# AGENDA OVERVIEW (Virtual Part)

## Sept. 15, 2021

### 10:00-17:00

| Zoom Meeting ID | *Room 1 ID: 979 0046 1385* | *Room 2 ID: 930 3313 8929* |
|---|---|---|
| *Item* | Invited Speaker Equipment Test | Authors Equipment Test |

## Sept. 16, 2021

### 14:30-17:00 Virtual Sessions

| Zoom Meeting ID | *Room 1 ID: 979 0046 1385* | *Room 2 ID: 930 3313 8929* | *Room 3 ID: 827 9043 9167* | *Room 4 ID: 816 7808 8000* |
|---|---|---|---|---|
| *Session No.* | V01 | V02 | V03 | V04 |

***V01: Laser Technology** <Chair: Longqing Cong>
Invited Speeches (Mohammed Zahed Mustafa Khan; Yanhua Luo);
Oral Presentations (G2977, G2952, G2929, G295)

***V02: Optical Communication and Networks - A** <Chair: Biao Chen>
Invited Speeches (Wenjia Zhang; Chongfu Zhang); Oral Presentations (G2955, G29151, G2974, G2935)

***V03: Near-infrared, Mid-infrared and Far-infrared Technologies and Applications** <Chair: Chuantao Zheng>
Invited Speeches (Yuan Ren; Chuantao Zheng; Wenxue Li); Oral Presentation (G29125)

***V04: Quantum Optics and Information** <Chair: Qiang Zhou>
Invited Speeches (Jie Zhao); Oral Presentations (G2944, G2979, G2958, G2954)

## Sept. 17, 2021

### 10:00-12:15 Virtual Sessions

| Zoom Meeting ID | *Room 1 ID: 979 0046 1385* | *Room 2 ID: 930 3313 8929* | *Room 3 ID: 827 9043 9167* | *Room 4 ID: 816 7808 8000* |
|---|---|---|---|---|
| *Session No.* | V05 | V06 | V07 | V08 |

***V05: Biophotonics and Optical Biomedicine** <Chair: Wenjun Ni>
Invited Speeches (Quan Liu; Zhenhua Hu; Tzuen-Rong Jeremy Tzeng);
Oral Presentations (G29139, G2916)

***V06: Optoelectronic Devices and Applications** <Chair: Mengyuan Ye>
Invited Speeches (Changzheng Sun; Mengyuan Ye; Weiqiang Xie; Sunny)

***V07: Perovskite Materials and Optoelectronic Applications** <Chair: Aung Ko Ko Kyaw>
Invited Speeches (Jia Lin; Yongbo Yuan; Hin-Lap Yip); Oral Presentation (G2911)

***V08: AI Photonics** <Chair: Hongwei Chen>
Invited Speeches (Sabidur Rahman; Avishek Nag; Bhavin J. Shastri; Tian Zhang);
Oral Presentation(G29118)

### 12:00-13:30 Break

### 14:30-17:00 Virtual Sessions

| Zoom Meeting ID | Room 1 ID: 979 0046 1385 | Room 2 ID: 930 3313 8929 | Room 3 ID: 827 9043 9167 | Room 4 ID: 816 7808 8000 |
|---|---|---|---|---|
| *Session No.* | V09 | V10 | V11 | V12 |

***V09: Silicon Photonics** <Chair: Wei Jiang>
Invited Speeches (Yating Wan; Huang Ying; Xu Wang; Wei Jiang); Oral Presentation (G29143)

***V10: Fiber-Based Technologies and Applications** <Chair: Yunqi Liu>
Invited Speeches (Wei Yan; Yu Cheng); Oral Presentations (G29115, G2957, G29123, G2999)

***V11: Near-infrared, Mid-infrared and Far-infrared Technologies and Applications** <Chair: Jiagui Wu>
Invited Speeches (Jiagui Wu; Peng Wang; Xiaoqiong Qi; Hairui Guo); Oral Presentation (G2951)

***V12: Optical Communication and Networks** <Chair: Chen Chen>
Invited Speeches (Chen Chen; Fangzheng Zhang; Biao Chen; Xian Zhou);
Oral Presentations (G2978, G2933, G2917)

## Sept. 18, 2021

### 10:00-12:00 Virtual Sessions

| Zoom Meeting ID | Room 1 ID: 979 0046 1385 | Room 2 ID: 930 3313 8929 | Room 3 ID: 827 9043 9167 | Room 4 ID: 816 7808 8000 |
|---|---|---|---|---|
| *Session No.* | V13 | V14 | V15 | V16 |

***V13: Translational Photomedicine and Biophotonics** <Chair: Wenbo Hu>
Invited Speeches (Huilin Shao; Wenbo Hu); Oral Presentations (G2931; G2932)

***V14: Quantum Optics and Information** <Chair: Xuejian Wu>
Invited Speeches (Saijun Wu; Yogesh S. S. Patil; Tongcang Li; Jiafeng Cui)

***V15: AI Photonics** <Chair: Jianqiang Li>
Invited Speeches (Hsuan-Tung Peng; Nan Hua; Ching Eng PNG)

***V16: THz Metamaterials and Device Applications** <Chair: Jingbo Wu>
Invited Speeches (Yihao Yang; Jingbo Wu; Kaveh Delfanazari)

### 14:30-17:30 Virtual Sessions

| Zoom Meeting ID | Room 1 ID: 979 0046 1385 | Room 2 ID: 930 3313 8929 | Room 3 ID: 827 9043 9167 | Room 4 ID: 816 7808 8000 | Room 5 ID: 896 3784 6459 |
|---|---|---|---|---|---|
| *Session No.* | V17 | V18 | V19 | V20 | V21 |

***V17: Perovskite Materials and Optoelectronic Applications** <Chair: Aung Ko Ko Kyaw>
Invited Speeches (Wei Lin Leong; Vincenzo Pecunia; Yuxi Tian, Bo Xu, Zhanhua Wei); Oral Presentation (G29159)

***V18: Quantum Optics and Information** <Chair: Yong-Chun Liu>
Invited Speeches (Shau-Yu Lan; Xuejian Wu; Wei Zhang; Chunlei Qu; Victoria Xu; Yong-Chun Liu)

***V19: Fiber-Based Technologies and Applications** <Chair: Xia Yu>
Invited Speeches (Wonkeun Chang; Shifeng Zhou); Oral Presentations (G2961, G2940, G2948, G2928)

***V20: AI Photonics** <Chair: Chaoran Huang>
Invited Speeches (Xin Yuan; Jianning Lu; Chaoran Huang; Shi Yan; Yubin Zang)

***V21: Liquid Crystal Photonics** <Chair: Jiangang Lu>
Invited Speeches (Jiangang Lu; Lishuang Yao; Yong Xie; Jingxia Wang)

# Guideline of Virtual Talks

1. **Time Zone**
   - China Standard Time (CST) UTC/GMT+08:00
   - Please make sure that both the clock and the time zone on your computer are set to the correct China Time
2. **Equipment Needed**
   - A computer with an internet connection (wired connection recommended)
   - USB plug-in headset with a microphone (recommended for optimal audio quality)
   - Webcam(optional): built-in or USB plug-in
3. **Environment Requirement**
   - Quiet Environment
   - Stable Internet Connection
   - Proper lighting
4. **Platform: ZOOM**
   - For Users from mainland China: www.zoom.com.cn/download
   - For General Users: https://zoom.us/support/download
5. **Zoom Help Center**
   - https://support.zoom.us/hc/en-us/articles/206175806
6. **Sign In and Join**
   - Join a meeting without signing in: A Zoom account is not required if you join a meeting as a participant, but you cannot change the virtual background or edit the profile picture
   - Sign in with a Zoom account: All the functions are available
7. **Additional Suggestions**
   - A computer with an internet connection (wired connection recommended)
   - USB plug-in headset with a microphone (recommended for optimal audio quality)
   - Webcam (optional): built-in or USB plug-in
   - Stable Internet Connection
   - Quiet environment
   - Proper lighting
   - Formal dress
8. **Voice Control Rules**
   - The host will mute all participants while entering the meeting.
   - Speakers can unmute microphone when it is turn for his or her presentation.
   - Q&A goes after each speaker, the participant can raise questions.
9. **Oral Presentation**
   - Regular Author Presentation: a maximum of 15 minutes in total.
   - Invited talk: a maximum of 30 minutes in total.
   - Please join the meeting room 10 minutes in advance.
10. **Conference Recording**
    - The whole conference will be recorded. We appreciate you proper behavior and appearance.
    - The recording will be used for the conference reports among the committee. It won't be distributed to or shared with anyone else, and it shall not be used for commercial nor illegal purpose. It will only be recorded by the staff, the presenters are not allowed to record.

