优秀青年基金获得者、中国科学院青年创新促进会优秀会员、浙江省杰青，入选上海市青年科技启明星计划、上海市青年科技英才扬帆计划等。主要围绕超表面的红外光场调控及其光电探测变革应用开展工作，以第一或通讯作者在 Science Advances、Nature Communications、Light-Science & Applications、Advanced Materials、Nano Letters 等国际期刊发表论文 50 余篇。担任 英国物理协会期刊 Journal of Physics D: Applied Physics 顾问委员会委员、Frontiers in Photonics 副主编、Symmetry 期刊客座编辑和中国光学工程学会光与物质相互作用委员会委员等。

Title:

Infrared Metasurface Dispersion Light Field Control and Its Detection Enhancement

Abstract:

传统的极化多路复用受限于极化状态的固有正交性，限制了信道多样性和实际应用。我们提出了一种新型的非正交极化基多路复用技术，利用元原子内空间变化的本征极化状态，创建了全局非正交信道，且具有最小串扰。这种方法使得在三个非正交信道上生成自由矢量全息图成为可能，实现在极低能量泄漏的情况下获得完整的自由度。此外，它将琼斯矩阵的维度扩展到前所未有的 10×10 规模。通过将可控本征极化工程与矢量衍射神经网络相结合，我们在这些扩展的信道上实验实现了 55 种复杂的全息图样式。基于检测过程中对光电探测器灵敏度的需要，我们制备了一种高增益低噪声 APD。这里我们选择双极 2D WSe₂ 作为 APD 的沟道材料，并精心制作具有最佳匹配功函数的 Pt/WSe₂/Ni APD，以解决传统 APD 高增益，低噪声不可兼得难题。器件在室温下可达到 5×10^5 的增益，NEP 低至 $8.09 \text{ fW}/\text{Hz}^{0.5}$ 。这一突破为全息，量子加密等技术的进步铺平了道路。



Name: Menglu Chen 陈梦璐

Organization: Beijing Institute of Technology 北京理工大学

Biography:

陈梦璐，北京理工大学光电学院教授/博导。入选国家级青年人才计划、北京市科技新星、中国科协“青年人才托举工程”等，获省级技术发明一等奖（3/10，2024）、国际先进材料协会科学家奖 IAAM Scientist Medal（1/1，2022）、美国芝加哥大学杰出研究奖 Yodh Prize（1/1，2019）等奖项。博士就读于美国芝加哥大学物理系、本科就读于中国科学技术大学少年班学院。长期从事新型红外光电探测技术及低维材料物理性质的研究，在室温运行红外量子点光电探测器、带内跃迁窄带红外量子点探测器、长波及甚长波量子点红外探测器等方面以第一或通讯作者发表包括 *Nature Materials*, *Light: Science & Applications* 等在内的 SCI 期刊 30 余篇。

Title:

量子点红外探测与成像技术

Abstract:

红外光电传感器能够全天时工作，在目标探测、卫星导航、智能交通、农业监测等国防和民用领域都有着非常重要应用。量子点是一类尺寸在纳米级别的半导体材料。基于其独特的量子限域效应，人们可以通过改变量子点的尺寸，可以精确地调节其带隙，从而使其在不同的红外波段具有响应。2023 年诺贝尔化学奖授予蒙吉·巴文迪、路易斯·布鲁斯和阿列克谢·叶基莫夫三位科学家，以表彰他们在发现和合成量子点方面的贡献。目前，量子点材料的吸收波段虽然已覆盖紫外、可见光、红外甚至太赫兹，但其探测器应用仍主要局限于短波和中波红外。本次报告将讨论量子点红外探测的部分进展和挑战。



Name: Zhijun Ning 宁志军

Organization: ShanghaiTech University 上海科技大学

Biography:

宁志军，课题组长/博士生导师，中组部万人计划（2020年），科技部中青年科技创新领军人才，上海市青年科技精英，上海市优秀学术带头人，获得霍英东教育基金会高等院校青年科学奖，上海市自然科学一等奖（排名第四）。共发表文章 130 余篇，以通讯作者或第一作者在 Nature, Nature Electronics, Nature Energy, Nature Photonics, JACS, Science Advance, Nature Communication, Joule, Advanced Materials 等期刊发表文章 60 多篇。发展了多项重要的纳米结构、表面调控方法和器件结构，获得了广泛应用，Web of Science 引次数超过 16000 次，多次入选科睿唯安交叉学科领域的高被引科学家和 Scopus 高被引学者。受邀在 Gordon 会议、MRS 会议、MATSUS 会议、ACS 会议、ECS 会议多次做邀请报告。目前担任 Cell Reports Physic Science 顾问编委，ACS Material Letters 青年顾问编委，Science China Chemistry 和 Science Bulletin 的青年编委。

Title:

基于胶体量子点的红外上转换探测器

Abstract:

短波红外探测与成像在遥感、夜视、生物医学成像、自动驾驶、农产品检测、工业检测等领域有广泛的应用，而硫化铅胶体量子点材料具有红外吸收系数高、带隙可调、成本低、可溶液法处理、易于集成等优点，在制备高性能、低成本红外光电探测器等方面有突出的应用前景。这里将介绍在基于硫化铅胶体量子点的红外光电探测器和成像器件的一些工作。具体包括：1.传统红外成像方式需要将探测器像素和读出电路一对一的倒装键合，工艺复杂，像素规模提升困难。通过将红外探测器和可见光发光二极管结合，用溶液法制备了可以将红外光子转变为可见光子的红外上转换器件，该器件可以直接用来成像，光子转换效率达到了 6.5%；2.采用钙钛矿材料作为发光层，通过调节可见发光层与红外吸收层之间的能带势垒，增加了空穴传输能力，提高了红外光子转换效率。同时制备了大面积红外上转换器件，等效像素规模达到了 700 万，分辨率 11 微米；3.展示了一种量子点多级级联光探测器，通过对掺杂、带隙、器件结构的精确控制，提高了胶体量子点的增益带宽积。



Name: Hairun Guo 郭海润

Organization: Shanghai University 上海大学

Biography:

郭海润，教授，博士毕业于丹麦技术大学，光子学专业，后加入瑞士洛桑联邦理工学院，开展博士后研究工作。回国后加入上海大学特种光纤与光接入网重点实验室，聚焦光子集成的光学频率梳技术与应用，至今发表 Nature Photonics, Nature Physics 等学术论文 50 余篇，参加国际学术会议作邀请报告 30 余次，并兼任多个光学领域期刊的审稿人。

Title:

跨波段片上光学频率梳技术及应用

Abstract:

光子集成片上光频梳技术为精密时间-频率测量提供了全新的工具，其不仅具有可集成的巨大优势，性能也随着微纳器件的尺度发生了颠覆性的改变，从而能够在光通信、激光精密测量等领域带来新的应用。我们聚焦在氮化硅光子集成平台上发展片上光频梳技术，包括基于高品质因子的微腔光频梳和基于超连续谱的相干光频梳技术。这两种技术在光频梳性能方面可以相互弥补，由此产生不同的应用。本次报告中，我们将介绍团队近期在片上光频梳方向的研究进展，包括实现了多波段的微腔光频梳产生，以及基于微腔光频梳的应用案例。在片上相干超连续谱频率梳技术方面，我们将介绍一种基于布拉格色散的局部光谱调控机制，以及围绕超连续谱频率梳开展的激光频率传递与光场测量应用技术。



Name: Xiang Cheng 程祥

Organization: Huazhong University of Science and Technology
华中科技大学

Biography:

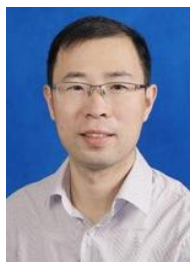
程祥，华中科技大学武汉光电国家研究中心教授。2014 年本科毕业于华中科技大学，2019 年于北京邮电大学获得工学博士学位，2019 年至 2024 年在加州大学洛杉矶分校从事博士后研究工作。2024 年入选国家高层次青年人才（海外）。研究工作聚焦于高维量子纠缠与片上量子信息处理，研究成果以第一及通信作者发表于 *Nature Photonics*, *Communications Physics*, *npj Quantum Information* 等高水平期刊。

Title:

集成光量子信息处理

Abstract:

高维度、多自由度的量子系统可以有效提高量子信道容量和信息容错能力，有利于推动未来量子互联网的发展。我们总结了近期在量子信息处理方面的研究进展，重点展示了基于硅光子平台的芯片级双量子比特门以及双光子频率梳中的高维时间-频率纠缠的实现。我们在硅绝缘体平台上实现了首个偏振-空间动量量子 SWAP 门，具有高保真度与量子相干性。该量子逻辑门可作为理想的量子接口用于连接不同自由度的量子系统，构建芯片量子系统之间都得光量子互联。此外，我们在双光子频率梳中实现了希尔伯特空间维度高达 648 的高维时间-频率纠缠，为密集安全信息处理提供了重要的基础资源。针对实际应用，我们还提出了单滤波方案，有效提升了高维纠缠态的分发速率，并原理性验证了高维量子密钥分发。我们的研究旨在充分挖掘高维和多自由度光子系统的潜力，推动构建高速率、资源高效的量子互联网。



Name: Jun Wang 王军

Organization: University of Electronic Science and Technology of China
电子科技大学

Biography:

王军，电子科技大学教授、博导，电子科技大学光电科学与工程学院副院长、光电探测与传感集成教育部重点实验室副主任。主要从事室温红外探测技术研究，承担完成国家重大专项、自然科学基金、重点研发计划课题等，获基金委国家优秀青年基金、教育部新世纪优秀人才计划资助。在 *Advanced Materials*、*Light Science & Application*、*Laser & Photonics Reviews*、*ACS Nano* 等期刊发表论文 100 余篇，研究成果获得国家、工信部和教育部技术发明奖励。兼任中国光学工程学会理事、《红外与激光工程》、《光学学报(网络版)》、《功能材料与器件学报》等期刊编委。

Title:

二维-三维狄拉克材料探测器技术研究

Abstract:

红外探测器在夜视侦察、生物医学、环境监测等军民领域有广泛应用，新型窄带隙/零带隙材料具有优异电光特性适用于红外探测领域。本研究将二维石墨烯材料与有机异质结相结合，利用有机异质层辅助吸收提高探测器性能，并且通过栅极调控实现探测器功能与应用拓展。合成窄带隙狄拉克半金属材料并构筑异质结器件结构，有效抑制探测器暗电流提升红外探测器性能，基于该材料制备的探测器件实现了无接触人机交互功能演示。



Name: Ziteng Zhang 张孜腾

Organization: Shanghai Institute of Technical Physics, CAS
中国科学院上海技术物理研究所

Biography:

I am a PhD student at the Shanghai Institute of Technical Physics, Chinese Academy of Sciences. My current research focuses on the growth of HgTe quantum wells and HgCdTe thin film materials, as well as the study of transport properties under low-temperature and high magnetic field conditions.

Title:

Magnetic Transport Properties of Mbe Growth Hgte Quantum Wells

Abstract:

HgTe quantum wells (QWs) are two-dimensional semiconductor systems that change their properties at the critical thickness d_c , corresponding to the band inversion and topological phase transition. The quantum spin Hall effect (QSH) is found in HgTe QW when the well width $d > 6.5\text{nm}$. [1] which caused great concern in the physics community. Meanwhile the MBE-grown HgTe QWs show a potential as a new generation of infrared and THz detectors. [2] We growth high quality HgTe/HgCdTe quantum Wells on GaAs(211) substrate. Using micro/nanofabrication technologies, we make these materials into Hall-bar structures and devices controlled by gate voltage. Subsequently, Clear S-dH oscillations and quantum Hall platforms were observed in low-temperature magnetotransport experiments, confirming the excellent quantum properties of the samples. Further, through angle-dependent magnetotransport experiments, it is obvious that there is no magnetic oscillation at 90° , and the properties of different angles are better symmetric according to 90° . At $0-45^\circ$, the magnetoresistance at the maximum magnetic field gradually increases, and then decreases at $45^\circ-90^\circ$. In addition, through light modulated magnetic transport, we find an interesting phenomenon that the light before the 900nm wavelength increases the sample reluctance. Illumination after 1000nm reduces the magnetoresistance of the sample, and makes the longitudinal resistance approach 0 with the Landau filling factor is 1. By tuning the gate voltage, we achieved effective control over the Fermi level in the system, providing an experimental foundation for the exploration of quantum state manipulation mechanisms in the future.



Name: Rongsheng Chen 陈荣胜

Organization: Shanghai Institute of Technical Physics, CAS
中国科学院上海技术物理研究所

Biography:

上海技术物理研究所在读博士研究生从事中红外光学超表面相关研究文章发表于
Advanced Science

Title:

基于相干 δ 函数展开实现摩尔纹抑制的多功能光计算超表面

Abstract:

掌握动量空间内的空间频率操控技术是至关重要的，但同时也极具挑战性，特别是在减少对图像质量有显著负面影响的摩尔纹方面。传统方法通常需要在空间分辨率上做出妥协，或者无法彻底消除不需要的频率，并且常常伴随着复杂的后处理需求。本文介绍了一种通过全硅超表面实现的新颖相干 δ -函数展开技术，该技术通过对选定的空间频率进行精细的 k 空间振幅和相位调制，提供了无与伦比的协同控制能力。这种方法超越了传统的全局方法，利用多个 δ -函数组成的复杂集合，实现了空间频率的整体操控。本研究引入的周期性还使得超表面能够在保持高能量利用率的同时实现无限的空间拼接扩展。此方法在仔细去除局部摩尔频率的同时，还在光学领域内实现了包括混合偏微分和噪声抑制在内的多种高级光学功能。这项工作标志着光学操控领域的重要进步，提供了一个可行且可扩展的替代方案，以简化复杂的电子后处理。通过本研究，不仅解决了光学物理中长期存在的挑战，也为光电探测和光学处理技术的研究与应用开辟了新的途径。

Session 13

JAN. 13-14.2025

Exhibition Center Hall C1

Light Field Manipulation and Applications

光场调控及应用





Name: Qiong-hua Wang 王琼华

Organization: Beihang University 北京航空航天大学

Biography:

Qiong-Hua Wang is a professor of optics at Beihang University. She was a professor at Sichuan University from 2004 to 2018. She was a research scientist at the School of Optics/CREOL at the University of Central Florida from 2001 to 2004. She was a faculty at the University of Electronic Science and Technology of China (UESTC) from 1995 to 2001. She received B. S., M. S. and Ph. D. degrees from UESTC in 1992, 1995 and 2001, respectively. She published more than 350 papers cited by science citation index and authored 3 books. She holds about 200 U. S. and Chinese patents. She is fellow of SID, OPTICA, SPIE, COS and CSOE. Her research interests include display and imaging technologies.

Title:

Light field 3D display with high performance

Abstract:

Light field 3D display based on integral imaging is an important 3D display. This talk will give an overview of light field 3D display technology, and introduce in detail the desktop light field 3D display and the high-resolution light field 3D display based on integral imaging developed by our team. The former achieves good 3D display effect with 360° horizontal view angle, and the latter achieves good 3D display effect with high resolution. The structure, principle and performance of the light field 3D displays will be given. Finally, the development trend of the light field 3D display is prospected.