# VIRTUAL SESSIONS / Sept. 16, 2021

**V01: Laser Technology**

**Zoom Meeting Room 1**

**ID: 979 0046 1385 | Time: 14:30~16:30**

Session Chair: **Longqing Cong**, Southern University of Science and Technology, China

## 14:30~15:00 | Invited Speaker: Mohammed Zahed Mustafa Khan

MOHAMMED ZAHED MUSTAFA KHAN received the B.E. degree from Osmania University, India, in 2001, and the M.S. and Ph.D. degrees in electrical engineering from King Fahd University of Petroleum and Minerals (KFUPM) and King Abdullah University of Science and Technology (KAUST), Saudi Arabia, in 2004 and 2013, respectively.

From 2014 to 2015, he was a SABIC Postdoctoral Research Fellow with Photonics Laboratory, KAUST. Since 2015, he is with Electrical Engineering Department, KFUPM, where he is currently an Associate Professor. His prior research involved developing numerical models for integrated optical device simulation. His current research focuses on the development of near-infrared and visible semiconductor lasers and systems for applications in optical communications. Dr. Khan is a senior member of the IEEE and OSA.

**----Invited Talk----**

***Semiconductor InAs/InP Quantum-dash Lasers in Tbit/s Optical and 5G Wireless Networks***

**Abstract—**InAs/InP Quantum-dash (Qdash) nanostructure-based semiconductor lasers has shown tremendous progress in the past decade with application spanning from a wavelength division multiplexed green optical communication to very recently, millimeter-wave (MMW) applications. This waveguide-based laser has demonstrated a rule-changing broad multiwavelength lasing spectrum, thanks to the inherent and wavelength tunable broad gain profile offered by the Qdash active-gain region covering C- and L-band regions. Moreover, exploiting mode-locking and injection locking, highly coherent Qdash comb laser have been realized that opened a new paradigm for deployment of this new class of semiconductor device in green optical and 5G wireless networks. In this talk, recent progress on utilization of InAs/InP Qdash laser source, supporting several sub-carriers, in energy-efficient 1550 and 1610 nm wavelength division multiplexed optical networks will be discussed, exhibiting data capacity in Tbits/s. Moreover, very recent deployment in radio-over-fiber and millimeter wave (MMW) wireless networks will also be presented, concentrating on the 28-60 GHz frequency spectrum.

## 15:00~15:30 | Invited Speaker: Yanhua Luo

Dr Yanhua Luo received his B.E and PhD degrees from University of Science and Technology of China (UTSC) in 2004 and 2009, respectively. Currently, he works as a deputy director of Photonics & Optical Communications at University of New South Wales (UNSW) to maintain the National Joint Fibre Facility at UNSW and develop the next generation functional specialty optical fibers and their devices. So far he has held 2 China patents and co-authored over 200 refereed journal/conference papers and 10 book chapters on these subjects. In 2018, Dr. Luo was elected as both IEEE Senior Member and OSA Senior Member.

**----Invited Talk----**

***3D Printing Based Specialty Optical Fibers and Their Photonics Applications***

**Abstract—**Traditional optical fiber manufacturing processes, such as chemical vapor deposition (CVD) and stacking processes, are generally limited by the centered design or centered symmetry. With the development of information society, there is more and more demand for specialty optical fibers with more complex structures. The traditional technology can no longer meet the application requirements. Meanwhile, 3D printing technology, as a disruptive manufacturing technology, offers greater flexibility and diversity in material and structure designs. It has become a key enabling technology, allowing the manufacture of polymer optical fibers (POF), soft glass fibers and silica optical fibers. This technology not only realizes the arbitrary design and manufacture of specialty optical fiber, but also realizes the manufacture of diversified optical fiber materials. Therefore, 3D printing optical fiber technology enables a new generation of specialty optical fiber with materials and structures that have been impossible so far. In addition, these 3D printed specialty optical fibers offer more opportunities and applications for the development of the specialty optical fiber devices, like fiber sensor, fiber splitter, fiber filter, etc. It is expected to bring a major breakthrough in optical fiber manufacturing, Internet of Things, optical communications, etc.

## 15:30~15:45 | G2977

High-Power Multi-wavelength DFB Laser Array

**Yuxin Ma**, Xingtao Zeng, Yuechun Shi, Zhenxing Sun and Xiangfei Chen

Nanjing university, China

**Abstract—**We have fabricated a 16-wavelength 1200um DFB laser array with high precision channel spacing based on the reconstruction-equivalent-chirp (REC) technique. High power efficiency is obtained by utilizing the high-reflective coating and anti-reflective coating at both facets of the laser array. Good single-longitudinal-mode (SLM) operations are obtained by introducing equivalent π phase shifts by REC technique. Equivalent π phase shifts are implemented in the 1/5 laser cavity, which is close to the high-reflective coating. Due to the nanoscale of grating period, high precision control of grating phase structure is required in the practical fabrication. Therefore, the REC technique can provide the fabrication of high-precision grating. In terms of fabrication with REC technique, only holographic exposure is needed to produce a uniform basic grating and a micron-scale lithography to produce a sampling structure, instead of nanoscale fabrication with electron beam lithography. REC technique simplifies the fabrication and reduces the cost. Moreover, the feature manufacturing of sampling structure is extended from nanometer to micron, the precision of wavelength control is significantly improved 2 orders of magnitude and higher than that of traditional methods (such as electron beam lithography) in the theory. The average channel-spacing of the proposed high-power laser array is 1.63 nm, which is on 0.03 nm deviated from our design. The output power of all the 16 channels are above 100 mW at the biasing current of 350 mA and the average slope efficiency is 0.58 W/A at the temperature of 25 °C. Good single mode operations are obtained for all the 16 channels with the side mode suppression ratios of above 45dB. Besides, the relative intensity noise of the high output-power laser array is below -150 dB/Hz.

## 15:45~16:00 | G2952

Mode-locked thulium-doped fiber laser in multi-wavelength operation regime

**Jincan Lin**, Zilong Li, Zimin Zha, Huanhuan Liu and Hairun Guo

Shanghai University, China

**Abstract—**We demonstrate a tunable mode-locked thulium-doped fiber laser within a wide wavelength range 1880-1990 nm, in the regime of soliton mode-locking and multi-wavelength operation. The gain spectrum of the laser cavity is periodically modulated induced by the nonlinear polarization rotation (NPR) effect, which enables mode-locking at a number of selected wavelengths, individually and simultaneously. With Kelly sidebands in the soliton spectrum, we further extract a wavelength-dependent cavity net dispersion that may contribute to the knowledge of thulium-doped fiber laser systems as well as cavity dissipative soliton dynamics at the onset of mid-infrared range.