Name: Xuewen Chen 陈学文

Organization: Huazhong University of Science and Technology
华中科技大学

Biography:

陈学文，华中科技大学物理学院教授。2008年获浙江大学博士，曾任苏黎世联邦理工博士后、马普光学所研究科学家、斯坦福大学 Ginzton 实验室访问学者，2014年入选国家高层次青年人才计划，同年入职华中科技大学。陈学文教授致力于深纳米尺度光学相关的基础与应用研究，取得了一系列原创性成果，以第一或通讯作者发表了包括 *Nature Photonics*、*Phys. Rev. Lett.*、*Nat. Commun.* 等等期刊论文 60 余篇，主持国家自然科学基金重点项目、重大研究计划培育项目、面上项目等基金项目，是中国光学工程学会期刊 *Photonix* 的高级编委和美国光学学会传统期刊 *JOSA B* 的主题编委。

Title:

深纳米物质与局域光场的可控高效耦合

Abstract:

单个量子系统与单模式光场的耦合是量子光学教材中讨论的一个理想模型。该模型简单直观，能够展示丰富的物理现象。然而，在实验研究中，特别是关于纳米发射体与深亚波长场之间的相互作用，实现发射体与单模光场的耦合是一项重大挑战。这一难题不仅使得对实验结果的精确定量解释变得困难，还阻碍了通过光场实现系统最佳性能的有效利用。在本报告中，我们将讨论如何在实验中实现单颗粒纳米晶体发射体与单个纳米腔模之间的受控耦合。同时，我们将展示基于单发射体-单纳米腔模耦合系统的超高亮度上转换荧光以及高亮度无闪烁的单量子点发射。



Name: Wenjie Wan 万文杰

Organization: Shanghai Jiao Tong University 上海交通大学

Biography:

万文杰，研究员，上海交通大学密西根学院、物理与天文学院。课题组研究领域为非线性纳米光学，多篇研究成果发表于国际著名期刊，包括 *Science*、*Nature Physics*、*Nature Photonics*、*Physical Review Letters*，并受邀为多家国际一流期刊审稿。万文杰前期所演示的基于光学微腔的光学相干完全吸收器（媒体报道为“反激光器”）的工作发表于 *Science* 杂志，并于 2011 年入选由中国科学院院士和中国工程院院士投票评选的 2011 年“世界十大科技进展”。

Title:

彩色相干完美吸收器

Abstract:

完美相干吸收器(CPA)通过控制入射波之间的干涉，实现对电磁辐射的完全吸收，这一系统能够影响光与物质的相互作用，有着极高的应用价值。其中，宽谱或多频率的完美相干吸收器备受关注，却尚未在实验中实现。在本工作中，我们首次提出了一种在回音壁模式光学微腔中实现多色完美相干吸收的方法，并通过实验演示了一个铌酸锂微盘腔中的双色完美相干吸收。我们同时将一个 1560nm 基频光和一个 780nm 倍频信号耦合进微腔中，通过调节光纤位置使基频达到临界耦合状态，在线性情况下，倍频信号将处于欠耦合状态。然而由于基频光与倍频之间的二阶非线性耦合提供了一项额外的增益/损耗，原本较强的基频光几乎不受影响，而对于较弱的二次谐波模式，该非线性项可以平衡其本征损耗和耦合损耗，使其达到完美相干吸收的条件，即耦合出的，光纤中剩余的，以及基频模式产生的二次谐波，三者之间相干相消。我们从理论上论证了该系统中的 CPA 条件，并通过调节两路入射信号的功率和相位差，在实验中实现了对基频和倍频两个不同频率的同时完美吸收。此外，我们也能够通过功率和相位的调制，实现对这一系统的相干调制。此外，通过利用诸如和频，四波混频等其他非线性效应，我们的系统可以进一步实现对更多频率的完美吸收。这一工作实现了多色的完美相干吸收，提供了一种全光调控手段，在全光信号处理和量子信息等领域有着应用价值。



Name: Deng Pan 潘登

Organization: East China Normal University 华东师范大学

Biography:

华东师范大学紫江优秀青年研究员。2016 年于中国科学院物理研究所获得凝聚态物理专业博士学位，导师为徐红星院士。2016 年 6 月起至 2020 年 12 月，在西班牙巴塞罗那光子学研究中心（ICFO）从事博士后研究工作。2021 年 1 月加入华东师范大学精密光谱与技术国家重点实验室。其主要研究领域为微纳光学，具体的研究内容包括等离激元光学，石墨烯光学，卡西米尔效应，纳米尺度传热学和电子束中的光学激发现象。研究成果曾获得 2016 年“中国光学重要成果奖”。目前主持多项基金委和科技部项目。曾入选国家级别青年人才、上海市海外高层次人才和上海市拦蓄人才。

Title:

光学近场新特征电子束探测

Abstract:

与传统光学研究的远场光学不同，微纳光学关注的是束缚在材料表面附近的光学近场，例如等离激元光场等。光学近场具有不同于远场的物理特性，使得其在众多应用领域中展现出巨大潜力。近年来，研究者们不断发现一系列光学近场的新特性，例如近场自旋特性、近场热涨落和近场非互易性等。然而，这些新特性常常难以通过传统实验手段进行探测。在本报告中，我们将介绍电子束作为探测光学近场新特性的有效工具。我们将展示电子束与光学近场相互作用中所产生的各种新颖散射现象，包括电子束的自旋起偏、电子束的定向偏转，以及基于电子束的近场等能曲线测量。通过这些研究，我们揭示了电子束在微纳光学基础物理研究和应用中的全新视角。

Name: Yuwei Shan 单雨薇

Organization: Changchun Institute of Optics, Fine Mechanics and Physics, CAS
中国科学院长春光机所

Biography:

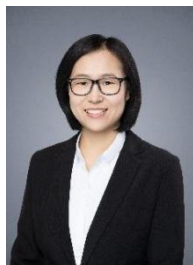
单雨薇，中国科学院长春光机所副研究员。2019 年获得复旦大学物理系凝聚态物理博士学位，同年入职长春光机所。目前的研究方向聚焦可片上集成的低维材料以及表界面的非线性光学性质的响应机制以及调控的研究。同时，开展自研多场调控的角分辨非线性光学平台的开发，可实现自动化微区角分辨非线性光谱的原位采集。主持国家自然科学基金 1 项，参与国家自然科学基金 2 项。在 *Nature Photonics* 等杂志共计发表论文 30 余篇。

Title:

少层二维材料中层数调控的非线性光学响应

Abstract:

少层二维材料的倍频效应易于通过多种手段调控，如层数、堆垛序、门电压、界面、光学功能结构因素。本报告主要讨论了少层石墨烯，过渡金属硫属化合物 (TMDs) 中二硫化铼 (ReS₂) 和二硫化钼 (MoS₂) 等的倍频效应，通过改变材料的对称性、能带结构、材料处的光场强度等实现对倍频信号的调控。实验结果表明少层二维材料的倍频信号受堆垛序，层数，基频光子能量以及偏振方向的调控。例如，在少层 ReS₂ 中，电偶极矩近似下，(AB_y)_n 堆垛的 ReS₂ 能产生倍频信号，而 A_n 和 (AB_y)_nA 堆垛的 ReS₂ 没有倍频信号 (n 代表层指数)。在 AB_y-ReS₂ 中，当调节基频光子能量与激子能级共振或非共振，倍频强度最高有 2 个数量级的变化。同时 AB_y-ReS₂ 的倍频偏振图样表现出了强各向异性，且偏振图样与基频光子能量有很强的依赖关系。除了材料本征性质会影响其倍频效应，一些外部因素，如多层膜结构，也能有效调控倍频信号。通过设计“二维材料/介质/金属”多层膜结构使二维材料位置处的基频光场和倍频光场同时干涉相长(相消)，可以实现对倍频信号强度的调控。我们通过理论与实验结合的方式，证实了“单层 MoS₂/二氧化钛 (TiO₂)/银 (Ag)”的多层膜结构可以在 3 个数量级范围内调控单层 MoS₂ 的倍频强度。



Name: Tianyue Zhang 张天悦

Organization: Beijing University of Posts and Telecommunications
北京邮电大学

Biography:

张天悦，副研究员，博士生导师。2009年本科毕业于哈尔滨工业大学光信息科学与技术专业，2014年获得北京大学现代光学研究所博士学位。2014-2015年在慕尼黑大学物理学系从事博士后研究。2016年于暨南大学光子技术研究院纳米光子学及器件课题组工作。2023年加入北京邮电大学集成电路学院。主要从事微纳光子学研究，围绕光学衍射极限这一核心科学问题，致力于纳米光学技术、光场调控、突破光学衍射极限的超分辨成像检测方面的研究。发表SCI论文40余篇，其中包括以第一作者或通讯作者发表在 *Nature Communications*, *Science Advances*(in press), *Nano Letters*, *Advanced Optical Materials*, *Photonics Research* 等，授权发明专利3项。

Title:

米散射调控与超分辨定位成像

Microscopic Imaging with Mie Resonators

Abstract:

Artificial nanostructures with ultrafine and deep-subwavelength feature sizes have emerged as a paradigm-shifting platform to advanced light field management, becoming a key building block for high-performance integrated optoelectronics and flat optics. However, direct optical inspection of such integrated chips with densely packed complex and small features remains a missing metrology gap that hinders quick feedback between design and fabrications. Here, we demonstrate that photothermal nonlinear scattering microscopy can be utilized for direct imaging and resolving of integrated optoelectronic chips beyond the diffraction limit. We reveal that the inherent coupling among deep-subwavelength nanostructures supporting leaky resonances allows for the pronounced heating effect to access reversible nonlinear modulations of the confocal reflection intensity, leading to optical resolving power down to 80 nm ($\sim \lambda/7$). The versatility of this approach has been exemplified by direct imaging of silicon grating couplers and metalens with a minimum critical dimension of 100 nm, as well as central processing unit (CPU) chip with 45 nm technology, unfolding the long-sought possibility of in-situ, non-destructive, high-throughput optical inspection of integrated optoelectronic chips and nanophotonic chips.



Name: Yuanyuan Chen 陈圆缘

Organization: Xiamen University 厦门大学

Biography:

陈圆缘，厦门大学物理科学与技术学院，副教授，博士生导师。2019 年博士毕业于南京大学，2016 年至 2018 年在奥地利科学院量子光学与量子信息研究所进行联合培养。主要从事光场调控、量子光学与量子信息的实验和理论研究，目前主持国家自然科学基金青年项目、福建省自然科学基金青年项目等。以第一或通讯作者身份在国内外学术期刊发表论文 20 余篇，包括 Phys. Rev. Lett., npj Quantum Information 等。

Title:

基于非么正多层石墨烯的损耗辅助的反常 Hong-Ou-Mandel 干涉

Abstract:

Hong-Ou-Mandel 干涉是一种超越经典物理学范畴的内在量子现象，在量子信息科学中有着众多应用。虽然光子-光子的相互作用从根本上受限于光子的玻色子性质及常用么正光学元件提供的受限相位响应，作者提出非么正材料提供了另一种自由度来调控双光子量子干涉，甚至揭示出在么正配置中不存在的反常量子干涉路径。作者精心设计了一种损耗型多层石墨烯，它可以作为非么正的分束器，用于探索其在空间模态中对有效光子-光子相互作用的可调性，并通过在量子态滤波器中开展实验以验证粒子交换统计。这一方案进一步推广，在无损耗和损耗型分束器上观测到四维量子干涉图样，显示了它即使在高维希尔伯特空间中照样适用。



Name: Chunting Xu 徐春庭

Organization: Nanjing University 南京大学

Biography:

徐春庭，现为南京大学现代工程与应用科学学院博士后，师从胡伟、陆延青教授。本科毕业于厦门大学，博士毕业于南京大学。研究方向为液晶微结构与光场调控。目前在 *Light: Sci. Appl.*、*Photonix*、*Laser Photonics Rev.* (2)、*Adv. Opt. Mater.*、*Appl. Phys. Lett.* (2)、*Adv. Quantum Technol.* 等国内外著名 SCI 期刊上发表第一作者/共同一作/共同通讯论文 9 篇，其中封面文章 4 篇。

Title:

基于胆甾相液晶的多功能平面光学元件

Abstract:

光具有振幅、偏振、相位、波长、时间等多个维度，光的多维和大规模并行操控，特别是工作波长和空间相位波前的按需调控，在现代光学中受到高度关注。超薄的平面光学元件为此提供了一个小型化、集成化和多功能化的平台，正在成为新一代光计算、光通讯和显示等领域的核心。液晶（LC）作为一种典型的软物质材料，具有优异的多元外场响应特性，被广泛应用于平板显示、智能传感、信息通讯、光束整形等领域。胆甾相液晶（CLC）具有自组装的螺旋超结构，由于其圆偏振选择性和外场可调谐性，为新型智能光电元件开辟了新的道路[1]。提出了冲洗-再填充图案化螺旋超结构的策略，揭示了电场调谐与相位调制机制，为实现动态和正交的几何相位调制奠定了材料和理论基础[2]。基于一种特殊的倾斜螺旋胆甾相液晶实现了低电压驱动的超宽带可调的工作波长，设计制备了一种动态可调的反射式空间光场调制器[3]。利用具有负介电各向异性的聚合物稳定胆甾相液晶实现了光学元件工作波长范围的拓展。设计了轨道角动量复用全息，实现了波长信道可电控的并行轨道角动量模式的产生，验证了该元件在线式、无损的轨道角动量检测的功能[4]。提出了频率合成相位工程方案，构建了波长相位独立操控的空间光调制器，通过堆叠多个不同螺距和起始取向的 CLC 层，分别实现了色差消除、色差增强以及彩色路由的功能[5]。这些工作丰富了对软物质光子学的基本理解，并可能升级现有的光学信息学。

关键词：液晶、胆甾相液晶、光控取向、几何相位、光场调控

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Name: Alberto Bramati

Organization: Sorbonne Université

Title:

Towards Integrated Single Photon Source Based on Solid States Emitters Coupled to An Optical Nanofiber

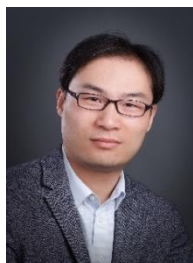
Abstract:

Quantum photonics applications require on-demand single photon sources with high brightness and short lifetimes. Various materials systems have been investigated as candidates for single photon emission, such as single atoms and ions, and solid-state emitters such as organic molecules, color centers in diamonds and quantum dots.

The integration of quantum emitters with photonic interfaces, such as waveguides and optical fibers, represents a promising avenue to develop their practical applications.

In this talk I will discuss our recent achievement of the coupling of a single perovskite nanocube with a tapered optical nanofiber. Through near-field interaction, a significant fraction of the emitted light is coupled into the nanofiber, providing proof of principle for a compact and integrated single photon source [1].

To further enhance the emission properties and increase the collection efficiency of emitters coupled to the nanofibers, we developed a novel fabrication method, based on Electron Beam Induced Deposition, to directly fabricate plasmonic nano-pillars and nano-antennas on a tapered optical nanofiber. The high spatial resolution and the deterministic control on position, size and geometry of the plasmonic nanostructure open the way for the realization of a compact, efficient and high-brightness integrated single photon source operating at room temperature.