## 16:00~16:15 | G2929

Optimal design of high-speed electro-absorption modulated laser based on double stack active layer structure

**Yuanxin Sun**, Huayu Jia, Yonghua Xiong and Dengao Li

Taiyuan University of Technology, China

**Abstract—**This paper aims to further improve the response speed of the selective area growth double-stack active layer structure electro-absorption modulated laser (SAG-DSAL-EML) in a high-frequency modulation environment and improve the far-field divergence angle characteristics of the laser. We present a new structure of SAG-DSAL-EML. The new structure SAG-DSAL-EML active area into mesa structure and adopts iron-doped buried technology to complete the waveguide structure design. Iron-doped InP layers are grown on both sides of the active zone, which can effectively improve the high-speed frequency response characteristics of the modulator while improving the far-field divergence angle characteristics of the chip. In this paper, the Advanced Laser Diode Simulation (ALDS) software is used for simulation analysis, and it is compared and verified with the fabricated high-speed electro-absorption modulated laser sample chip with double active area laminated structure. Software analysis shows that compared with the ridge waveguide structure, the iron-doped buried structure has a smaller difference between the lateral and longitudinal angles of the far-field divergence angle, and the optical field coupling efficiency is better. Experiments show that the threshold current of the laser is 14.5mA at room temperature, and the side-mode suppression ratio of the laser at 1310nm is 45.64dB. The extinction ratio of the modulator under 3v reverse bias exceeds 16dB, and when the bias voltage is 0.9V, the modulation bandwidth under -3dB exceeds 40Ghz, which meets the basic requirements of high-speed laser communication.

## 16:15~16:30 | G295

Modeling and measurements of metastable argon atoms in a radio-frequency capacitive discharge

**Zhifan Zhang**, Zhifan Zhang, Pengfei Sun, Peng Lei, Duluo Zuo and Xinbing Wang,

Huazhong University of Science and Technology, China

**Abstract—**The metastable rare gas atoms are used as lasing species for optically-pumped rare gas laser (OPRGL), which are mainly produced by electrical discharge. Radio-frequency (RF) capacitive discharge is a promising technique for the continued production of the large volume needed for OPRGL systems. In this work, we examined the feasibility of using a RF discharge to produce a continuous gain medium with a gain volume of 4 cm3. Metastable argon atoms were measured using tunable Ti: sapphire laser absorption spectroscopy. Simulations of an -mode RF discharge are performed for varying mixtures of argon and helium using a one-dimensional model. The model is validated qualitatively and quantitatively by measurement in many aspects. The measured and simulated results indicated that the metastable densities decrease with the pressure and reach a peak as the Ar-fraction increases. The model predicted a 35 times increase in peak power with respect to the continuous wave power by use of the cavity dumping technique.

## V02: Optical Communication and Networks
## Zoom Meeting Room 2
## ID: 930 3313 8929 | Time: 15:00~17:00

Session Chair: **Biao Chen**, Zhejiang University, China

### 15:00~15:30 | Invited Speaker: Wenjia Zhang

Wenjia Zhang received the B.S.E degree (2007) and PhD (2012) from Beijing University of Posts and Telecommunications. He visited the Lightwave Research Laboratory at Columbia University from Sep. 2010 to Mar. 2012. He was with Singapore-MIT Alliance for Research and Technology (SMART) as a postdoc researcher from Aug.2012 to Jun.2014 and with Finisar Shanghai as a senior optical engineer from Jun.2014 to Nov.2015. He joined Shanghai Jiao Tong University at Dec.2015 now as an associate professor. His research interests include integrated optical interconnect and computing.

**----Invited Talk----**

***Compressed Nonlinear Equalization for Short Reach Optical Interconnects***

**Abstract—**The ever-increasing bandwidth requirement in data centers will demand for 100 and 200 Gbps/lane intensity modulation and direct detection (IM/DD) technologies to provide high energy and cost-efficient data connectivity. In order for reliable data communication, digital signal processing (DSP) technologies such as maximum likelihood sequence estimation (MLSE), Volterra-series based equalization (VE) and neural network based equalization (NNE) have been proposed to provide powerful and flexible compensation capability for dealing with linear and nonlinear signaling impairments. In this talk, we will discuss the compressed nonlinear equalization including VE and NNE for short reach optical interconnects. In order to implement nonlinear equalizers for real-time applications, we will comment on the equalization performance and stability of pruning algorithms, and the challenges of hardware implementation. We believe that the smart algorithms implemented in the advanced processing chip will become a disruptive solution for optical module architecture.

### 15:30~16:00 | Invited Speaker: Chongfu Zhang

Dr. Chongfu Zhang, received the Ph.D. degree from the University of Electronic Science and Technology of China (UESTC), China, in 2009. From 2013 to 2014, he was a Visiting Scholar with OCLAB, University of Southern California. He is currently a full Professor of Communication and Information System with UESTC. He was selected by the program for new century excellent talents in university by the Chinese Ministry of Education. He has authored or co-authored over 100 papers, and has over 60 patents. His current research focuses on broadband access networks, optical wireless communications, and optical signal processing. He is a senior member of the IEEE and member of the OSA. Along with colleagues, he has received six awards of science and technology from nation, province or ministry.

**----Invited Talk----**

***Fiber-Wireless Technologies with Reconfigurable Intelligent Surfaces for Millimeter-wave C-RAN***

**Abstract—**To achieve the required capacity KPIs, many works favor ultra-dense millimeter-wave (mmWave) small cells. Consequently, the cloud radio access network (C-RAN) provides an efficient solution to connect these dense mmWave small cells. Analog-Radio-over-Fiber (A-RoF) can employ all major hardware within the centralized BBUs, and thus it is essential to implement the C-RAN, i.e., the fiber-wireless systems. The integration of multiple-input multiple-output (MIMO) and mmWave communications is one of the key technologies for future fiber-wireless access networks. Moreover, reconfigurable intelligent surfaces (RISs), as the extension of MIMO technologies for fiber-wireless access networks, have received considerable attention recently. Introducing the RISs into the mmWave C-RAN makes the training and feedback overheads increase dramatically. The low-complexity precoding and the cost-effective beamforming implementation are still major challenges in the RIS-empowered mmWave C-RAN. Herein, some heuristic schemes about the limited feedback for the RIS-empowered mmWave C-RAN are discussed and the future development of RIS-based fiber-wireless systems is also prospected.

### 16:00~16:15 | G2955

Investigation of InAs/InP Quantum-dash Laser as a Source in 28 GHz MMW wireless QPSK Transmission

**Mohammed Zahed Mustafa Khan**, Q. Tareq, A. Ragheb, M. Esmail, S. Alshebeili
King Fahd University of Petroleum and Minerals, Saudi Arabia

**Abstract—**Generation and transmission of 28 GHz millimeter-wave signal are reported from a simple and costeffective self-injection-locked InAs/InP quantum-dash-laser based dual-wavelength source emitting in mid-L-band. arrowlinewidth with low phase-noise of ~-120 dBc/Hz and successful transmission of 2Gbps QPSK signal over 2 m wireless channel is demonstrated

### 16:15~16:30 | G29151

Design of Visible Light Communication Transceiver System

**Han Liu**, Fanshu MA
University of Science and Technology Beijing, Beijing, China

**Abstract—**Visible light communication technology is a wireless optical communication technology based on LED lighting.

Making use of the high speed response characteristic of LED, visible light communication technology can realize the dual functions of lighting and communication. As a new way of data access and a supplement to radio frequency communication, visible light communication has been widely concerned. This paper is based on the development of application-oriented visible light communication system based on intelligent terminal, in order to accelerate the practical process of visible light communication. By changing the traditional visible light receiving scheme and using smart phone as the receiving device of the visible light system, a visible light communication system based on intelligent terminal is built. Through the research on the existing receiving algorithm, a new receiving algorithm is proposed to improve the adaptability and BER performance of the system.