Name: Shuming Wang 王澈明

Organization: Nanjing University 南京大学

Biography:

王澈明，南京大学物理学院教授，从事微纳光学，量子光学和非线性光学等方面的研究。获得国家自然科学基金杰出青年项目资助和第四届江苏青年光学科技奖。研究成果两次获得中国光学十大进展（2018，2020）。在 *Science*, *Nature Nanotechnology*, *Nature Communications*, *Physical Review Letters*, 等学术刊物上发表论文 80 余篇，总引用次数超过 3000 次。

Title:

光学超构表面成像研究

Abstract:

一直以来，如何将这个丰富多彩的世界更好的成像和显示，都是光学领域的一个最重要的课题。色差是影响成像效果的最主要问题。我们使用相位分离的原理，将理想消色差所需要的复杂的相位分解成相对简单的基础相位和色差相位，实现了在近红外波段的消色差反射聚焦镜和反射板。在可见光频段，实现了覆盖整个可见光频段的消色差透镜，并第一次得到了基于超构表面透镜的全彩成像。将超构表面的应用向前推进一大步。针对可见光宽带消色差透镜存在数值孔径和通光口径不能同时很大，我们引入了超构透镜阵列的体系，不但实现了成像效果的提升，同时可以实现光场成像的效果。为了进一步获取更多的光学信息，我们还将色差在焦平面上横向拉开，制备出了超色差的超构透镜阵列，并通过深度学习对光谱重建，从而同时获取光谱和深度的信息，实现了不同材质分析与光谱信息检测。此外，报告人还通过优化算法实现对超构表面的逆向设计，制备出两倍于传统拜耳滤色片的成像效率，且分辨率达到像素级别的超构彩色路由器件。



Name: Shiyao Fu 付时尧

Organization: Beijing Institute of Technology 北京理工大学

Biography:

付时尧，北京理工大学教授、博导，教育部青年长江学者。长期从事激光光场调控技术及应用研究，主持基金委原创探索计划、国家重点研发计划、某基础科研计划等项目十余项，出版专著 2 部，发表论文 60 余篇，获授权发明专利 22 项，研究成果已应用于多个系统，并被《人民日报》等媒体报道。曾入选博新计划，获北京市自然科学二等奖（序 1）、中国电子学会优秀博士论文奖、王大珩光学奖等。现为 Optica Senior Member、中国激光杂志社第三届青年编委员会委员、《光学学报》等期刊青年编委、中国光学工程学会会刊《红外与激光工程》青编委会执行委员会委员等。

Title:

深度学习辅助复杂涡旋光场调控

Abstract:

人工智能技术的蓬勃发展为光场调控技术带来新飞跃。本报告将重点介绍本团队在深度学习辅助复杂涡旋光场调控方面的最新研究进展，探讨深度学习在涡旋光场调控及模态分析方面的优势。具体内容包括基于深度学习的宽谱轨道角动量光梳以及多自由度高维光场的调控方法，涡旋光子态大范围快速分析方法，以及其在工程技术中的应用。



Name: Zhenwei Xie 谢振威

Organization: Shenzhen University 深圳大学

Biography:

谢振威，深圳大学微纳光电子学研究院副教授，从光学轨道角动量这一新的复用维度出发，提出了独特的旋涡光场模式产生、复用/解复用新机理，国际上首次提出矢量光场奇偶宇称霍尔效应，并拓展了光学拓扑态布洛赫斯格明子调控新维度。相关成果以第一及通讯作者在 Nature Communications、Light: Science & Applications、Advanced Photonics、Applied Physics Reviews、ACS Photonics、Laser & Photonics Reviews、Photonics Research、Applied Physics Letter、Optics Letters 等国际著名期刊发表论文 30 余篇。目前共发表 SCI 论文 90 余篇，Google 引用 5120 次，H-index: 34；9 篇（次）论文获得杂志的 TOP Download 论文奖，2 篇获得 ESI 高被引论文，5 篇被选为 Featured Article 或封面，获得深圳市自然科学二等奖。主持基金委面上项目、青年项目、广东省面上项目、深圳市海外高层次人才启动项目等，作为核心成员参与基金委重点项目、科技部重点研发计划、广东省基础与应用基础重大项目、深圳市重点项目等；入选全球前 2% 科学家 “2021, 2022, 2023 年度科学影响力排行榜”。

Title:

涡旋光场中的宇称及拓扑态调控

Manipulation of Parity and Topological States in Optical Vortex

Abstract:

光场具有非常丰富的调控自由度，如：相位、振幅、偏振、角动量、频率/波长等，如何调控这些自由度是实现各种光子器件的关键技术。偏振态是光场的一个重要调控自由度，已经在光子学的各个学科中得到广泛利用。一般具有均匀偏振态分布的称为标量光场，而另一种空间偏振态有变化的分布则称为矢量光场。矢量光场（包括：包括圆柱矢量光束（CVB）、Poincaré 光束以及光纤中的矢量 HE 模式等）因其丰富的偏振特性而具有非常特殊的光与物质相互作用机制，在相关领域得到了广泛关注，如：光镊、光学超分辨显微成像、光通信等。其中，圆柱矢量光束（CVBs）是矢量光场里面非常重要的例子，它是圆柱对称边界条件下矢量亥姆霍兹方程的本征解，也可以表示为拉盖尔-高斯（LG）、厄米特-高斯或贝塞尔-高斯模式的叠加。除了其固有的偏振拓扑结构外，矢量光场还包含着与偶（even）或奇（odd）相关的内在对称性宇称自由度，对应于一对简并的正交模式。然而，目前还未有关于如何调控奇宇称模式和偶宇称模式的研究。研究团队利用对称排列的具有形状双折射的超表面器件首次实现并验证了矢量模式的奇偶宇称霍尔效应，并进一步利用模式奇偶宇称霍尔效应演示了矢量简并奇偶模式解复用及矢量简并奇偶模式编码全息，展示了其在光通信及全息成像领域的潜在应用。另外研究团队还拓展了新型光场斯格明子、半子等拓扑结构，研究了相关拓扑特性由对称性驱动的调控机理。这些工作不仅拓展了光场调控的自由度，而且还展示了基于奇偶宇称及光学拓扑态的光场调控新手段。

Name: Feng Li 李峰

Organization: Xi'an Jiaotong University 西安交通大学

Title:

微腔极化激元的自旋轨道耦合效应

Spin-Orbit Coupling in Cavity polaritons

Abstract:

微腔激子极化激元(exciton-polariton)是一种半光半物质的准粒子，由光学微腔中的光子与腔内发光材料中的激子通过强耦合作用形成。本报告中，我将简述微腔激子极化激元的基本概念及其自旋光子学（spinoptronics）相关研究概况，并重点介绍近年来我们在此研究领域的一系列工作，包括圆形势阱中极化激元凝聚的自旋涡旋态与斯格明子态、微腔与偏振各向异性激子材料相结合产生的宏观旋光性，以及在此基础上观测到的非平庸拓扑能谷、极化激元能带上的非厄米奇异点与发散量子度规等有趣现象。微腔自旋光子学对于实现光子芯片上以手性为基础的各类拓扑光子学效应，具有重要的意义。

Name: Lingyu Ai 艾灵玉

Organization: Jiangnan University 江南大学

Biography:

艾灵玉，江南大学集成电路学院副教授，2018 年 2 月获韩国光云大学全息多媒体研究中心工学博士学位，师从韩国总统奖获得者 Eun-Soo Kim 教授。主要研究方向包括面向芯片检测与生物医学的 3D 成像系统，AR/VR 中的定位测姿、电路小型化及内容生成等。曾主持多项科研项目，如国家青年科学基金项目“非相干光场研究”、科技部外国专家项目、国家博士后面上项目“基于深度神经网络重构特性研究”、江苏省自然科学基金青年项目“基于集成成像的研究与开发”以及教育部数码激光成像与显示工程研究中心开放课题“基于物理模型驱动的亚波长结构衍射全息 3D 成像与显示研究”等。其带领的“AI 算法与透镜阵列设计联合优化的 3D 成像产品及产业化”项目在 2024 年“科创无锡”“创响无锡”创新创业大赛中获市级决赛奖杯，并在路演中引起广泛关注。两次获得市级以上科技奖。

Title:

Application of Metasurface in Future Displays

Abstract:

光学超表面作为前沿研究领域，凭借人工双折射结构或结构共振，为光的振幅、相位与偏振调控开辟新径，在设计超薄透镜、超宽带消色差透镜及轨道角动量发生器等平面光学元件方面成效显著。其高集成密度与功能多样性使其在光场显示领域极具应用潜力，有力克服传统显示组件的诸多缺陷。本研究先系统梳理超表面的相位调制方式及结构共振原理，进而深入探讨其于全息显示领域的应用及彩色打印功能的实现路径，全面总结全息显示、光场显示与近眼显示中的 3D 显示策略，剖析超表面在 3D 显示领域的应用优势与挑战。最后，对超表面为契合 3D 显示技术需求的优化方向予以展望，涵盖人工智能辅助的逆向设计、可调谐多功能特性的实现，以及未来 3D 显示应用中亟待攻克的关键难题，旨在为超表面在显示技术领域的进一步发展提供理论参考与实践指导。

Name: Xiaolong Zhu 朱晓龙

Organization: East China Normal University 华东师范大学

Biography:

I am currently a research professor at the East China Normal University (faculty since 2021). My BSc (2008) and MSc (2011) academic degrees were awarded by Fudan University while my PhD (2014) degree was obtained from the Technical University of Denmark. My research focus is on complex wave phenomena and light-matter interactions in artificially structured materials. The list of past and present research topics includes photonic crystals, nanoplasmonics, metasurfaces, nanophotonics & ultrafast phenomenon.

Title:

Resonant Laser Printing of Large-Area Optical Metasurfaces

Abstract:

Optical metasurfaces are a new class of ultra-thin optical elements comprising arrays of nanoscale artificial atoms which collectively control the amplitude, phase, polarization, and spectrum of light. Arrays of optically resonant nanostructures have offered the control of light with nanoscale precision, which are typically realized by the state-of-the-art nanofabrication technologies. The resonant absorption in metallic or dielectric materials provides a new route for photo-to-thermal conversions and post-processing. Recently, we introduce an ultrafast resonant laser printing (RLP) technique as a flexible photothermal laser-post-writing technology for mass-customization of optical metasurfaces. [1-2] In RLP, photothermal effects are taking place in the center of the resonant nanostructures, which helps to gradually control structural and shape modifications of the nanostructures. Depending on the laser pulses' energy density, different surface morphologies that support different optical resonances can be created. We applied the laser-induced reshaping in color printing and wave-front modulation. This technology can realize laser nanoprinting of metasurfaces with a printing resolution up to 127,000 DPI. [1-2]

In this work, we used the ultrafast RLP [3-4] method for achieving self-organized nanostructures of high refractive index materials within large-area thin films systems. It is actuated by an ultrafast pulsed laser irradiating at a frequency that resonates with the system, and regulated by a phase feedback mechanism with self-adaptive surface structures morphology. Taking the advantage of ultrafast RLP, optical metasurfaces composed of self-organized surface structures are designed and successfully fabricated. These surface structures present different structural colors and wave-front modulations. The work is studied by measured and simulated approaches to analyze and prove structural and spectroscopic properties. Furthermore, the optical properties of the metasurfaces including phase modulation, transmittance and focusing ability are examined. This ultrafast and resonant-mode-based laser fabrication method is with superiority of large-scale, cost-effective and time-saving, thus of importance for the future fabrication of functional optical elements and devices.

Session 14

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Exhibition Center Hall C1

Integrated Photonics and Photonic Computing

集成光子与光子计算





Name: Chaoyang Lu 陆朝阳

Organization: University of Science and Technology of China
中国科学技术大学

Biography:

Chao-Yang Lu is a Chair Professor in Physics at the University of Science and Technology of China (USTC). He completed his BS and PhD degrees at the USTC and the University of Cambridge in 2011. He has been appointed as the Deputy Director of the Shanghai Center for Quantum Sciences and as the Executive Director of the Quantum Computing Division at the Hefei National Laboratory since 2022. His current research interest includes quantum computation, solid-state quantum photonics, quantum teleportation, superconducting circuits, and atomic arrays. He is the author of over 160 papers in major research journals which have attracted >32000 citations. His work has been selected as by *Physics World* as “Breakthrough of the Year” in 2015, by *APS Physics* as one of the top ten “Highlights of the Year” in 2021 and 2022, and by UNESCO as “World’s top 10 digital innovation technologies” in 2021. He is an OSA/Optica/APS Fellow, and a recipient of the EPS Fresnel Prize, AAAS Newcomb Cleveland Prize, Nishina Asian Award, IUPAP-ICO Young Scientist Prize in Optics, OSA Adolph Lomb Medal, APS Rolf Landauer and Charles H. Bennett Award in Quantum Computing, CLEO James P. Gordon Memorial Speakership, and OCPA Achievement in Asia Award. He serves as the Divisional Associate Editor for *Physical Review Letters*, and recent appointed as the Chairman of World Association of Young Scientists

Title:

From Science-for-QC to QC-for-Science

Abstract:

I will go through our recent efforts in my group using photons and atoms to build increasingly large-scale quantum computers and, in turn, how these early quantum computers can already be used for studies of fundamental problems in mathematics, quantum physics, and condensed matter physics. We use the protocol of Gaussian boson sampling to demonstrate quantum computational advantage, with up to 255 detected photons [Zhong et al. *Science* 2020, *PRL* 2021, Deng et al. *PRL* 2023]. We develop an AI-enabled constant-time-overhead rearrangement protocol to prepare a 2024 defect-free atomic array [Lin et al. 2024]. Using a single atom trapped in an optical tweezer and cooled to the motional ground state in three dimensions, we faithfully realize the Einstein-Bohr recoiling-slit gedankenexperiment tunable at the quantum limit [Zhang et al. 2024]. Based on a bottom-up quantum engineering approach, we experimentally created the fractional quantum Hall state using strongly interacting photons [Wang et al. *Science* 2024]. We further use the quantum computing platform to rule out a real-value description of standard formalism of quantum theory [Chen et al. *PRL* 2022].