**16:30~16:45 | G2974**

Analysis of THz Earth-Satellite Link Capacity in the Mid-Latitude Regions

**Muhammad Saqlain**, Nazar Muhammad Idrees, Shiwei Wang, Lu Zhang, Xianbin Yu
Zhejiang University, Hangzhou, China

**Abstract—**Terahertz (THz) communication is considered a favorable technology for future non-terrestrial high data-rate applications due to huge bandwidth available. However, THz signals suffer from scattering loss due to clouds, rain, and snow, along with water vapor attenuation in the path, particularly when establishing a geostationary-satellite-to-earth-station (GEO-ES) THz link. In this work, we theoretically analyze the effect of snow and rain particle scattering on the communication capacity of GEO-ES links in the selective THz bands (140 GHz, 220 GHz, and 345 GHz), and evaluate the data capacity of a GEO-ES optoelectronic link in the mid-latitude regions. The analysis results show that under the cloud and dry snow scenarios, the capacity has some potential to support reasonable data rates in the 140 and 220 GHz bands for a GEO-ES link.

**16:45~17:00 | G2935**

Adaptive Diversity Combining Technology with Deep Neural Network for High-Speed and Reliable Underwater Visible Light Communication System

**Wangwei Shen**, Hui Chen, Zhongya Li, Junhui Hu, Sizhe Xing, Chao Shen, Ziwei Li, Junwen Zhang and Nan Chi
Fudan University, China

**Abstract—**We proposed and experimentally demonstrated a high-speed and reliable underwater visible light communication (UVLC) system using single-input multi-output (SIMO)-based adaptive diversity combining technology (ADCT) with deep neural network (DNN) for performance enhancements. The Maximum Ration Combine (MRC) algorithm is used for ADCT with SIMO receiver-array to combat the underwater turbulence, and the multi-layer perception (MLP)-based DNN is employed to compensate the nonlinearity impairments. To the best of our knowledge, this is the first study to combine SIMO system, MRC algorithm and MLP in the UVLC system, achieving a maximum 2.4Gbps data transmission in balanced received-power case and a 0.25 Gbit/s data-rate increase while maintaining system stability in unbalanced received-power case under the BER threshold of 1x10-2.

## V03: Near-infrared, Mid-infrared and Far-infrared Technologies and Applications

**Zoom Meeting Room 3**

**ID: 827 9043 9167 | Time: 14:30~16:15**

Session Chair: **Chuantao Zheng,** Jilin University, China

**14:30~15:00 | Invited Speaker: Yuan Ren**

Yuan Ren received the Ph.D degree in astrophysics from the Delft University of Technology, Delft, The Netherlands, in 2012, and from the Purple Mountain Observatory, Nanjing, China, in 2013.
From 2013 to 2016, he was a Research Associate with the Cavendish Laboratory, University of Cambridge, Cambridge, U.K. Since 2017, he has been a Professor with the Purple Mountain Observatory. His research interests include the development of terahertz heterodyne spectrometer for astronomic and atmospheric applications.

**----Invited Talk----**

***Terahertz Two-dimensional Phase Gratings***

**Abstract—**High efficiency and accuracy phase gratings are of crucial importance for large format heterodyne array receivers at terahertz frequencies. Here, we report the development of a design approach that can create gratings with arbitrary two-dimensional diffraction distributions. In addition, we report the realization of up to 10×10 diffraction beam two-dimensional phase grating designs at terahertz wavelengths, using an adaptation of the Gerchberg-Saxton (GS) scheme known as the Mixed-Region-Amplitude-Freedom algorithm. Rigorous full wave simulation proves the efficiency and accuracy of the design, which overcomes the inaccurate intensity of the beam distribution drawbacks originated from the standard GS algorithm. The results pave the way for the development of large-pixel terahertz multi-beam heterodyne receivers.

## 15:00~15:30 | Invited Speaker: Chuantao Zheng

Chuantao Zheng is a Professor in State Key Laboratory of Integrated Optoelectronics, College of Electronic Science and Engineering, Jilin University, China. His research interests includeinfrared laser spectroscopy and gas sensing system. He achieved the young and middle-aged leading scientific and technological innovation talents in Jilin Province in 2018. He is a senior member of China Optical Society, a senior member and director of the Optical Society. Jilin province, and also a member of organizing committee of national laser spectral technology academic forum. In 2005, 2007 and 2010 he obtained the Bachelor, Master and Ph. D degree from Jilin University. In September 2013, he became an associate professor. In December 2016, he became a Ph.D supervisor. From September 2015 to September 2016, he went to Rice University as a visiting scholar. He was appointed as a full professor in September 2018. He has undertaken 19 projects supported by National Natural Science Foundation of China, National Key R & D Program. As a first or corresponding author, he has published over 170 peer-reviewed papers. He has applied for 12 national invention patents (8 authorized), published one academic monograph, and won the Jilin Natural Science Academic Achievement Award in 2014.

**----Invited Talk----**

***Quartz-enhanced photothermal and photoacoustic spectroscopy in the near-infrared for gas sensing***

**Abstract—**Gas sensors are important for multiple application scenarios, such as chemical substance detection and environmental pollution monitoring. The development of quartz tuning fork (QTF) based quartz-enhanced photoacoustic and photothermal spectroscopy (QEPAS/QEPTS) was reported. With respect to QEPAS, a novel QTF-embedded off-beam QEPAS (E-OB-QEPAS) spectrophone configuration was used to improve sensitivity and the optical-acoustic couplingstrength , and decrease the difficulty in assembly process and alignment process. Based on E-OB-QEPAS spectrophone, a sensitive methane sensor system and a dual-gas methane/acetylene sensor system were developed. With respect to QEPTS, an all-fiber QEPTS configuration was used to solve the problems of large size, optical light path alignment and integration process in free-space QEPTS. Then, a wavelength-locked QEPTS-based methane sensor system was proposed by utilizing a fiber-coupled sensing probe for long-distance in-situ gas sensing. At last, a double spot-ring Herriott-cell was used to realize a wide detection range and high detection sensitivity simultaneously in the QEPTS-based gas sensor system.

## 15:30~16:00 | Invited Speaker: Wenxue Li

Wenxue Li received the Ph.D. degree in physics from East China Normal University. In 2008, she joined East China Normal University as assistant professor, where she became full Researcher in 2014. Dr. Li's Current research interests include high power lasers, precision measurement and ultrafast science.

**----Invited Talk----**

***Femtosecond Optical Frequency Combs and Dual-comb Spectroscopy***

**Abstract—**Fiber optical frequency comb (OFC) system has attracted much attention on science applications such as distance measurement, coherent anti-stokes Raman scattering spectroscopy (CARS), and atomic spectroscopy. Especially, high-power infrared fiber OFCs can provide a high-resolution potential to molecular spectroscopy, sensing, and imaging based on a developing dual-comb technique. We propose a low-noise high-power fiber amplifier. Through OFC locking technique, we control the repetition rate and carrier envelop phase, and realize a high-power broadband ultrafast fiber OFC. Moreover, we construct a dual-comb measurement system consisting of two homemade broadband OFCs, an interferometer unit, an imaging unit and a spectroscopy unit. We demonstrate a spectrum-encoded three-dimensional imaging research. We also realize a dual-comb molecular spectroscopy of ethylene via an optically modulation dual-comb system with a teeth resolution.

## 16:00~16:15 | G29125

Long wavelength ($\lambda$>13 μm) quantum cascade laser based on diagonal transition and three-phonon-resonance design

**Yuhao Jin**, Qi Jie Wang

Nanyang Technological University, Singapore

**Abstract—**An InP-based quantum cascade laser structure emitting at a wavelength of 13.6 μm is proposed and demonstrated. The active region is based on a diagonal transition and three-phonon-resonance design. A 5 mm long, 30 μm wide high-reflection (HR) coated device with a double channel ridge waveguide structure has shown a threshold current density of 3.0 kA/cm2, a dynamic range of 4.4 kA/cm2, a peak output power close to 1 W, and an average optical power up to 11.7 mW at 3% duty cycle, at 293 K. The laser shows a characteristic temperature T0 of 314 K and T1 of 336 K over a temperature range from 283 to 313 K.

This work was partially supported by National Research Foundation Singapore programme (NRF-CRP18-2017-02 and NRF–CRP19–2017–01), and Singapore Ministry of Education Tier 2 MOE2018-T2-1-176.

## V04: Quantum Optics and Information
## Zoom Meeting Room 4
## ID: 816 7808 8000 | Time: 15:00~16:30

Session Chair: Qiang Zhou, University of Electronic Science and Technology of China, China

### 15:00~15:30 | Invited Speaker: Jie Zhao

Jie Zhao is currently a Photonics researcher at Nokia Bell Labs, USA. Before joining Bell Labs, She received her Ph.D. in Photonics from University of California San Diego in 2020. Her research focuses on integrated nonlinear photonic devices based on the thin-film lithium niobate material platform. She is particularly interested in the quasi-phase-matched three-wave mixing processes and their applications in both classical and quantum communications. She is a recipient of the Dean's Office Fellowship from UCSD in 2015 and the China National Scholarship from 2010 to 2013.

**----Invited Talk----**

***Periodic poling of thin-film Lithium Niobate for second-harmonic generation and entangled photon-pair generation***

**Abstract—**High-fidelity periodic poling of thin film lithium niobate (TFLN) waveguides is critical for robust, quasi-phase-matched three-wave mixing process such as second-harmonic generation and spontaneous parametric down conversion. Over the past decade, extensive research has been performed on design and fabrication of TFLN based optical waveguides, demonstrating high performance electro-optic modulators, efficient wavelength converters and revealing their great potentials in heterogeneous integration with the conventional silicon photonic material platform. However, studies on poling of TFLN are still lacking, and uniformity of TFLN poling needs to be further improved, to achieve a comparable conversion efficiency as in its bulk counterparts. This talk discusses evaluation and optimization of TFLN poling, waveguide design, and device demonstration through characterization of efficient second-harmonic generation and high-quality entangled photon-pair generation. The results presented here indicate promising applications for robust and efficient TFLN devices in nonlinear and quantum optics in the telecommunications regime.

### 15:30~15:45 | G2944

Generation of discrete frequency-bin entangled two-photon state via cascaded second-order nonlinear processes

**Jiarui Li**, Jia-Rui Li, Chen-Zhi Yuan, Si Shen, Zi-Chang Zhang, He-Qing Wang, Hao Li, Li-Xing You, Zhen Wang, You Wang, Guang-Wei Deng, Hai-Zhi Song and Qiang Zhou

University of Electronic Science and Technology of China, China

**Abstract—**By using the cascaded second-order nonlinear optical processes in a periodically poled lithium niobate waveguide, we generate 1.5 μm discrete frequency-bin entangled two-photon state with a spatial quantum beating visibility of 93.0 ± 5.2%.

### 15:45~16:00 | G2979

Hong-Ou-Mandel Interference between surface plasmon polariton and photon

**Tao Tang**, Boyu Fan, Haizhi Song, You Wang, Guangwei Deng, Qiang Zhou

University of Electronic Science and Technology of China, China

**Abstract—**In this paper, we provide a theoretical design of hybrid coupler for investigating the Hong-Ou-Mandel interference between a single-long-range-surface-plasmonpolariton (LRSPP) and a single-photon. With the help of coupling between LRSPP and single photon, our method opens a way to study the intrinsic properties of LRSPPs and the indistinguishability between single-photon and LRSPP.

### 16:00~16:15 | G2958

Multi-wavelength correlated photon pairs generation in Si3N4 microring resonator

**Yunru Fan**, Chen Lyu, Chen-Zhi Yuan, Bo-Yu Fan, Bo Jing, Dian-Li Zhou, Guang-Wei Deng, Qiang Zhou

University of Electronic Science and Technology of China, China

**Abstract—**Based on Si3N4 microring resonator, the generation of multi-wavelength correlated photon pairs is investigated. We demonstrate the single-photon spectrum from 1480 nm to 1620 nm, and study the photon pair generation rate, CAR, and the collection efficiency at different pump powers.

### 16:15~16:30 | G2954

Microwave Quantum Illumination via Cavity Magnonics

**Qizhi Cai**, Jinkun Liao, Bohai Shen, Guangcan Guo, and Qiang Zhou

University of Electronic Science and Technology of China, China

**Abstract—**Quantum illumination (QI) is a quantum sensing protocol mainly for target detection which uses entangled signal-idler photon pairs to enhance the detection efficiency of low-reflectivity objects that are immersed in thermal noisy environments. Especially, due to the naturally occurring background radiation, the photon emitted toward potential targets more appropriately lies in the microwave region. Here, we propose a hybrid quantum source based on cavity magnonics for microwave QI, where the medium that bridges the optical and the microwave modes is magnon, the quanta of spin wave. Within experimentally accessible parameters, significant microwave-optical quantum resources of interest can be generated, leading to

orders of magnitude lower detecting error probability compared with the electro-optomechanical prototype quantum radar and any classical microwave radar with equal transmitted energy.

# VIRTUAL SESSIONS / Sept. 17, 2021

**V05: Biophotonics and Optical Biomedicine**

**Zoom Meeting Room 1**

**ID: 979 0046 1385 | Time: 10:00~12:00**

Session Chair: **Wenjun Ni**, South-Central University for Nationalities, China

## 10:00~10:30 | Invited Speaker: Quan Liu

Dr. Quan Liu received a bachelor's degree in electrical engineering from Xidian University, Xi'an, China, a master's degree in electrical engineering from the Graduate School of University of Science and Technology of China in Beijing, China and a PhD degree in biomedical engineering from the University of Wisconsin, Madison, USA. He is currently an associate professor in the School of Chemical and Biomedical Engineering at Nanyang Technological University in Singapore. His research interest is focused on hyperspectral imaging and optical spectroscopy for medical diagnostics.

Dr. Liu has published more than 60 journal papers and held 21 patents/patent applications in the field of biomedical optics. Dr. Liu is a senior member of SPIE.

**----Invited Talk----**

***A cost effective chip towards malaria field diagnosis based on surface-enhanced Raman scattering***

**Abstract—**We report a chip based on surface-enhanced Raman scattering (SERS) developed towards malaria field diagnosis. Only a mixture of 10-ml water and 10-ml blood is required as the sample input to the chip. Water is the only lysing agent to hemolyze blood cells while keeping the malaria biomarkers, hemozoin biocrystals, at locally high concentrations within parasites and/or their vacuoles. Then, SERS-active silver nanoparticles are synthesized on site near hemozoin in these concentrated regions when the blood/water mixture flows through and dissolves dried chemical patches that are earlier deposited inside the channel, which subsequently arrives at the detection region for SERS measurements. It should be highlighted that the procedure can be accomplished without a laboratory requirement and the risk of exposure to hazardous chemicals. Additionally, raw chemicals deposited inside the chip are chemically more stable than those readymade SERS substrates, thus the shelf life of the chip can be much longer. These results show the feasibility to exploit this cost-effective yet highly sensitive SERS-based technique for malaria field diagnosis.