Name: Xiaosong Ma 马小松

Organization: Nanjing University 南京大学

Biography:

马小松教授从事的研究领域是量子光学实验、量子通信与量子模拟等。利用现代量子光学的实验技术，实现对单光子与多光子量子态的产生、调控与探测，实现量子通信与量子信息技术的应用。他主持科技部重点研发计划课题 1 项（2022 结题）、参与 1 项；主持国家自然科学基金面上项目 1 项、国际合作项目 1 项等。他获得了 2014 年中组部“海外高层次人才（青年）”、2017 年江苏省杰出青年基金、2016 年江苏省“双创人才”、欧盟玛丽居里 Fellow，2019 年“中国光学十大进展—基础研究类”，2020 年 Springer-Nature 出版社发表的中国作者年度高影响力研究等荣誉。

马小松教授在量子通信与量子光学领域中的工作包括：长距离量子隐态传送（Nature, 489, 269. (2012)）；光量子态的远程制备（Nat. Phys., 8, 666. (2012)）；纠缠交换（Nat. Phys., 8, 480. (2012)）；基于光纤网络的非局域量子调控（Nat. Photonics, 13, 872 (2019), Rev. Mod. Phys., 88, 015005. (2016)），基于自由空间链路的非局域量子调控（PNAS, 110, 1221. (2013), PNAS, 107, 19708. (2010)），光量子芯片与其在量子通信与量子信息中的应用（Advanced Photonics, 3: 055002 (2021), npj Quantum Inf, 6, 30. (2020), Nat. Commun., 7, 10352. (2016)），光量子模拟（Phys.Rev.Lett. 125, 240501 (2020), Nat. Phys., 7, 399. (2011)）与量子物理基础物体的实验验证（Nat Commun 14, 1480 (2023)）等。

Title:

基于网络的硅基光量子芯片



Name: Jianji Dong 董建绩

Organization: Huazhong University of Science and Technology
华中科技大学

Biography:

董建绩，华中科技大学教授、博士生导师，武汉光电国家研究中心主任助理。国家重点研发计划首席科学家，国家杰出青年基金、国家优秀青年基金、全国百篇优秀博士学位论文奖获得者。从事集成光子学和光计算的研究工作，2次获得湖北省自然科学一等奖，1次获得国家（研究生）教学成果二等奖。担任期刊《Frontier of Optoelectronics》执行主编、全国智能计算标准化委员会委员、中国光学学会纤维光学与集成光学专委会常务委员、中国通信学会光电融合技术专委会委员。

Title:

面向人工智能的光电计算芯片

Abstract:

光子计算具有高速、低延迟、低功耗、并行计算的优势，可以和电子计算形成互补，有望颠覆算力瓶颈和功耗瓶颈。本报告提出了若干大算力光电计算芯片方案，重点介绍“黑盒式”物理训练模型，以及在可重构片上衍射神经网络、大算力光电通用计算领域的应用，充分发挥光子“传播即计算”的特点。

Name: Anning Zhang 张安宁

Organization: Beijing Institute of Technology 北京理工大学

Biography:

张安宁，北京理工大学准聘教授。科研方向为量子信息、量子成像、量子光学的实验研究；量子成像、量子遥感、量子雷达、极弱光成像的工程实践。迄今共发表 SCI 论文 30 余篇【包括 Nature（1 篇）、Phy. Rev. Lett.（7 篇）】，SCI 引用 2000 余次，授权专利十余项；研究成果 2 次入选中国科学院和工程院的“中国科技十大进展”，1 次入选欧洲物理学会的“物理学十大进展”；承担过国防科工局民用航天、总装“十二五”加强、国家自然科学基金等十余个项目，参与 SJ20 号卫星研制。

Title:

量子信息的成像识别技术

Name: Tang Li 李唐

Organization: Shanghai Institute of Optics and Fine Mechanics, CAS 中国科学院上海光学精密机械研究所

Biography:

李唐，现任中国科学院上海光学精密机械研究所（上海光机所）研究员、博士生导师。他于自 2000 年起，李唐在上海光机所工作，历任研究实习员、助理研究员、副研究员，2019 年晋升为研究员。其研究领域主要包括量子频标、超稳激光和光学频率梳等。他主持和参与了多项国家级科研项目，取得了重要成果，曾获中科院杰出成就奖和军队科学技术进步一等奖等荣誉。此外，李唐还在国内外学术期刊上发表了多篇高水平论文，为我国光学工程领域的发展作出了积极贡献。

Title:

冷原子矢量磁场测量

Name: Bin Zheng 郑赞

Organization: Peking University 北京大学

Biography:

郑赞，北京大学物理学院博士研究生，指导教师为王剑威研究员。主要研究方向为集成光芯片在量子通信网络方面的应用。其中，“具有纠缠修复能力的多芯片高维量子网络”工作在《科学》（**Science**）上发表，该工作发展了硅基光量子芯片晶圆级制造、片上多维混合复用量子调控等关键技术及核心器件，提出一种高维量子纠缠自修复方法，可快速恢复在复杂介质传输中已退化的高维纠缠，实现了多芯片高维纠缠量子网络，为进一步构建大规模可实用化量子网络开辟了新路径。多次参加国内外学术会议作口头报告，并获评优秀报告。曾获研究生国家奖学金、北京大学现代光学研究所博士研究生所长奖学金、北京大学三好学生标兵、北京市三好学生等多项荣誉和奖励。

Title:

基于大规模集成光量子芯片的量子网络与量子信息处理



Name: Zhaohui Li 李朝晖

Organization: Sun Yat-sen University 中山大学

Biography:

Zhaohui Li, a Professor at the School of Electronics and Information Technology, Sun Yat-sen University, serves as the director of a Guangdong Provincial Key Laboratory of Optoelectronic Information Processing Chips and Systems.

He has been engaged in research in the fields of optical communication systems, photonic integrated circuits, and intelligent optical signal processing for a long time. He has published over 250 SCI papers, including more than 10 papers in internationally influential academic journals such as Nature Communications, Science Advances, and Light: Science & Applications; he has applied for 115 national invention patents, 61 of which have been authorized, and 8 international invention patents have been authorized as the first completer. His research achievements have won the first prize of the Guangdong Provincial Technological Invention.

He has hosted the National Key Research and Development Program of China, the National Science Fund for Distinguished Young Scholars, and the National Natural Science Foundation of China.

Title:

Hybrid-integrated chalcogenide photonics

Abstract:

High-quality photonic materials are critical for promoting integrated photonic devices with broad bandwidths, high efficiencies, and flexibilities for high-volume chip-scale fabrication. Recently, we designed a home-developed chalcogenide glass (ChG)-Ge₂₅Sb₁₀S₆₅ (GeSbS) for optical information processing chips and systems, which featured an ultrabroad transmission window, a high Kerr nonlinearity and photoelastic coefficient, and compatibility with the photonic hybrid integration technology of silicon photonics. Chip-integrated GeSbS microresonators and microresonator arrays with high quality factors and lithographically controlled fine structures were fabricated using a modified nanofabrication process. Moreover, considering the high Kerr nonlinearity and photoelastic effect of ChGs, we realised a novel ChG hybrid integrated chip, inspired by recent advances in integrated soliton microcombs and acousto-optic (AO) modulators.

Name: Xingjun Wang 王兴军

Organization: Peking University 北京大学

Biography:

王兴军，北京大学二级教授、博士生导师、电子学院副院长、区域光纤通信网与新型光通信系统国家重点实验室副主任、教育部纳光电子前沿科学中心副主任、国务院学科评议组成员、入选教育部重大人才计划特聘教授，科技部重点研发计划项目首席，国家自然科学基金重点项目负责人（2次）。近五年，以第一/通讯作者在 *Nature*、*Nature Photonics*、*Light: Science&Applications*、*Nature Communications* 等高水平期刊发表论文 60 余篇，在 OFC、CLEO 等行业顶级学术会议发表论文 20 余篇，SCI 他引 2500 余次，授权发明专利 30 余项，OFC、CLEO、OECC、ACP 等国际会议邀请报告 50 余次。代表性成果入选 2013、2016、2021 ACP PDP 论文、2022 OFC PDP 论文、2022 中国十大科技创新奖、2022 中国光学十大进展、2022 中国光学十大社会影响力事件、2022 年中国芯片科学十大进展、2022 中国半导体十大研究进展提名奖等奖项。部分成果获得 2021 年北京市科学技术奖自然科学二等奖。作为主编撰写专著 2 本：《硅基光电子集成技术-光波导放大器与激光器》和《硅基集成微波光子技术》。获得北京大学优秀教师、北京大学优秀共产党员、北京大学教学优秀奖、北京大学教学成果奖等荣誉。

Title:

高分辨跨频段硅基光电子集成芯片与系统

Name: Yaocheng Shi 时尧成

Organization: Zhejiang University 浙江大学

Biography:

时尧成，博士，教授，博士生导师，国家优秀青年科学基金获得者，浙江省万人计划科技创新领军人才，浙江省自然科学基金创新群体负责人。现任浙江大学光电科学与工程学院副院长、国家光学仪器工程技术研究中心副主任、教育部高等学校光电教指分委副秘书长。

主要从事光通信器件，光互连、光传感用光子芯片的研究，在多通道片上高速光互连芯片、片上相控阵激光雷达扫描芯片、高性能波导微腔等领域取得了多项重要进展，近年来在 *Nature Communications*, *Laser & Photonics Reviews*、*Optics Letters* 等国际权威期刊共发表 SCI 收录论文 180 余篇，被引用 7500 余次，h-index 50。受邀担任国际光电子与通信大会

（*Optoelectronics and Communications Conference, OECC*）程序委员会共主席、亚洲光通信与光电子学会议（*Asia Communications and Photonics Conference, ACP*）组织委员会主席、国际光通信与网络会议（*International Conference on Optical Communication & Networks, ICOCN*）程序委员会共主席等本领域重要国际会议的 程序委员会共主席、组织委员会主席等 10 余次，同时，受邀在美国西部国际光电会议（*Photonics West*）、亚洲光电子会议（*Photonics Asia*）以及亚太激光及光电峰会（*CLEO PR*）等本领域重要国际会议作特邀报告 30 余次，并获已授权国家发明专利 12 项。作为项目负责人承担国家自然科学基金重点项目、国家自然科学基金优秀青年科学基金、国家重点研发计划课题等国家级项目 10 余项，获浙江省自然科学一等奖、中国光学学会光学科技一等奖等奖项。

Title:

Optical Phased Array for Wide-Angle Beam Steering

Name: Xiuyou Han 韩秀友

Organization: Dalian University of Technology 大连理工大学

Biography:

韩秀友，工学博士，教授，博士生导师，大连理工大学光电工程与仪器科学学院副院长，“辽宁省先进光电子技术重点实验室”副主任。入选辽宁省“兴辽计划”科技创新领军人才、辽宁省高校创新人才计划。主持和参加国家部委重点项目、国家基金重点项目、国家重点研发计划课题、国家自然科学基金等多项课题。致力于微波光子技术和集成光子技术创新及其在新一代宽带通信、卫星通信、雷达等领域应用研究，以第一发明人授权发明专利 30 余项、美国发明专利 2 项，在 *Chip, Photonics Research, Optics Letters, Optics Express, IEEE Journal of Lightwave Technology* 等光电领域知名期刊和国际会议上发表论文 100 余篇。

担任国家重点研发计划会评专家、国家自然科学基金委通信评审专家、教育部学位与研究生教育发展中心通信评审专家、中国博士后科学基金评审专家、大连市科技项目评审专家。担任 IEEE、SPIE 会员、中国光学学会纤维光学与集成光学委员会委员、中国激光杂志社青年编辑委员会委员、《光子学报》首届青年编委会委员，教育部高等学校光电教指分委协作委员。

Title:

Integrated Photonic Rf Self-Interference Canceller for In-Band Full-Duplex Communication

Name: Yating Wan 万雅婷

Organization: King Abdullah University of Science & Technology 阿卜杜拉国王科技大学

Biography:

Dr. Yating Wan is an Assistant Professor at KAUST, specializing in Silicon Photonics with a focus on integrating on-chip light sources. She earned her Ph.D. in 2017 from HKUST (supervised by Prof. Kei May Lau). From 2016 to 2022, she worked at UCSB (supervised by Prof. John Bowers), where she led Intel's project on heterogeneously integrated quantum dot lasers, making significant contributions to Si CMOS-compatible light sources. Dr. Wan has authored over 100 peer-reviewed publications, including 29 first-author journal papers (10 as covers), 7 corresponding-author journal papers, and >20 invited talks in international conferences. With over 3,500 citations and an h-index of 33, her research has received prestigious awards, including HKUST PhD Research Excellence Award (2017), PIERS Young Scientist Award (2018), CLEO Tingye Li Innovation Prize (2021), Rising Stars of Light by Light: Science & Applications (2022), MIT Technology Review's "35 Innovators Under 35 for China" (2023), Optica Ambassador (2024), and Sony Women in Technology Award with Nature (2025). She is the Associate editor in Applied Optics, IEEE JQE, guest associate editor in IEEE JSTQE, TPC member of IPC and CLEO, and Committee Member of the IEEE Photonics Society (IPS) Conference Council.

Title:

Integrated Silicon Photonics with On-Chip Lasers

Abstract:

Integrated silicon photonics has emerged as a transformative technology, garnering significant attention and investment from both academia and industry. Its appeal lies in the potential to deliver scalable, power-efficient, and environmentally sustainable solutions for optical communications. At the core of this platform is the light source, which has been a focal point of intensive research and development. This presentation explores the state-of-the-art advancements in application-driven on-chip silicon lasers. As the integration of photonics and electronics on the silicon platform becomes increasingly crucial, the demand for efficient on-chip lasers continues to grow. We aim to highlight recent breakthroughs and inspire further innovation in this field. Looking ahead, we anticipate a future where photonic integrated circuits equipped with on-chip lasers achieve transformative performance, eco-friendly solutions, and the viability of large-scale production.

Name: Lei Shi 施雷

Organization: Huazhong University of Science and Technology 华中科技大学

Biography:

华中科技大学武汉光电国家研究中心教授、博士生导师，湖北光谷实验室“光谷产业教授”（双聘）。研究方向为微腔光子学，主要包括超高品质因子光学微腔及集成光子器件，研究其在微型激光器、非线性光学、光信号处理及传感中的应用。作为项目负责人主持国家重点研发计划课题（课题负责人）及国家自然科学基金项目多项，在光电领域重要学术期刊发表论文五十余篇（包括多篇封面论文），在国际国内学术会议作邀请报告三十余次，授权国家发明专利五项，研究成果被 *Photonics Spectra*、*SPIE*、*EurekAlert!* 等国际知名杂志和科技媒体专文报道。欢迎光电信息科学与工程、物理学/应用物理学、电子科学与技术等专业的同学联系，所从事研究方向涵盖了前沿基础与应用研究，对于毕业后不论是直接就业还是继续深造均可有较好的选择（包括在华为、中兴等知名企业从事技术研发；在高校担任正式教职，如华中科技大学、中国科学技术大学、南京航空航天大学、中国地质大学等；入选国家选调生；赴国际知名研究组攻读博士/从事博士后研究，如德国马普光学所、瑞士洛桑联邦理工学院、澳大利亚悉尼大学、新加坡南洋理工大学等）。

Title:

宽带平坦薄膜铌酸锂集成电光频率梳及其应用

Name: Yuxing Han 韩昱行

Organization: Shanghai Institute of Optics and Fine Mechanics, CAS
中国科学院上海光学精密机械研究所

Biography:

研究方向为高功率衍射光栅。博士期间以第一作者在 *Nature Communications* 等国际期刊上发表论文 5 篇、申请专利 5 项。面向高功率激光系统，以高功率反射式脉冲压缩光栅为研究对象，研发了 400nm 超宽带金光栅、发明了琥珀金光栅技术、阐明了 TM 偏振介质光栅阈值优越性等。在学期间获得上海分院科技攻关新星荣誉称号、尚光优秀研究生、范·杨苏一等奖学金、大恒光学优秀奖、北京市优秀毕业生、国科大优秀毕业生等荣誉。

Title:

高功率中红外衍射光栅新进展

Name: Yanzhi Wang 王胭脂

Organization: Shanghai Institute of Optics and Fine Mechanics, CAS

中国科学院上海光学精密机械研究所

Biography:

王胭脂，中国科学院上海光学精密机械研究所研究员、博士生导师，现任高功率激光元件技术与工程部（共性部）副主任。研究方向主要集中在超快激光薄膜和空间激光薄膜领域，致力于高性能光学薄膜的设计、制备及应用。在科研工作中，取得了多项重要成果，主持和参与了多项国家级科研项目，发表了多篇高水平学术论文，并获得多项专利。她的研究为高功率激光系统的发展提供了关键技术支持。

Title:

超快强激光薄膜技术发展与应用研究

Name: Qi Wang 王琦

Organization: University of Shanghai for Science and Technology 上海理工大学

Biography:

王琦，上海理工大学教授，博导，美国伊利诺伊香槟分校访问学者。主要从事液晶器件、微纳光学器件设计与制备、生物传感等方向的研究。发表 SCI 学术论文 80 余篇，获授权的国家发明专利 14 件（第一发明人），荣获高等学校科学研究优秀成果二等奖、上海市科学技术奖三等奖，入选上海东方英才青年项目，主持科技部重点研发课题、国家自然科学基金面上和青年等省部级及以上项目 7 项。

Title:

Liquid Crystal Integrated Metasurface Devices and Their Applications

Abstract:

多维度光信息操控在光信息科学领域具有重要意义，是信息科学部重点发展领域。将液晶材料与超表面集成，控制光场、电场、温度等外场调节，改变液晶材料的取向，通过液晶材料的几何相位或传播相位的调控赋予超表面动态可调谐的特性，探讨将其应用在光学防伪、可调结构色、复用全息成像等领域的研究。

Name: Fang Wei 魏芳

Organization: Shanghai Institute of Optics and Fine Mechanics, CAS

中国科学院上海光学精密机械研究所

Biography:

魏芳，中国科学院上海光学精密机械研究所副研究员，主要研究领域包括单频激光器、激光相频精密控制以及光纤激光时频传递。她的研究工作在光学工程领域具有重要影响，特别是在高精度光纤时频传递的实验研究方面取得了显著成果。

Title:

集成化窄线宽激光器及其在传感测量方面的应用



Name: Lingjie Zhang 章令杰

Organization: University of Electronic Science and Technology of China
电子科技大学

Biography:

章令杰，电子科技大学光电科学与工程学院微波光子研究中心讲师。主要从事微波光子学研究，在 APL Photonics、Journal of Lightwave Technology、Optics Express、IEEE Photonics Journal 等光学期刊和 ACP、ICOON 等国际会议上发表多篇学术论文，目前主持自然科学基金青年科学基金项目 1 项，参与在研国家级科研项目 2 项。曾于 2021 年获得首届全国光学与光学工程博士生学术联赛“全国百强”称号，该联赛由 Light: Science & Applications 杂志主办；于 2022 年在由中国光学工程学会主办的第七届微波光子学技术及应用研讨会上被评为“2022 年度全国微波光子学学术新星”。

Title:

基于光电振荡的微波光子耗散孤子产生及调控技术

Abstract:

在非线性宽带光电振荡器中，存在丰富的动力学现象，耗散孤子是其中一种具有代表性的现象。我们通过对非线性宽带光电振荡器施加一个外部的扰动，产生了可控的超宽带电脉冲，即微波光子时域耗散孤子。在此基础上，我们开展了系列工作，具体如下：（1）该结构具有再生记忆特性，能在撤离外部激励后，保持原先脉冲位置，基于此特性，我们实现了利用低速有理数阶谐波激励的方式产生高重复频率的脉冲序列，实现了对微波光子耗散孤子重复频率的调控；（2）在较高外部强度激励下，能产生脉冲簇，我们通过外部控制信号波形的控制，实现了对脉冲簇时域分布特性的调控；（3）通过在光电振荡环路中引入多时间尺度特性，实现了孤子分子、周期性呼吸孤子波包等孤子形状的产生及形态调控。上述研究工作为超宽带电脉冲产生和调控提供了新途径，也为神经形态光计算、超宽带雷达探测等领域提供了一种新技术。

Session 15

JAN. 13-14.2025

Exhibition Center Hall C1

Integrated Photonics and Photonic Computing

集成光子与光子计算



Name: Xiaoyong Hu 胡小永

Organization: Peking University 北京大学

Biography:

Xiaoyong Hu is the professor of Department of Physics, Peking University. His research focus on photonic crystal information processing chip.

Title:

Optical Neural Network Chip for Topological Optics

Abstract:

Photonic topological insulators provide unique photonic topological states, which offers a new platform for the on-chip information processing. We construct several silicon based optical neural network chip for the study of topological phase transition of photonic topological insulators, including ordered and disordered SSH topological insulators, AAH topological insulators. Topological phase transition laws are revealed by using the optical neural network chips.

Name: Minghui Lu 卢明辉

Organization: Nanjing University 南京大学

Biography:

卢明辉, 现南京大学现代工程与应用科学学院材料科学与工程系教授, 博导, 副院长。获首批“万人计划”中组部青年拔尖人才(2012), 国家自然科学基金委杰出青年基金计划(2016), 万人计划科技创新领军人才(2018), 江苏省特聘教授(2019)等人才计划支持。研究领域涉及光学、声学、热学、凝聚态物理等相关领域及其交叉学科领域, 主要研究方向为超构材料, 人工微结构材料、光声检测等, 迄今申请及授权中外专利 40 余项, 在 *Science*, *Nature*, *Nature Mater.*, *Nature Phys.*, *Nature Rev. Phys.*, *Nature Commun.*, *PRL*, *NSR* 等国际一流刊物上发表论文两百五十余篇, 文章他引 16000 余次, H-index 61, 2007 年获得《中国基础研究十大新闻》, 2010 年获得全国优秀博士学位论文奖, 2015 年获国家自然科学基金二等奖(排名第 2), 2021 年获南京市十大科技之星, 2024 年获江苏省青年科技杰出贡献奖等荣誉。目前兼任中国材料研究学会青委会理事、副秘书长, 中国材料研究学会超材料分会常务理事, 中国仪器仪表协会显微分会理事, 苏州市声学学会常务副理事长等职务。

Title:

Optical Neural Network Chip for Topological Optics

Abstract:

In recent years, the compact size and low transmission loss of solid-state elastic wave devices operating at microwave frequencies have garnered widespread attention in emerging fields such as wireless communication, quantum acoustics, elastic spintronics, and microwave photonics. Precise control over wave transmission is crucial to fully harness the potential of solid-state elastic waves. Phononic crystal band engineering provides an effective means to control elastic waves transport, but fabrication defects and disturbances leading to backscattering, which limits the performance of elastic wave devices. Topological effects offer an effective solution to this issue. However, the design of topologically protected elastic wave devices is complicated due to the various propagation modes of elastic waves in solids, including longitudinal, transverse, Lamb, and surface acoustic waves. This presentation focuses on achieving precise control of various types of elastic waves within the frequency range of 10 KHz to 2 GHz, and on advancing the development of novel elastic wave devices through both theoretical design and experimental fabrication of macro- and micro-nanoscale topological phononic crystals. The report highlights the active monolithic integration of lithium niobate-based topological phononic crystals, a technology that is crucial for the future development of opto-acoustic-electric hybrid integrated materials and devices.

Name: Shaojie Ma 马少杰

Organization: Fudan University 复旦大学

Biography:

Shaojie Ma, Ph.D. in Theoretical Physics from Fudan University, completed postdoctoral research at the University of Birmingham in the United Kingdom and the University of Hong Kong. In November 2022, he joined Fudan University as a Young Researcher and Ph.D. Supervisor. He has been awarded funding from overseas young talents programs and the leading talents program in Shanghai. His research focuses on electromagnetic metamaterials and topological photonics, particularly in the areas of high-dimensional topological systems, Moiré structures, and the control of electromagnetic metasurfaces, resulting in a series of innovative achievements. As of now, he has published 43 papers in authoritative academic journals, including Science, PRL, and other internationally influential journals. His work has been cited over 3100 times on Google Scholar, with an H-index of 26.

Title:

Higher-Order Topological Insulators in Photonic Metamaterials

Abstract:

Higher-order topological insulators (HOTIs) exhibit a distinctive bulk-boundary correspondence, supporting boundary states at least two dimensions lower than the bulk. While tight-binding models (TBMs) have driven significant advancements in realizing HOTIs across various physical systems, it remains an open theoretical question whether alternative frameworks beyond TBMs can exhibit similar HOTI behavior. Here, we demonstrate a cylinder with an arbitrary cross section, composed of an electromagnetic medium with nontrivial second Chern numbers $c_2=\pm 1$ in a synthetic five-dimensional space, exhibits topologically protected HOTI-type hinge states. This behavior arises from the interplay between the Weyl arc surface states, guaranteed by c_2 , and the effective magnetic field induced by unavoidable variations in the cylinder's boundary normal direction. The coupling give rise to topologically protected chiral zero modes (CZMs), which manifest as HOTI-type hinge states in three-dimensional laboratory space. We experimentally implement such a cylinder using a photonic metamaterial and confirm the existence of hinge states via microwave near-field measurements. Our findings deepen the understanding of higher-order topology and open avenues for leveraging HOTI states in photonic systems.

Name: Chunqing Gao 高春清

Organization: Beijing Institute of Technology 北京理工大学

Biography:

Prof. Chunqing GAO is a full professor in Beijing Institute of Technology (BIT), China since 2001. He received B.Sc. and M.Sc. degrees from BIT, and Ph.D. degree from Technical University Berlin, Germany. His research interests include novel laser devices and techniques, laser beam manipulation, and their applications. He has published two books and about 300 scientific papers in journals and conferences and holds 30 patents in the fields of optics and lasers.

Title:

Advances on Single-Frequency Vortex Lasers

Abstract:

Vortex beams, also known as twist beams, carry orbital angular momentum (OAM) and have attracted broad attention for more than 30 years. Many attempts have been made to generate vortex beams using passive and active methods. The passive methods usually use optical elements or systems outside the laser resonator to transform the incident beam into a vortex beam, such as cylindrical lenses, spatial light modulators, Q-plates, metasurfaces, etc. Active methods generate vortex beams directly from the laser resonator by using off-axis pumping, annular pumping, defect spot cavity mirrors, etc. In this talk the advances on single frequency vortex lasers are discussed.



Name: Kun Ding 丁鲲

Organization: Fudan University 复旦大学

Biography:

丁鲲青年研究员 2013 年毕业于复旦大学物理学系并获博士学位，导师为周磊教授。2013-2018 年，他于香港科技大学高等研究院和物理系先后担任博士后和科研助理教授，导师是陈子亭教授(Prof.C.T.Chan);2019-2020 年，他在英国帝国理工学院 Sir John B. Pendry 教授课题组从事博士后研究。2021 年 1 月丁鲲青年研究员加入复旦大学物理学系，近年来主要的研究方向为非厄米物理、涨落物理和等离子体激元。

Title:

Algebraic Skin Effect in Two-Dimensional Non-Hermitian Metamaterials

Abstract:

Non-Hermitian systems, due to their ubiquity, have drawn extensive attention. Amid the variety of phenomena, non-Hermitian skin effects (NHSEs) and the associated non-Bloch theory are at the core. Recent efforts in the generalizing of non-Bloch theory to higher dimensions reveal that the higher-dimensional non-Hermitian systems possess some unique features compared to the one-dimensional one and can give rise to the algebraic skin effect (ASE), which adds another type

to the NHSE family. Meanwhile, the one-dimensional non-Bloch theory has been pushed to the metamaterials, but it remains an open question whether the higher-dimensional generalizations and the ensuing ASE can also be extended to the metamaterials or not. By realizing this, we have utilized a photonic crystal composed of metal and air as a prototype to reveal that effective medium theory assists in demonstrating the validity of the non-Bloch theory in two-dimensional metamaterials, including the amoeba theory and distinct dimensionality of generalized Fermi surfaces. Furthermore, by mismatching the optical axis of the metamaterial and the geometric shape, we have shown the presence of ASEs in the photonic system. Our work validates the higher-dimensional non-Bloch theory in continuous systems and guides the implementation of ASEs in possible experimental realizations.

Name: Meng Xiao 肖孟

Organization: Wuhan University 武汉大学

Biography:

肖孟教授2010年从武汉大学本科毕业,并于2014年在香港科技大学陈子亭(C. T. Chan)教授课题组获得物理博士学位。此后先后在香港科技大学物理系陈子亭教授、斯坦福大学Edward L. Ginzton实验室师从范汕洄(Shanhui Fan)教授课题组从事博士后研究。2018年10月回武汉大学任教。研究方向包括:拓扑光/声学、凝聚态物理(模型构建和经典波类比验证)、非厄米系统和奇异点、光子晶体、量子光学(传输和拓扑性质)、光机系统(光声耦合)。

Title:

Arbitrarily Configurable Nonlinear Topological Modes

Abstract:

Topological modes (TMs) are typically localized at boundaries, interfaces and dislocations, and exponentially decay into the bulk of a large enough lattice. Recently, the non-Hermitian skin effect has been leveraged to delocalize the wavefunctions of TMs from the boundary and thus to increase the capacity of TMs dramatically. Here, we explore the capability of nonlinearity in designing and reconfiguring the wavefunctions of TMs. With growing intensity, wavefunctions of these in-gap nonlinear TMs undergo an initial deviation from exponential decay, gradually merge into arbitrarily designable plateaus, then encompass the entire nonlinear domain, and eventually concentrate at the nonlinear boundary. Intriguingly, such extended nonlinear TMs are still robust against defects and disorders, and stable in dynamics under external excitation. Advancing the conceptual understanding of the nonlinear TMs, our results open new avenues for increasing the capacity of TMs and developing compact and reconfigurable topological devices.



Name: Xintao He 何辛涛

Organization: Sun Yat-sen University 中山大学

Biography:

Xin-Tao He is now the Associate Professor in Sun Yat-sen University. He received the B.S. and Ph.D. degrees from Sun Yat-sen University, Guangzhou, China, in 2012 and 2017, respectively. As the head of the project, he has been funded by the general project of National Science Funding of China and the Outstanding Youth project of National Science Funding of Guangdong Province. He engages in the fundamental research of topological photonics and their applications for nanophotonics, by publishing some high-impact SCI papers such as Nature Communications, Physical Review Letters and Laser & Photonics Reviews. Nature Communications 2019 has been selected as Highly Cited Papers in ESI with the citation over 500.

Title:

Topological Anti-Scattering Transmission and Robust Beam Splitting in Artificial Micro-Nano Optical Structures

Abstract:

Photonic topological metamaterials provide theoretical guidance for the manipulation of complex optical fields. With the deep combination of nanophotonics and topological physics, numerous novel effects in optics and designs for nanophotonic devices have been achieved. This report will focus on the quantitative characterization of sharp-bending topological propagation and the prototype of a robust optical power splitter based on topological nanophotonic crystals. For one thing, we will report on the characterization of sharp-bending robustness in the integrated topological interface of valley photonic crystals (VPCs) by experimentally quantifying the bending loss below to be 0.02 dB/turn. For another, we will report on the developing a framework for topologically optical beam splitters. Tolerance analysis confirms the superiority on broad bandwidth of 48 nm and robust splitting against dimensional errors of 20 nm. These findings highlight the resilience of the sharp-bending propagation and the robust splitting ratio, as well as the potential of realizing robust and fabrication-tolerant topological nanophotonic devices in a wide variety of applications such as LiDAR, sensing, and optical coherence tomography.