## 10:30~11:00 | Invited Speaker: Zhenhua Hu

Zhenhua Hu is a professor and doctoral supervisor of the Institute of Automation, Chinese Academy of Sciences, winner of the National Science Fund for Excellent Young Scholars and the Beijing Natural Science Fund for Distinguished Young Scholars. She specializes in optical molecular imaging and the related techniques. Besides, she has carried out the research and development of new optical molecular imaging techniques and successfully translated them into the clinic. In the past five years, she has published over 20 SCI papers as the first author and the corresponding author (including co-author), including 2 papers published on Nature Biomedical Engineering, and several papers on IEEE Transactions, Trends in Molecular Medicine, and Advanced Materials. Her work received a special review on the Nature sub-journal and the "first-in-human" evaluation unanimously from several experts in different fields. She has been invited to give oral presentations at international conferences many times. Until now, she has presided over 8 national and provincial-level projects such as the State Key Program of National Natural Science of China, programs from the Ministry of Science and Technology of China, and the Beijing Natural Science Fund for Distinguished Young Scholars. She has published thirteen US patents and national invention patents. Besides, she serves as the standing director of the first council of the Chinese Nuclear Society Radiopharmaceutical Branch, the standing member of the Digestive Endoscopy and Molecular Imaging Professional Committee of the Chinese Research Hospital Association, etc. She is also the editor and reviewer of several international academic journals.

**----Invited Talk----**

***Research and clinical transformation of novel in vivo optical molecular imaging technology***

**Abstract—**The difficulty in detecting small tumor lesions with conventional methods has become an important reason for tumor recurrence. Optical molecular imaging is often used for intraoperative detection of small tumor lesions because of its advantages such as high resolution and sensitivity. On the subject of small tumor lesions detection, the reporter will first introduce the international research advances that have been achieved so far, and then the reporter will introduce the work done by the team in recent years, which include Cherenkov luminescence tomography (CLT), optical imaging derived from Cerenkov luminescence imaging, and NIR-II multi-spectrum fluorescence imaging. Aiming to further improve the detection ability of small tumor lesions, the team focused on creating novel imaging methods, developing imaging systems for small animals and clinical use, and promoting biomedical applications, which finally facilitated the clinical application of the technologies developed by the team. To summarize, the work of the team formed a full research chain of "imaging method-imaging system-clinical application-

industrialization".

## 11:00~11:30 | Invited Speaker: Tzuen-Rong Jeremy Tzeng

Dr. Tzeng is currently an associate professor in the Department of Biological Sciences. Dr. Tzeng holds a B.S. in Food Science from Tungahi University, Taiwan, and a Ph.D. in Microbiology from Clemson University. The long-term goal of Dr. Tzeng's research is to develop prevention and therapeutic approaches to reduce, augment, enhance, or replace the use of antibiotics. He studies the microbe and host interactions as well as the mechanisms enabling the microorganisms to be resistant to the actions of antibiotics. His team has developed nanoparticles that display multivalent bacterial adhesin-specific receptors, mimicking host cell surface, to facilitate their bindings to targeted bacteria. In addition, he has functionalized iron-oxide nanoparticles with adhesin-specific receptors and demonstrated the feasibility of using such magnetic nanoparticles for inactivation of targeted microorganisms via magnetic-mediated energy delivery. Dr. Tzeng is an active member of the NC1194: Nanotechnology and Biosensors Committee and the ISO/TC 189 Committee.

**----Invited Talk----**

***X-ray excited luminescent chemical imaging (XELCI) for non-invasive imaging of implant infections***

**Abstract—**Diagnosis and treatment of medical implant associated infections can be challenging, as clinical symptoms are often delayed or, sometime, asymptomatic until infection reaches a later stage. Early diagnosis of implant associated infections and non-invasive continuous monitoring of infection to assess treatment effectiveness has not been established yet. We have developed a pH sensor based on X-ray Excited Luminescence Chemical Imaging (XELCI) to non-invasively monitor pH changes of a surface with high spatial and pH resolution while minimizing tissue scattering effects. Our pH sensor can be attached to the implant surface to non-invasively diagnose and monitor implant associated infection in situ. Bacteria and inflammatory responses cause a pH drop in the area and pH shifts to acidic from in situ pH (~7.3). Our pH sensor consists of a layered structure of a pH sensitive polymer film over radioluminescent particles. The pH sensor is characterized for reversibility, sensitivity and resolution. XELCI provides high spatial resolution images mainly limited by X-ray beam width with minimum increase from X-ray scattering in the tissue. It allows point by point mapping of the surface with minimum background. We studied pH changes during the formation of biofilm on the pH sensitive sensor film. In summary, our sensor provides a novel approach to non-invasively image surface pH to diagnose implant infection and assess treatment. This work makes treatment of implant infection without implant removal a possibility when infection can be diagnosed at its onset.

## 11:30~11:45 | G29139

Feasibility Study of Spectral Detection Bovine Serum Albumin

**PO-JU WU**, Zhi-Ting Ye, Hsin-Ching Kuo
National Chung Cheng University, Taiwan, China

**Abstract—**The optical spectrum detection method of albumin proposed in this study can help patients find proteinuria problems in the early stage, which can be detected in the early stage of microalbumin. The absorption coefficient relationship is used to determine the specific gravity of proteinuria in urine. The minimum linear error rate at 264nm in the best linear region of the albumin absorption band is 1.4%, and the correlation coefficient is 0.9860. The linear error rate of the albumin optical spectrum concentration corresponding to the peak absorption band 285nm is 4.98%, and the correlation coefficient is 0.9502. In addition, the timeliness of albumin was discussed according to the attenuation of the absorbance corresponding to the number of days the albumin was stored. It is hoped that this research will be used as a reference cornerstone for the future development of portable LED biomedical optical systems.

## 11:45~12:00 | G2916

ADGAN: An Asymmetric Despeckling Generative Adversarial Network for Unpaired OCT Image Speckle Noise Reduction

**Xiaojun Yu**, Zixuan Fu, Chenkun Ge, Muhammad Zulkifal Aziz and Linbo Liu
Northwestern Polytechnical University, China

**Abstract—**Optical coherence tomography (OCT) suffers from the inherent speckle noise in its imaging process, which severely degrades the quality of OCT images. To address such an issue, this paper proposes an asymmetric despeckling generative adversarial network (AD-GAN) for OCT speckle noise reduction, based on an unsupervised learning scheme utilizing unpaired clean and noisy images. Specifically, the OCT image despeckling problem is treated as an image-to-image translation problem first, and then the speckle noise reduction is achieved by transferring the noisy images from the noisy domain to the clean domain. Moreover, considering the fact that the information within the clean domain and the noisy domain are imbalanced, an information balancing factor is introduced to capture residual noisy information and help to generate high quality despeckling results. Experimental results show our method surpasses the other state-of-the-art despeckling methods regarding quantitative evaluation metrics and visual qualities.

## V06: Optoelectronic Devices and Applications
## Zoom Meeting Room 2
## ID: 930 3313 8929 | Time: 10:00~11:15

Session Chair: **Mengyuan Ye**, Sun Yat-Sen University, China

### 10:00~10:30 | Invited Speaker: Mengyuan Ye

Mengyuan Ye received a B.E degree from Sun Yat-Sen University, a Ph.D. degree in optical engineering from Huazhong University of Science and Technology and is now an Associate Professor in China University of Geosciences. His research interests include silicon photonics, multi-mode manipulation and photonics integration.

**----Invited Talk----**

***Silicon integrated multimode components***

**Abstract—**As an effective way to increase transmission capacity, multimode photonics has attracted increasing attentions in past decades. On the other hand, silicon photonis is of significant interest for its compatibility with the mature CMOS technology. Ramarkable progress on silicon integrated multimode photonics has been made over 10 years, and continuous researches on new material, novel structure, intelligent design are still highly desired. Here we demonstrate recent progress on silicon integrated multimode conponents and discuss the future challenges on this topic.