Name: Jianwen Dong

Organization: Sun Yat-sen University

Biography:

Jian-Wen Dong, professor in School of Physics at Sun Yat-sen University, won the Youth Science Award of the Ministry of Education and the Top Ten China Optics Award, was supported by Cheung Kong Young Scholar Program and National Outstanding Youth Foundation. He has carried out basic and application research on (1) topological nanophotonics and PIC devices and (2) metasurface and light field imaging/display. Professor Dong presided over Key Program of the National Natural Science Foundation of China and the first batch of Outstanding youth teams of Guangdong Basic and Applied Basic Research Foundation.

Professor Dong has published 150 papers, including 5 articles in Nature series journals such as Nature Materials, 8 Physical Review Letters, and 8 Light/eLight. Additionally, he has authored 7 review papers, including a 30-page comprehensive review in Laser & Photonics Reviews. Among his research outputs, 8 papers have been recognized as ESI Highly Cited Papers, with 4 of them cited over 300 times. Professor Dong holds 8 authorized invention patents, including one U.S. patent. He serves as a board member of the Chinese Optical Society, a board member of the Chinese Society for Optical Engineering, and a board member of the China Metamaterials Society. Currently, he is the Vice Dean of the School of Physics at Sun Yat-sen University.

Title:

Topological Bilayer Metagratings

Abstract:

Asymmetric radiation is a common optical property of micro and nanoscale subwavelength structures, such as metasurfaces and photonic crystals. It is characterized by differences in the amplitude and phase of radiated fields in upward and downward directions. Achieving asymmetric radiation is crucial for enhancing the energy efficiency of photonic devices and enabling coherent light manipulation. In this talk, we introduced the novel concept of pseudo-polarization in asymmetric radiation optics, providing a unified physical framework for understanding asymmetric radiation phenomena. Our study demonstrates that topological optical modes, such as Bound States in the Continuum (BIC) and Unidirectional Guided Resonance (UGR), represent special cases of pseudo-polarization. By employing bilayer metasurfaces with lateral displacement, we achieved precise control over the generation and splitting of pseudo-polarization vortices, allowing independent manipulation of the directionality and phase difference of out-of-plane radiation fields. Furthermore, we established a connection between half-integer pseudo-polarization vortices and coherent perfect absorption (CPA), realizing robust CPA with a continuously tunable phase difference ranging from $\pi/2$ to $3\pi/2$. Additionally, we elucidated the mechanism by which asymmetric radiation influences the Fano resonance scattering spectrum, enabling high-contrast, angle and wavelength-selective imaging. This approach overcomes the traditional limitations of band dispersion in filter-based imaging. Our findings offer a novel perspective on the topological properties of asymmetric radiation optical behavior, paving the way for innovative photonic devices capable of light control and asymmetric dynamic modulation. The proposed strategies have broad potential applications in optoelectronic detection, thermal radiation, micro-LED light control, quantum emission, augmented reality, and precision bilayer nanofabrication.



Name: Daohong Song 宋道红

Organization: Nankai University 南开大学

Biography:

宋道红，南开大学教授。主要从事拓扑光子学方面的研究，重点关注拓扑光学微结构中狄拉克锥、平带相关光传输及光物理现象。近年来在 *Science*, *Nat. Mater.*, *Nat. Commun.*, *Phys. Rev. Lett.*, *Light: Sci. & Appl.* 等期刊发表论文七十余篇。主持承担了多项国家自然科学基金项目和国家重点研发计划项目课题。作为主要完成人获得天津市自然科学一等奖和首届中国光学科技二等奖。

Title:

Novel Topological Phenomena in Dirac-Like Photonic Lattices

Abstract:

狄拉克光子晶格是具有线性狄拉克锥能带的光学微结构，由于具有结构参数可调，激发探测手段便捷等特点为探究与狄拉克锥型能带相关的拓扑物态提供了便捷平台，可以实现在其他狄拉克体系中难以实现的拓扑现象。本报告将介绍我们最近在石墨烯及类石墨烯型狄拉克光子晶格中实现的多种与狄拉克锥相关的新颖拓扑态，包括石墨烯结构第四种基本边缘态、无带隙拓扑角态、狄拉克点导致的涡旋态及泵浦圆自旋态产生的光涡旋阶梯。相关研究不仅加深了对拓扑物理基本概念的理解，也为操控光场传输提供新物理机制。



Name: Mengxin Ren 任梦昕

Organization: Nankai University 南开大学

Biography:

任梦昕，南开大学物理科学学院教授。长期从事微纳体系非线性光学效应及其新式光场调控应用的研究，研究成果在 *Physical Review Letters*, *Nature Communications*, *Light: Science & Applications*, *Optica* 等物理和光学领域国际重要刊物上发表。获国家优秀青年基金、科技部重点研发计划、天津市杰出青年基金等科学基金资助。

Title:

Non-Phase-Matching Optical Nonlinearities: Challenges and Opportunities

Abstract:

Phase matching has traditionally been regarded as a cornerstone in second-order nonlinear optical processes, where both energy and momentum conservation are essential. This principle facilitates the constructive accumulation of the generated nonlinear waves within a nonlinear crystal, ensuring efficient nonlinear generation. However, the era of nanophotonics presents a significant dilemma: the demand for ultra-compact devices renders traditional phase matching techniques ineffective due to the ultrashort propagation distances involved, potentially limiting the applicability of nonlinear nanophotonic devices.

In this talk, we will delve into the nonlinear optical response of nanometer-thin lithium niobate films, where phase matching conditions are deliberately broken. This intentional phase mismatch reveals new phenomena and functionalities. We will present comprehensive measurements of the second-order nonlinear susceptibility and demonstrate the potential for polarization imaging techniques. These findings provide not only new insights into fundamental nonlinear optical physics but also suggest practical implications for the development of cutting-edge photonic technologies.

Name: Hui Liu 刘辉

Organization: Nanjing University 南京大学

Biography:

南京大学物理学院教授，博士生导师，南京大学物理学院副院长，固体微结构物理国家重点实验室副主任。2003 年南京大学博士毕业；2004-2005 年美国加州大学伯克利分校博士后；2008 年德国斯图加特大学访问学者；2009 年香港科技大学访问学者；2011 年入选教育部“新世纪优秀人才支持计划”；2012 年入选南京大学登峰人才计划 B 层次；研究成果入选中国光学杂志社评选的 2013 年“中国光学重要成果”；2014 年获得杰出青年基金资助；2015 年获得中国光学学会王大珩光学奖；2015 年获得江苏省光学科技奖；2019 年获得中国光学学会光学科技奖一等奖；2022 年获得江苏省科学技术奖一等奖，2023 年获得国家教学成果一等奖等。主持承担科技部纳米科技专项课题，自然科学基金重大项目课题。

Title:

Nodal Line in Twisted Bilayer Metasurfaces

Abstract:

Synthetic dimension plays a crucial role when studying physical properties in higher dimensions[1-5]. This work focused on the nodal line exist in synthetic dimension composed of wave vectors and twist angle in a twisted bilayer metasurface structure, it has been found that the positions of the degeneracies are tuned by twist angle, and merged together when two metasurfaces are perpendicular to each other, these degeneracies are induced by breaking of the mirror symmetry (Fig 1). We fabricated samples with different twist angle using electron beam evaporation and focused ion beam, by the analysis of the isofrequency contour, we found this structure is potentially applicable in mode phase matching, mode division.

Name: Xulin Zhang 张旭霖**Organization:** Jilin University 吉林大学**Biography:**

Xulin Zhang is a professor at Jilin University. He received his bachelor and doctoral degrees from Jilin University in 2009 and 2015, respectively. He was a visiting scholar at the Department of Physics, Hong Kong University of Science and Technology from 2016 to 2018. In recent years, he has been engaged in research on non-Hermitian photonics and integrated optics. In the past five years, he has published several papers as the first/corresponding author in journals including Nature Photonics, Nature Physics, Physical Review Letters, Nature Communications, etc.. He has led several national scientific research projects.

Title:

Integrated Photonics Based on Non-Abelian Holonomy Principle

Abstract:

Non-Abelian holonomy is a phenomenon in which multiple eigenstates of a physical system do not return to their original states after undergoing adiabatic evolution in a parameter space for one cycle. It can be seen as a matrix extension of the well-known Berry geometric phase. Due to the protection of the topological properties of the system during the non-Abelian holonomy process, the transformation of eigenstates can be achieved with high robustness based on this phenomenon, giving rise to various applications in photonics. Based on this principle, broadband and highly robust photonic devices can be designed. In this report, I will report how to apply the non-Abelian holonomy principle to Hermitian and non-Hermitian systems. In Hermitian systems, we have designed one-dimensional and two-dimensional non-Abelian Thouless pumps based on this principle, revealed the non-Abelian group behind the non-Abelian Thouless pump, and verified the non-Abelian phenomenon that the pumping results depend on the pumping order. In non-Hermitian systems, we have constructed a non-Hermitian non-Abelian holonomy process by using the interplay between non-Abelian holonomy and non-Hermitian exceptional points. Compared to the Hermitian non-Abelian holonomy process with only the degenerate degrees of freedom, this process exhibits both degenerate degrees of freedom and energy level degrees of freedom, providing new degrees of freedom for applications of non-Abelian holonomy.

Name: Cuicui Lu 路翠翠

Organization: Beijing Institute of Technology 北京理工大学

Biography:

Cuicui Lu is a professor in Beijing Institute of Technology, and a Young Changjiang Scholar of the Ministry of Education of 2022. Her research interests include topological photonics and nanophotonics. As the first or corresponding author she has published more than sixty papers in Physical Review Letters, Nature Communications, Science Advances, etc. She serves as a Topical Editor of Optics Letters, a young editorial board member of Chinese Optics Letters, APL Photonics, Chip. She received Young Scientist Award of PIERS in 2021, and Young Scientist Award of OGC in 2023.

Title:

Landau Rainbow Induced by Artificial Gauge Fields

Abstract:

The ability to generate Landau levels using pseudo magnetic field (PMF), also called artificial gauge field, opens up new pathways for exploring fundamental physics and developing novel applications based on topological protection. We realize PMF and pseudo-electric field (PEF) on a photonic crystal (PC) platform simultaneously, observe a rainbow effect of the Landau zeroth modes, and we term the phenomenon "Landau rainbow". The PMF induces a series of discretized Landau levels of photons in a similar way as the quantum Hall effect for electrons, and the PEF breaks the degeneracy of the flat band of Landau levels over a broad range, thus different frequencies of the Landau modes can be dispersed into different spatial positions. The Landau rainbow, induced by the joint action of PMF and PEF, features robustness, broadband, and scalability, and may find applications in slow-light effect, multi-frequency divider, and optical information multiplexing.



Name: Xiang Yuan 袁翔

Organization: East China Normal University 华东师范大学

Biography:

Xiang Yuan received Bachelor's and PhD degrees in physics from Fudan University in 2014 and 2019, respectively. He was a joint Ph.D. student at the University of California, Berkeley. Later that year, he joined the State Key Laboratory for Precision Spectroscopy at East China Normal University. He engaged in experimental research of topological physics, developing high magneto-infrared spectroscopy technology, and exploring topological physical phenomena in new spatial dimensions induced by a high magnetic field. Representative works include the discovery of 1D Weyl fermions, 1D Chiral Zero Modes, 3D van Hove singularities, and 3D Quantum Hall effect. Prof. Yuan was honored with a selection to the Shanghai S&T 35U35 Program and featured in the MIT Technology Review Innovators Under 35 list.

Title:

The Discovery of Three-Dimensional Van Hove Singularity

Abstract:

Arising from the extreme/saddle point in electronic bands, Van Hove singularity (VHS) manifests divergent density of states (DOS) and induces various new states of matter such as unconventional superconductivity. VHS is believed to exist in one and two dimensions, but rarely found in three dimension (3D). Here, we report the discovery of 3D VHS in a topological magnet EuCd_2As_2 by magneto-infrared spectroscopy. External magnetic fields effectively control the exchange interaction in EuCd_2As_2 , and shift 3D Weyl bands continuously, leading to the modification of Fermi velocity and energy dispersion. Above the critical field, the 3D VHS forms and is evidenced by the abrupt emergence of inter-band transitions, which can be quantitatively described by the minimal model of Weyl semimetals. Three additional optical transitions are further predicted theoretically and verified in magneto-near-infrared spectra. Our results pave the way to exploring VHS in 3D systems and uncovering the coordination between electronic correlation and the topological phase.

Name: Yanji Zheng、Lulu Cui

Organization: Beijing Institute of Technology

Biography:

Yanji Zheng is a PhD student at the School of Physics, Beijing Institute of Technology. His research interest is topological photonics. Cuicui Lu is a professor in Beijing Institute of Technology, and a Young Changjiang Scholar of the Ministry of Education of 2022. Her research interests include topological photonics and nanophotonics. As the first or corresponding author she has published more than sixty papers in Physical Review Letters, Nature Communications, Science Advances, etc. She serves as a Topical Editor of Optics Letters, a young editorial board member of Chinese Optics Letters, APL Photonics, Chip. She received Young Scientist Award of PIERS in 2021, and Young Scientist Award of OGC in 2023.

Title:

Landau Rainbow Induced by Artificial Gauge Fields

Abstract:

The ability to generate Landau levels using a pseudomagnetic field (PMF), also called an artificial gauge field, opens up new pathways for exploring fundamental physics and developing novel applications based on topological protection. We simultaneously realize a PMF and a pseudoelectric field (PEF) on a photonic crystal platform and observe a rainbow effect of the Landau zeroth modes. While a PMF induces a series of discretized Landau levels of photons in a similar way as the quantum Hall effect for electrons, a PEF breaks the degeneracy of the flat band of Landau levels over a broad range. Different frequencies of the Landau modes can be dispersed into different spatial positions, leading us to term this phenomenon the “Landau rainbow.” The Landau rainbow, induced by the joint action of PMFs and PEFs, features robustness, broadband capability, and scalability, and may find applications in areas such as slow-light effect, multifrequency divider, and optical information multiplexing.



Name: Yinghui Lv

Organization: East China Normal University

Biography:

I am Lv Yinghui, a doctoral student of Professor Jing Jietai's research group from the State Key Laboratory of Precision Spectroscopy Science and Technology of East China Normal University. My research direction is quantum information, and the paper on the poster has been published in Physical Review Letters.

Title:

Deterministic All-Optical Continuous-Variable Quantum Telecloning

Abstract:

Quantum telecloning, a pivotal multiuser quantum communication protocol in the realm of quantum information science, facilitates the copy of a quantum state across M distinct locations through teleportation technique. In the continuous-variable regime, the implementation of quantum telecloning necessitates the distribution of multipartite entanglement among the sender and M receiver parties. Our scheme allows the two receivers to achieve input state reconstruction solely by utilizing beam splitters, significantly simplifying its complexity. We experimentally demonstrate all-optical $1 \rightarrow 2$ quantum telecloning of coherent state and achieve the fidelities of $58.6\% \pm 1.0\%$ and $58.6\% \pm 1.1\%$ for two clones, exceeding the corresponding classical limits ($51.9\% \pm 0.5\%$ and $51.9\% \pm 0.6\%$). Our results establish a platform for constructing a flexible all-optical multiuser quantum network and promote the field of all-optical quantum information processing.