### 10:30~11:00 | Invited Speaker: Weiqiang Xie

Xie Weiqiang received a Bachelor's Degree in Applied Physics from Xi'an Jiao tong University in 2008, and a Master's Degree in Condensed Matter Physics from Shanghai Jiao tong University in 2011. Then he joined the Photonics Research Group in Ghent University and obtained his PhD degree in Photonics Engineering in 2016. From 2017 to 2021, he worked as a postdoctoral researcher in heterogeneous photonics integration with the group of Prof. John Bowers at University of California, Santa Barbara. Now he is an Associate Professor in Shanghai Jiao Tong University. Dr. Xie's research focuses on silicon/silicon nitride photonics and their heterogeneous integration with novel materials (III-V, quantum dots, etc.), including design, fabrication and characterization of integrated passive/active photonic devices (low-loss waveguides, high-Q microresonators, modulators, integrated nonlinear photonics, lasers, optical phased arrays for LiDAR, etc.). His research involves applications such as telecom, optical interconnect and sensing. He has authored and coauthored over 30 journal papers including Nature Communication, Advanced Materials, Nano Letter, Laser & Photonics Reviews and so on. He is a recipient of 2016 Chinese Government Award for Outstanding self-financed Students Abroad.

**----Invited Talk----**

***III-V/Si Heterogeneous Integration for Ultra-efficient Nonlinear Photonics***

**Abstract—**III-V semiconductors have excellent optoelectronic properties. They also possess strong material nonlinearity as well as high refractive indices, for example, (Al)GaAs has much stronger nonlinearity than the dielectrics ($SiO_2$, Si, or $Si_3N_4$). Therefore, they hold great potentials for high-confinement, ultrahigh-efficiency, compact nonlinear photonic integrated circuits (PICs). While nonlinear studies on III-V platforms have gained increasing interests over the past few years, it remains a challenge to develop a low-loss nonlinear photonic waveguide platform. In this talk, we present our recent work on heterogeneously integrated low-loss AlGaAs nanowaveguide platform on Si and show ultra-high quality (Q) AlGaAs nonlinear microresonators with Q factors >3×10^6 and demonstrate ultra-efficient frequency comb generation with a world-record low threshold of pump power of only a few tens of microwatts. We also talk about the full integration of InP lasers and AlGaAs high-Q nonlinear microresonators aiming for chip-scale nonlinear sources and show some preliminary results.

### 11:00~11:30 | Invited Speaker: Changzheng Sun

Changzheng SUN received the B.E., M.E. and Ph.D. degrees in electronic engineering from Tsinghua University, China, in 1995, 1997 and 2000, respectively. He became a faculty member of the Dept. of Electronic Engineering, Tsinghua University, China, in 2000, and was promoted as a full professor in 2010. His research interests include physics and fabrication technologies of high-speed photonic integrated circuits, nonlinear dynamics in semiconductor lasers and nonlinear optics in optical micro-resonators. Up to now, he is the author or co-author of over 100 scientific papers.

**----Invited Talk----**

***High Performance Modulators and Photodetectors for Microwave Photonics Applications***

**Abstract—**Thin-film lithium niobate (TFLN) modulators with capacitively loaded traveling-wave electrodes are fabricated, exhibiting a bandwidth over 67 GHz as well as a half-wave voltage of 3.4 V. Uni-traveling-carrier photodiodes (UTC-PDs) with a bandwidth over 150 GHz and a saturation power of 1.93 dBm are demonstrated by incorporating inductive peaking.

**11:30~11:45 | G29117**

Photo-response Analysis of Oxygenated Ge2Sb2Te5

**Sunny**, Vibhu Srivastava

Indian Institute of information Technology, Allahabad, Prayagraj (India), India

**Abstract—**Among various available phase-change materials, ternary chalcogenide Ge2Sb2Te5 (GST) is the most popular one due to its excellent electrical and optical properties. Enormous investigations have been performed to alter or modulate its properties further by incorporating some foreign elements by various methods including oxygen. Oxygenated GST is of interest due to its higher compatibility with Si/SOI technology along with modulation in phase-change behavior for different photonic applications. This work presents the photodetection behavior of oxygenated GST in the simple metal-semiconductor-metal structure. The photo-response of the oxidized GST thin films in both the amorphous and crystalline phases has been measured. It is found that the electrical along with photo-conductivity of both phases of GST reduce upon the increasing extent of oxidation due to an increase in bonding lattices. A proper shifting of the bandgap has also been observed while increasing the amount of oxidation.

## V07: Perovskite Materials and Optoelectronic Applications

## Zoom Meeting Room 3

## ID: 827 9043 9167 | Time: 10:00~11:45

Session Chair: **Aung Ko Ko Kyaw**, Southern University of Science and Technology, China

**10:00~10:30 | Invited Speaker: Jia Lin**

Jia Lin obtained his PhD in 2013 from Shanghai Jiao Tong University. He is a Distinguished Professor at the Department of Physics, Shanghai University of Electric Power. His research interests include optics, photonics, optoelectronics, and energy materials.

**----Invited Talk----**

***Structures and optoelectronic properties of new type of halide perovskite materials***

**Abstract—**Halide perovskite materials have attracted more and more attention in recent years due to their unique optical, electronic, magnetic, and optoelectronic properties, and potential applications in optoelectronic devices. The halide perovskite and perovskite analogues are a class of ionic material with a 'soft' lattice, which results in a highly reconfigurable crystal structure with relatively easy structural rearrangements. Our research focuses on the development of new composition and new structure perovskite materials, and exploration of structure-related unique optoelectronic properties. We mainly discuss the development of new structure of halide perovskites and the connection between the structure and properties of bulk materials; mixed halide perovskite for solar cells; controlled synthesis of low-dimensional halide perovskites and light-emitting behaviors; the emission mechanism of new type of inorganic lead-free halide perovskite; and the exploration of the applications of functional halide perovskite materials.

**10:30~11:00 | Invited Speaker: Yongbo Yuan**

Yongbo Yuan is a Professor in the Hunan Key Laboratory of Super-microstructure and Ultrafast Process and the School of Physics and Electronics in Central South University (CSU). He got his B.S. degree of physics in 2004 and Ph.D. degree of condensed matter physics in 2009 from Zhongshan University. He then joined Prof. Jinsong Huang's research group at University of Nebraska-Lincoln as a postdoctor in 2009. He joined CSU in 2016 as full Professor. His current research interests include perovskite/ polymer solar cells, organic thin film transistors and hybrid photodetectors. He had published more than 50 scientific papers with citations over 10000 and H-index of 35. He was listed as "Highly Cited Researchers"by Thomson Reuters in 2018 and 2019.

**----Invited Talk----**

***Ion migration in hybrid perovskites and its impacts on photo-oxygen-induced degradation***

**Abstract—**Compared with other photovoltaic materials, hybrid perovskites have significant ion migration, which impacts on the electrical properties of perovskites and influence the device working mechanisms. Generally, defects in perovskite crystal are responsible to the initial degradation of perovskite solar cells due to its nonideality. The migration of charged ions or defects under applied electric field may accelerate the degradation of perovskite solar cells since it increases local defect concentration in the active layer. From this point of view, insights on the synergistic effect between ion migration and other device failure mechanism is desired. In recent study, we demonstrated that mobile defects can significantly accelerate the reactions between oxygen and perovskites in light condition, leading to addition pathway for materials decay. Meanwhile, A-site cation engineering was developed to suppress such detrimental synergistic effect. We will show that there is a repulsion effect between doped Cs+ cations and iodine vacancy, which enhances the intrinsic stability of perovskite materials by suppressing mobile ions and superoxide ions.