Name: Qianglong Yang

Organization: Shenzhen University

Biography:

杨强龙，深圳大学物理与光电工程学院 2024 级光学工程专业博士生，主要研究方向为生物医学与光子学。

Title:

Cellular lipid studies based on coherent anti-Stokes Raman scattering

Abstract:

Modern optical microscopy can visualize microscopic biological tissues, and nonlinear microscopy has great potential in vivo imaging in a label-free way, one of the powerful imaging methods is coherent anti-Stokes imaging, which can produce a resonant response to the vibration of specific chemical groups, especially lipids, and the main constituent substances of cell membranes are lipids, as a medium for the transmission of energy and information, which can help us understand the process of metabolism and information transduction at the biological cell level within cancer. We have achieved coherent anti-Stokes imaging of cellular lipids using a spectrally focused approach and summarized future work.



Name: Zhaoyuan Zhang

Organization: Shenzhen University

Biography:

深圳大学在读博士生，光电信息工程专业。硕士毕业于长春理工大学，研究方向为空间光通信及其组网应用，发表SCI论文1篇。

Title:

基于逆向调制的光空分多址无线激光通信技术

Abstract:

近年来，空间光通信技术由于其通信容量大、传输速率高、保密性好等优点蓬勃发展，点对点通信模式已有成熟的工程化应用，在卫星通信和深空探测等领域发挥重要作用。当前，不管是无人机集群作业，微小卫星星座组网，还是应急救援现场临时组网等前沿场景，都对空间光通信稳定性、设备轻量化、低能耗以及便携部署提出严苛要求，轻小型、低功耗、多节点已经成为空间光组网通信面临的主要挑战。鉴于此，基于光空分多址原理，提出空间光组网通信总体方案，深入探究其中关键技术：一方面，专注于设计实现端机轻小型、低功耗的逆向光学系统，从光学设计、光机结构设计等多个维度着手，降低端机体积与重量，控制功耗；另一方面，构建空间光耦合效率模型，精确量化光信号在空间传输与耦合过程中的能量变化情况。针对存在大气湍流干扰的复杂实际通信环境，深入研究优化策略，提升有大气湍流时空光的耦合效率，保障光信号稳定、高效传输，对促进空间光通信更广泛应用、更深入发展具有重要作用。

Name: Tengfei Wu

Organization: AVIC Changcheng Institute of Metrology & Measurement

Biography:

武腾飞, 中国航空工业集团公司北京长城计量测试技术研究所, 研究员, 研究方向为飞秒光梳计量测试技术及应用; 赵春播, 中国航空工业集团公司北京长城计量测试技术研究所, 高级工程师, 研究方向为飞秒光梳测距技术及工程应用; 马丹妮, 中国航空工业集团公司北京长城计量测试技术研究所, 工程师, 研究方向为飞秒激光测距及太赫兹探测技术; 夏传青, 中国航空工业集团公司北京长城计量测试技术研究所, 高级工程师, 研究方向为新兴飞秒激光器及频率梳技术。

Title:

基于光频梳校正的非合作目标测距技术研究

Abstract:

在精密测量及装配领域, 不依赖合作目标开展高精度测距的能力需求日益广泛, 针对低反射率目标、弱回波信号的大尺寸高精度测距技术越来越受到关注, 而基于宽带可调谐光源的调频连续波测距技术由于在针对低反射率目标、弱回波信号方面具有优异的探测能力和高分辨测量能力逐渐成为研究热点。但是基于该技术的测距系统极易受到宽带光源调频非线性的影响从而引起测量回波信号频谱展宽, 造成测量分辨率下降, 因此开展光源系统调频非线性的校正研究就显得尤为必要。本研究从该需求出发, 利用光学频率梳高频率稳定度的特点开展调频非线性校正, 并在 2m 和 38m 处的硬反射目标(铝合金)完成了调频连续波测距试验, 其中在 38m 附近测量重复性均优于 $17.4 \mu\text{m}$ 。

Name: Ru Yuan

Organization: National Times Service Center, CAS

Biography:

袁茹，中国科学院国家授时中心，从事光纤光学频率传递相关研究。

Title:

基于光注入锁定的光学放大系统用于光频传递

Abstract:

光放大是延长光学频率传输距离的必要条件，对传输性能有重要影响。传统的 EDFA (掺铒光纤放大器) 是光频传输中最常用的光纤放大器。EDFA 虽然可以实现光放大，但由于其双向放大的特性限制了其最大增益，而且 EDFA 端面反射、瑞利散射产生了不必要的光损耗，再加上 ASE (放大自发辐射) 噪声影响，这样就很容易触发激光效应。当光纤链路过长，EDFA 增益小，无法补偿光功率损耗。一般情况下最佳增益限制在 20 dB 左右，相邻 EDFA 之间的距离不超过 100km，否则多余的损耗将随着长距离而累积。

为了解决以上问题，我们设计了一种基于光学注入锁定的高增益光学放大系统，该系统能够满足两个站点之间超过 200 公里的光频传输要求。实验表明，该系统可以实现增益超过 60dB 的光放大。在进行有效的噪声抑制后，该放大系统秒稳可以达到 5.56×10^{-17} ，万秒稳可以降至 1.58×10^{-20} 。基于该高性能系统，在长度为 200km 实验室光纤进行了测试，实现了具有 3.40×10^{-15} 稳定度的相干光传输，并且在 10000 秒时，经过修正的 Allan 偏差降至 3.39×10^{-20} 。

Name: Yuxuan Ren (任俞宣)

Organization: East China Normal University

Biography:

任俞宣，2021 年于长春理工大学获得理学学士学位，现为华东师范大学精密光谱科学与技术国家重点实验室 2021 级硕博连读学生

Title:

Ultrafast Nyquist Pulses in Mode-Locked Fiber Lasers

Abstract:

Nyquist pulses have wide applications in many areas, from electronics to optics, Mode-locked lasers are ideal platforms to generate such pulses. However, how to generate high-quality Nyquist pulses in mode-locked lasers remains elusive. We address this problem by managing different physical effects in mode-locked fiber lasers through extensive numerical simulations. We find that net dispersion, linear loss, gain and filter shaping can affect the quality of Nyquist pulses significantly. We also demonstrate that Nyquist pulses experience similariton shaping due to the nonlinear attractor effect in the gain medium. Our work may contribute to the design of Nyquist pulse sources and enrich the understanding of pulse shaping dynamics in mode-locked lasers.

Name: Bin You

Organization: East China Normal University

Biography:

PhD student of State Key Laboratory of Precision Spectroscopy, School of Physics and Electronic Science, East China Normal University

Title:

Strong Coupling between Moiré-type Plasmons and Phonons

Abstract:

Moiré superlattice is obtained by simple superposition of two identical periodic lattices. The twisted two-dimensional materials provide a pathway towards superconducting by adjusting the interlayer coupling or the band structure of constituent layers. In photonics, moiré superlattices have demonstrated high-quality factor characteristics, rainbow trapping, interlayer excitons modification, chirality, biosensing, heat transferring, and the enhancement of spontaneous emission. As a fundamental optical phenomenon, strong coupling between photons and condensed matter holds great scientific importance. However, there is a lack of research on the strong coupling between the moiré-type plasmons and the phonons. Here, we demonstrate a strong coupling phenomenon between moiré-type plasmons and phonons within moiré-superlattices both experimentally and analytically. We study the dependence of moiré wave vector and the twist angle, numerically simulate and experimentally fabricate metallic moiré superlattices on a suspended thin film SiO₂ substrate at different twist angles. The results suggest that the coupling strength initially increases and then decreases with increasing twist angles. When the twist angle is at 16.26°, we achieve a moiré-type plasmon-phonon strong coupling with a Rabi splitting strength approaching 45 meV. We further analyze the coupling system by utilizing the coupled-harmonic-oscillators theory and quantum mechanical theory. The calculations and numerical simulations further agree with the experimental results. The proposed strong coupling system has the potential to contribute substantially in electromagnetic field controlling and coupling. These results suggest that the geometric designs play an important role on the coupling strength within the plasmon-phonon coupling systems. Our work illustrates that how photons can be controlled by the plasmonic moiré superlattices through the coupling of moiré-like plasmons and phonons. This robust coupling system has the potential to advance research in the realm of plasmon-phonon polaritons, particularly in the exploration of moiré-like structures or other nanostructures with superlattices. In addition, the findings may hold potential for applications of coupling systems in quantum computing and communicating devices.

Name: Zhengru Guo

Organization: University of Shanghai for Science and Technology

Biography:

郭政儒，上海理工大学副研究员。研究方向为高功率飞秒激光技术及应用。发展了一种新型腔内滤波与激光锁模脉冲产生新方法，并结合固体激光放大技术实现了百瓦级，10 毫焦的大能量固体超快光源，相关产品获 2023 年“红光奖——超快激光器创新奖”。主持国家自然科学基金、国家重点研发计划等多项课题。研究成果发表在在包括 HIGH POWER LASER SCI., IEEE J. Light. Technol., APPL. PHYS. LETT., 等国际国内知名期刊上。授权国际国内发明专利十余项。

Title:

Spectrally-Divided Broadband Chirped Pulse Amplification using a Compact Zigzag

Abstract:

We propose a scalable folding geometry for CPA dispersion management that allows a 10-fold increase of the stretched pulse duration and a 3-fold increase of damage-limited extractable pulse energy compared to a standard grating-pair compressor with the same aperture.

Name: Mingkun Li

Organization: National Timing Center, CAS

Biography:

李铭坤，本科及硕士均就读于西北工业大学物理系，博士毕业于中国科学院大学测试计量技术及仪器专业，现任中国科学院国家授时中心助理研究员，主要从事飞秒光梳及其应用的研究，研究方向主要为飞秒激光器及超连续谱产生。

Title:

掺铒光纤激光器基于 EOM 的载波包络相移频率控制研究

Abstract:

光学频率梳能够进行光频和微波之间的频率转换，在时间频率计量、精密光谱学及基本物理常数测量等领域具有重要的应用价值。光梳的实现需要对锁模激光器进行载波包络相移频率（f_{ceo}）和重复频率/纵模频率控制。传统的 f_{ceo} 控制是通过泵浦电流调制来实现的，驱动电流的变化引起泵浦功率的变化，泵浦功率的变化再作用于受激辐射过程来实现噪声抑制。由于受激辐射响应速度的限制，泵浦电流调制的响应速度相对较低，控制带宽较小，通常在几十 kHz 量级。本文基于 NALM 锁模掺铒光纤激光器的提出了一种宽带频率控制方案，在 NALM 的 Sagnac 环中加入了电光偏振调制器，通过泵浦电流与激光偏振态的协同反馈对 f_{ceo} 的控制。EOM 具有更快的响应速率，因而能够实现更大的锁定带宽，同时泵浦电流反馈环路可以进一步抑制 f_{ceo} 的低频噪声。利用这种方案，我们将锁定带宽从单纯电流锁定时的 70 kHz 提升至 130 kHz，同时 f_{ceo} 的均方根时间抖动也由 0.75 fs 降至 0.54 fs。该方案有效提升了 f_{ceo} 的锁定带宽，降低了光学频率梳中 f_{ceo} 引入的相位噪声。

Name: Bingjie Rao

Organization: National Timing Center, CAS

Biography:

饶冰洁，女，中国科学院国家授时中心助理研究员。本科毕业于西北工业大学光信息科学与技术专业，硕士研究生毕业于西北工业大学光学工程专业。目前，博士就读于中国科学院大学测试计量技术及仪器。

Title:

用于铷频标稳定度测量的全保偏掺铒光纤光梳系统

Abstract:

飞秒光梳又称光学频率综合器，可以直接对光学频率进行测量，在天文光谱学的测量和定标、激光频率标尺、绝对距离测量和精密光谱测量等方面均有广泛应用。同时，基于无多普勒效应的铷双光子 S-D 跃迁具有更窄线宽及更低敏感性等优点，使其在频率标准中备受青睐。在利用光梳进行铷频标稳定度测量时，有两个必要条件：（1）光梳的频率控制稳定度满足铷频标稳定度的测量精度需求，（2）光梳输出光谱覆盖铷频标光谱。基于此，我们介绍了用于铷频标稳定度测量的“9”字腔掺铒光纤飞秒光梳系统的研制。该系统以“9”字型全保偏掺铒飞秒光纤激光器为激光源，输出光谱中心波长为 1554 nm，半高全宽约为 47 nm，重复频率为 200 MHz。通过 f-2f 自参考技术，搭建的光梳系统 fceo 信噪比约为 38 dB (RBW=300 kHz)，可满足锁定系统对 fceo 信噪比的需求。利用自制的锁相环电路，采用 EOM 与 PZT 等频率控制器，实现了光梳系统的长期稳定运行，frep 和 fceo 的环内秒级稳定度分别为 5.35×10^{-13} 和 5.15×10^{-18} 。在此基础上，光谱倍频及拍频单元将光梳光谱扩展至铷频标波长处，获得的 778nm 单模功率为 8515 nW，搭建拍频光路获得光梳与铷频标拍频信噪比为 35dB (RBW=300 kHz)，满足后续铷频标稳定度测量信号提取所需信噪比。

Name: Weichen Jia

Organization: Tsinghua University

Biography:

贾伟辰，清华大学精密仪器系博士研究生，主要研究兴趣为原子束干涉惯性传感器。

Title:

面向惯性导航应用的双轴原子束干涉惯性传感器

Abstract:

光脉冲原子干涉仪为新一代长航时、超高精度自主导航提供潜在解决方案。其中，基于连续型原子束源的原子干涉惯性传感器具有高数据更新率、大带宽、易闭环的特点，有望实现量子惯性传感器在动态环境下的实际应用。本文基于双向对射的横向冷却热原子束，实现面向双轴角速度-加速度同位同时测量的原子干涉惯性传感器。
本文所提出并实现的原子干涉惯性传感器如图 1 所示。双路对射 87Rb 原子束分别被二维光学粘胶横向冷却后，与一对拉曼脉冲 ($2L=0.54\text{m}$) 作用，形成双拉曼-马赫曾德尔 (Raman-Mach-Zehnder) 原子干涉仪。基于拉曼光相位调制和正交解调方法，实现干涉相移的高信噪比提取，并基于相位解卷绕方法拓展其无歧义动态范围。使用干涉相移的平均/差分解耦实现了角速度和加速度信号的无死区时间同位同时输出，基于干涉相移调控以模拟惯性输入，测试得到原子干涉惯性传感器的带宽约为 294Hz。通过在气浮平台上与高精度光纤陀螺仪和石英加速度计输出进行比对，验证了所搭建传感器的惯性敏感能力，据我们所知，这是国际上首次实现原子干涉惯性传感器无死区时间的双轴角速度-加速度解耦的惯性效应演示。
面向超高精度原子干涉惯性测量，本文基于三对空间拉曼光两两拍频和正交解调的光学干涉方法，实现了拉曼光初始相位所引入的非惯性干涉相移的直接测量及其闭环稳定。如图 2 所示，锁定后非惯性相移的周期波动被显著抑制。基于 Allan 标准差的分析表明，锁定后非惯性相移的波动降低约 96% (积分时间 1000s)，为实现长期稳定的原子干涉惯性绝对测量提供必要条件。
综上所述，本文所提出的原子干涉惯性传感器实现了双轴惯性量的大带宽、无死区时间同位同时复合测量。在后续的工作中，作者们将致力于进一步评估和提升当前传感器的精度、动态范围及测量轴数，实现动态环境中实用化的量子惯性测量单元。

Name: Shengzhe Wang

Organization: Tsinghua University

Biography:

王圣哲，清华大学博士研究生，研究课题与兴趣为：冷原子束制备、原子干涉、原子干涉惯性传感器。

Title:

低退相干的紧凑三维冷却原子束源

Abstract:

连续三维冷却原子束源能够输出三维低温、连续、速度可调的冷原子束，在原子干涉惯性传感器、原子钟等方面具有重要意义，同时能够为量子计算、玻色-爱因斯坦凝聚态等领域提供低相空间密度的连续物质波源。对于上述应用，物质波包的相干性十分重要。基于二维(Two Dimensional, 2D)磁光阱(Magneto Optical Trap, MOT)，三维(Three Dimensional, 3D) MOT, 2D+MOT 等的冷原子束源通常会产生沿着原子输出轨迹的冷却光，导致原子物质波包的退相干，从而不利于原子干涉、量子计算以及 BEC 等应用。我们提出并实现了一种低退相干的紧凑连续三维冷却 ^{87}Rb 原子束。我们通过真空腔内的反射镜将两对倾斜的 OM 光集成在 2D MOT 当中。2D MOT 用于原子束的横向冷却，倾斜 OM 的频率设定在移动参考系，将冷原子团输出为冷原子束的同时大幅减小进入后续腔体的冷却光，从而降低了原子束的退相干性。2D MOT 与 OM 在空间位置上错位，接近原子束输出位置的区域由 2D MOT 主导，提高了原子束通量。整个冷却区域仅有 50mm 长。目前在实验上使用飞行时间法测得该原子束源产生通量 $2.5 \times 10^9 \text{ s}^{-1}$ ，纵向温度为 $866 \mu\text{K}$ ，速度可在 10-20m/s 内调节。基于多普勒敏感 Raman 跃迁测得横向温度为 $209 \mu\text{K}$ 。基于 Raman-Ramsey 干涉，我们评估了该原子束源的退相干性。Raman 光分离距离为 100mm 时，Ramsey 干涉信号对比度高达 88.46%，表明具有很低的退相干性。这种低退相干的紧凑三维冷却原子束源有利于构建高带宽、高灵敏度的冷原子束干涉仪以及冷原子束钟，也能够用于基础物理学研究领域。

Name: Zhiguang Xia

Organization: University of Chinese Academy of Sciences

Biography:

夏志广，1998 年生，在读博士研究生，目前就读于中国科学院大学，导师是中国科学院国家授时中心董瑞芳研究员。研究方向为量子光源、量子光学、量子时间同步。在 *Physical Review Applied*, *Optics Express* 等期刊发表论文 13 篇，发明专利 3 篇（含美国专利）。

Title:

Superimposed quantum two-way time transfer based on energy-time entangled source

Abstract:

Quantum two-way time transfer (Q-TWTT) possesses high precision and security advantages. Nevertheless, the performance of time transfer can be affected by the jitter of the transmission wavelength. In this study, we demonstrated a superimposed quantum two-way time transfer (SQ-TWTT) based on energy-time entangled biphoton sources. The entangled photon pairs are transmitted to the opposite end via a common transmission technology, replacing the separate transmission after polarization discrimination in Q-TWTT. Eventually, two sets of Q-TWTTs (specifically, Q-TWTT1 and Q-TWTT2) will be obtained, and the SQ-TWTT can be theoretically calculated based on Q-TWTT1 and Q-TWTT2. Compared with Q-TWTT, SQ-TWTT has the protocol advantage of being insensitive to the jitter of the transmission wavelength. We verified the feasibility of our protocol over a 103 km spooled fiber links, and evaluated the timing stability performance using time deviations (TDEV). At an average time of 5120 s, the measured TDEVs for SQ-TWTT, Q-TWTT1 and Q-TWTT2 were 0.111 ps, 0.256 and 0.313 ps, respectively. Furthermore, we compared the performance of SQ-TWTT with Q-TWTT in consistent spatiotemporal settings. Both the short-term and long-term stabilities of SQ-TWTT are superior, respectively. These results show good agreement with theoretical expectations, highlighting the advantages of SQ-TWTT in the fields of high-precision time transfer and quantum network in the future.

Name: Xin Chen

Organization: National Timing Center, CAS

Biography:

陈鑫，中国科学院国家授时中心助理研究员及中国科学院大学在读博士生，从事光学频率梳及其控制技术和应用的研究。

Title:

与微波参考同步实现 10^{-19} 级相对稳定的光学频率梳的理论和实验研究

Abstract:

This manuscript delves into groundbreaking theoretical and experimental methodologies for ascertaining the repetition frequency (fr) stabilization of erbium-doped fiber optical frequency combs (OFCs). Pioneering in its approach, this investigation introduces a theoretical mathematical framework that incorporates measurable ambient noise from free-running operations to simulate the relative phase noise and stability of the OFC fr. Furthermore, this study has crafted a novel fr stabilization technique for OFCs, employing a phase-locked loop (PLL) integrated with a PFD+PIID system—a combination of a phase frequency detector and a proportional, first-order integral, second-order integral, first-order differential controller. The research has successfully derived the phase noise suppression factor (PSF) and the frequency stability suppression factor (SSF), which are pivotal for delineating the noise suppression features of the system. With synchronization to a microwave reference (REF), the study has accomplished remarkable relative frequency stabilities for OFCs: 2.81×10^{-15} at 1 second and 8.08×10^{-19} at 10,000 seconds for the 200 MHz fundamental frequency lock, and 4.25×10^{-16} at 1 second and 1.91×10^{-19} at 10,000 seconds for the 1200 MHz harmonic lock. The alignment between simulated and experimental outcomes is commendable, substantiating the accuracy of the theoretical model and experimental setup. This work paves the way with the inaugural reliable theoretical model for forecasting OFC lock stability, substantially enhancing the relative frequency stability of OFCs.

Name: Wenbin Wu

Organization: East China Normal University

Biography:

2020 年获浙江师范大学物理学学士学位，目前为华东师范大学精密光谱科学与技术国家重点实验室五年级博士研究生（硕博连读），导师为袁翔教授。研究方向为拓扑凝聚态物理的实验研究，主要聚焦发展强磁场红外光谱学技术并对磁场诱导的新空间维度拓扑物态及其电磁响应开展光谱学研究，其中代表性工作为在三维拓扑绝缘体中发现一维外尔费米子、在拓扑磁体中发现三维范霍夫奇点。以第一作者/共同一作发表 Nature Materials 1 篇、Nature Communications 1 篇、Advanced Science 1 篇。曾获博士研究生国家奖学金，入选国家自然科学基金委中德科学中心“林岛学者”，主持华东师范大学优秀博士生创新能力提升计划项目。

Title:

拓扑磁体 EuCd₂As₂ 的强磁场红外光谱学研究

Abstract:

由于时间反演对称性破缺，磁性外尔半金属磁性中允许只存在一对外尔点。从外尔半径半金属的最小模型出发，当固定外尔锥的面内费米速度而改变外尔锥面外费米速度时，我们发现当面外费米速度到达一临界值时，磁性外尔半金属能带会产生一个三维范霍夫奇点，在态密度上表现为发散行为，从而能够极大地影响体系的电磁响应。通过强磁场红外光谱，我们在拓扑磁体 EuCd₂As₂ 实现了上述物理的探究。外磁场下，EuCd₂As₂ 中磁性原子的内禀磁矩被有效调控，并进一步影响巡游电子与局域磁矩之间的交换相互作用，能带发生劈裂和移动。拓扑磁体 EuCd₂As₂ 在其磁性基态被认为是反铁磁拓扑绝缘体，当沿其 c 轴外加磁场时，能带发生自旋劈裂并交叉成一对外尔点，系统进入外尔半金属相。随着外磁场的增加，能带翻转程度不断加深，使三维外尔锥的费米速度增加。实验发现，当外磁场到达临界磁场 0.6 T 时光谱上突然出现显著的带间跃迁，证明了三维范霍夫奇点的形成。这一三维范霍夫奇点在能量位置、态密度以及光学活性上均表现出磁场可调性。通过在外尔半金属最小模型中引入交换作用我们对磁红外光谱上的中红外特征进行了定量描述并且进一步预言了位于近红外波段的三个光学跃迁以及相应的能量交叉。预言的光学跃迁在自主搭建的近红外磁光谱系统上进行了验证。我们的实验结果证明了在磁性外尔半金属中通过外加磁场实现三维范霍夫奇点，同时为研究磁性与拓扑相的相互作用提供了材料体系和光谱技术。

Name: Zhen Zhang**Organization:** East China Normal University**Title:**

Development and Application of Mid-Infrared Interfacial Quantum Materials

Abstract:

The infrared materials in this study have a strong emission radiation capability at 3 - 12 μm wavelength, and realize the precise control of optical and thermal properties in the mid-infrared (3 - 15 μm), and also make corresponding breakthroughs in nano-fabrication and interfacial engineering, which enhance the energy conversion efficiency and functionality of mid-infrared materials. Firstly, we prepared enhanced infrared LED devices. We used graphene as a substrate to prepare conductive device structures that can enhance infrared LEDs, and the stripe patterns on their surfaces can ensure a uniform electric field distribution and thus improve the radiation efficiency. Diverse excitation methods enable the material to achieve fast response, wide-band radiation (including multi-band or continuous-band infrared radiation) for a variety of different applications. At the same time, we have also developed a conductive flexible fiber, overcoming the traditional infrared difficult to larger modulus of elasticity and smaller deformation tolerance limit, to achieve the advantages of wearable, bendable flexibility, etc., the flexible fiber in the 5 - 12 μm wavelength also has a strong emission ability, and in different electrical excitation has a unique infrared thermal imaging performance, support for the electric field tuning of infrared emission, which for biomedical and other fields of applications This lays the foundation for biomedical applications. Its spectrum has the ability to be tuned in the atmospheric transparent window, and at the same time in the electric field tuning is also has good cyclic stability, as well as excellent radiation properties. All demonstrate the unique advantages and prospects of this material. Through the comparison with the traditional infrared thermal imager and RGO (graphene oxide) and the emissivity of ultra-wide band synergistic infrared emission materials, the new material in the same power, can greatly improve the energy conversion efficiency from electrons to infrared photons, which has a significant advantage in the energy utilization and efficiency improvement. This advantage can be visualized more clearly from radiation temperature comparison charts and the like. These materials show potential for energy technologies (e.g., energy conservation, etc.) that contribute to sustainable development. This will lead and promote the development of the fields of photonics and thermodynamics, which will have a wide range of future applications and development in a number of fields.

Name: Xin Zhou

Organization: East China Normal University

Title:

Mg-doped α -Ga₂O₃ nanorods for the construction of photoelectrochemical-type self-powered solar blind UV photodetectors and underwater imaging application

Abstract:

Underwater imaging technologies are increasingly crucial for environmental monitoring and resource exploration. However, the development of advanced photodetectors for such applications faces significant challenges, including interference from ambient visible and infrared light, adaptation to underwater environments, and cost-effectiveness. Photoelectrochemical-type solar-blind photodetectors (PEC-SBPDs) based on wide bandgap semiconductors have shown great promise in overcoming these challenges. Here, we present a novel approach to enhance the performance of α -Ga₂O₃-based PEC-SBPDs for underwater imaging through Mg-doping. By employing a low-cost hydrothermal synthesis technique, Mg-doped α -Ga₂O₃ nanorod arrays were fabricated, which induced the formation of V_O-Mg_{Ga} complexes that enhanced the interfacial catalytic activity and improved the transport of photogenerated carriers. The optimized PEC-SBPDs exhibited a remarkable 435% increase in photocurrent response compared to undoped α -Ga₂O₃, with a peak responsivity of 34.54 mA/W. A 5×5 PEC-SBPD array based on Mg-doped α -Ga₂O₃ nanorods was successfully demonstrated for underwater solar-blind imaging, achieving clear and efficient imaging in challenging underwater conditions. This study not only highlights the superior performance of Mg-doped α -Ga₂O₃ in underwater environments but also opens new avenues for the development of high-performance self-powered photodetectors in imaging, sensing, and other related applications.

Name: Shupeng Xu

Organization: East China Normal University

Title:

Femtosecond Plasma Grating-Induced Breakdown Spectroscopy: Technique and Applications

Abstract:

Nonlinear interaction of two or three synchronized coplanar filaments was demonstrated to generate plasma gratings with high electron density capable of effectively exciting samples. As the laser pulse energy increases, the full width at half maxima (FWHM) of spectral lines decreases, and the plasma lifetime is prolonged, particularly when using three coplanar coupled filaments, which results in an increase in plasma lifetime of approximately 50–60 nanoseconds compared to using two filaments. These findings not only indicate the potential of high-electron density in plasma gratings could improve the application of filament-induced breakdown spectroscopy by enhancing spectral resolution, radiative lifetime, and spectral reproducibility, but also prompt further exploration of plasma grating-induced breakdown spectroscopy (GIBS) in the field of trace metal element detection. In a study utilizing plasma gratings to create micropores and nanoparticles on a silicon sample surface, it was found that these features significantly enhance spectral intensity. For instance, at a laser energy of 2.7 mJ, the spectral intensity of the Si plasma increased by 2.4 times. Furthermore, the micropore structures and nanoparticles promoted the spectral intensity of Cr and Cd elements in water, with the intensity in the etched area being approximately 4.5 and 2.6 times that of the unetched area, respectively. The detection limits for trace levels of Cr and Cd in water were determined to be 6.40 mg/L and 75.0 mg/L, respectively. These findings highlight the promising potential of the enhanced GIBS as a more sensitive method for detecting trace metal elements in water.

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Application of multi-beam and multi-pulse plasma grating based controlled laser induction technology in femtosecond laser processing

Abstract:

Laser Induced Periodic Surface Structuring (LIPSS) has become a hot spot for many researchers to focus on due to its promising wide range of applications in the field of surface nanostructuring. However, there are many serious challenges in the preparation of LIPSS. When the high peak power laser is operating, the strong nonlinear effect will make the laser-material interaction extremely complicated, making the surface morphology difficult to precisely control and ultimately forming an irregular surface morphology. This affects the aesthetic appearance of the material surface and reduces the consistency and stability of the material surface properties. To cope with these difficulties, this study innovatively proposes and successfully validates a multi-beam femtosecond laser plasma grating method, which skillfully decomposes the femtosecond laser beam into multiple coherent light beams. At the same time, the time domain of the laser beams was precisely adjusted to ensure that they remained consistent in time, and the crossing angle of the laser beams was carefully adjusted so that the femtosecond pulsed intense light field was nonlinearly coupled at the crossing point, resulting in a regular light field. After pretreatment of the surface of the reinforced material, the formed regular light field is applied to the material's surface such as titanium alloy. At this point, the regular light field interacts with the material, instantaneously generating a plasma shock wave that initially processes the material and subsequently forms a unique plasma grating structure. Subsequently, the structure couples with the subsequent laser beam to generate a finer light field. By utilizing this fine-structured light field to deeply process and strengthen the surface of the material, not only regular nanoscale periodic structures are successfully induced on the surface of the titanium alloy, but also the coupling of the femtosecond laser field with the plasma grating structure effectively reduces the irregularity of the self-assembled structure and significantly extends the duration of the plasma shock wave. This series of action mechanisms not only improves the laser processing efficiency but also enhances the structural stability of the material so that the material can still maintain good performance under various complex external environments. This method opens up a new path for material surface treatment technology, which is expected to realize a wider range of applications in many fields and promote the technological upgrading and innovative development of related industries.