**11:00~11:30 | Invited Speaker: Hin-Lap Yip**

(Angus) Hin-Lap Yip joined the Department of Materials Science and Engineering and School of Energy and Environment at City University of Hong Kong as Professor in 2021. From 2013-2020, he was a Professor in the State Key Laboratory of Luminescent Materials and Devices (SKLLMD) and the School of Materials Science and Engineering (MSE) in South China University of Technology (SCUT). He got his BSc (2001) and MPhil (2003) degrees in Materials Science from the Chinese University of Hong Kong (CUHK), and completed his PhD degree in MSE in 2008 at the University of Washington (UW), Seattle. His research focuses on the use of an integrated approach combining materials, interface, and device engineering to improve both polymer and perovskite optoelectronic devices. He had published more than 220 scientific papers with citations over 25000 and a H-index of 81. He was also honored as ESI "Highly Cited Researcher" for 7 times from 2014-2020. He was a co-founder of Soluxra, LLC (2010-2018). In 2018, He was appointed as the Director for the Innovation Center for Printed Organic Photovoltaics in Dongguan, which focuses on translational research and commercialization of new generation photovoltaic technology. He currently serves as an editorial board member of Science Bulletin and Journal of Semiconductors, and international advisory board member for Matter.

**----Invited Talk----**

***Optical Engineering for Efficient White Perovskite Light-Emitting Devices***

**Abstract—**Metal halide perovskite light-emitting diodes (PeLEDs) show great potentials to be the next-generation lighting technology, with external quantum efficiencies (EQEs) exceeding 20% for infrared, red and green LEDs. However, the efficiencies of blue and white devices severely lag behind. To improve the performance of blue PeLEDs, we employed an integrated strategy combining dimensional engineering of perovskite film and recombination zone modulation in the LED device to obtain an EQE up to 5 %. While further incorporating the strategy of interfacial engineering, highly efficient blue PeLEDs with EQEs over 10% have been successfully realized in our group, establishing an excellent platform for white-light emission. In our latest work, we demonstrated efficient white PeLEDs by optically coupling a blue PeLED with a red emitting perovskite nanocrystal layer in an advanced device structure, which allows to extract the trapped optical modes (waveguide and SPP modes) of blue photons in the device to the red perovskite layer via near-field effects. As a result, a white PeLEDs with EQE over 10% is achieved, which represents the state-of-the-art performance for white PeLEDs.

### 11:30~11:45 | G2911

Optimization of Annealing Treatment for CsSnI3-Based Solar Cells with Enhanced Efficiency

**Shaoyang Ma**, Hailong Li, Ran Yao, Haoran Zhang, Tao Ye

Beijing Jiaotong University, China

**Abstract—**We demonstrate that the optimized two-step annealing treatment can effectively improve the quality of CsSnI3 perovskite film. The corresponding CsSnI3 solar cell yields an enhanced efficiency of 2.10% in ambient-air condition with increased photovoltaic parameters, especially the short-circuit current density (Jsc), compared with the control group device.

## V08: AI Photonics

## Zoom Meeting Room 4

## ID: 816 7808 8000 | Time: 10:00~12:15

Session Chair: **Hongwei Chen**, Tsinghua University, China

### 10:00~10:30 | Invited Speaker: Sabidur Rahman

Bio: Dr. Sabidur Rahman has recently completed his PhD in computer science from University of California Davis (2020). He received his MS and BS degree in computer science from the University of Texas at San Antonio (2014) and Bangladesh University of Engineering and Technology (2011), respectively. Dr. Sabidur is currently a tenure-track assistant professor at the department of computer science, Sonoma State University, CA, USA. He also has industry research and development experience with AT&T Labs, Epic Systems, and Samsung R&D. His research interests include cost-efficient network automation, computer network virtualization, use of machine learning, and data-driven solutions to solve practical problems. His research has been published in flagship IEEE conferences (IEEE ICC, IEEE Globecom, IEEE CloudNet, etc.) and high-impact IEEE Transactions (TNSM, TGCN, etc.). His research has gained invitation for talks at prestigious venues, including Lawrence Berkeley National Laboratory, USA; University of California Berkeley, USA; 8th Big Data Finance 2020 (Cornell Engineering); Asia Communications and Photonics Conference 2020; etc. He has also served as reviewer of IEEE/ACM Transactions on Networking; Elsevier Computer Networks Journal; IEEE Communications Surveys & Tutorials; IEEE Transactions on Services Computing, Springer Journal of Grid Computing; IEEE/OSA Journal of Optical Communications and Networking; IEEE Intl. Conference on Cloud Networking; etc.

LinkedIn: http://www.linkedin.com/in/kmsabidurrahman/

Google Scholar: https://scholar.google.com/citations?user=sk7J-OwAAAAJ&hl=en

**----Invited Talk----**

***Machine learning and data-driven solutions for network automation***

**Abstract—**Although a "Self-Driving" optical communication network is still a long way to go, many time-consuming complex tasks and decision making in photonic networks can be automated using machine learning, and other data-driven solutions. This talk explores recent contributions towards photonic network automation, such as alarm prediction, fault localization, resource auto-scaling, quality of transmission prediction, dynamic controller placement, automated service restoration, resource allocation and optimization, minimization of electricity and power supply cost minimization, user data analysis, etc. The studies explored in this talk, provide solution approaches to these problems using wide range of data-driven methods, machine learning, AI and deep learning based methods. This talk also discusses different challenges involving this interesting research areas, and provides the directions for future research opportunities.

## 10:30~11:00 | Invited Speaker: Avishek Nag

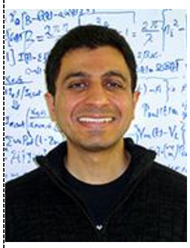
Dr Avishek Nag is currently an Assistant Professor in the School of Electrical and Electronic Engineering at UCD. Dr Nag received his PhD degree from the University of California, Davis in 2012. He worked as a research associate at the CONNECT Centre for future networks and communication in Trinity College Dublin. Dr Nag has published over 65 publications that include journals, conference proceedings, and book chapters. His research interests include Optical Networks, Software-Defined Networks, Machine Learning, Blockchain, and the Internet of Things. Dr Nag is a senior member of the IEEE and also the outreach lead for Ireland for the IEEE UK and Ireland Blockchain Group. He also serves on the editorial boards for the IEEE Transactions on Green Communications and Networking, Frontiers in Blockchain, and Frontiers in Communications and Networks.

**----Invited Talk----**

***The Role of AI in Network Engineering***

**Abstract—**Due to the continuing expansion of users with numerous smart gadgets, i.e., the 'smart world' surge, the network's complexity continues to rise. This creates a continual demand for a seamless end-to-end connection for all users, resulting in increased network operations scope and scale, as well as higher operational cost. Each piece of data gathered contains crucial information about the network as well as the user's behaviour. Predictive analysis of users and networks based on applications, dynamic resource allocation for network components (functions), root cause analysis and event correlation, and resolving the compromised parts of the network without disrupting the equilibrium would all benefit from learning from the parsed data. A network team can take hours or days to manually analyse a few of this information or find the root cause of the disruption, especially like a malware attack or natural cause destruction of the network nodes. Training the ML models like Deep Learning or Reinforcement Learning will provide more profound and insightful information about the problem by exploring numerous possibilities within a reasonable time. Detection becomes a much faster process. Thus some of these elements are encouraging AI adoption in day-to-day operations. This talk will focus on the general applicability of ML/AI models in network engineering and then discuss a specific application area in network function virtualisation.

## 11:00~11:30 | Invited Speaker: Bhavin J. Shastri



Dr. Bhavin J. Shastri is an Assistant Professor of Engineering Physics at Queen's University, Canada, and a Faculty Affiliate at the Vector Institute for Artificial Intelligence. With research interests in silicon photonics, photonic integrated circuits, neuromorphic computing, and machine learning, he has published more than 68 journal articles and 87 conference proceeding, 7 book chapters, and given over 40 invited talks and lectures including 2 Keynotes. He is a co-author of the book, Neuromorphic Photonics (Taylor & Francis, CRC Press, 2017).

Dr. Shastri is the winner of the 2020 IUPAP Young Scientist Prize in Optics "for his pioneering contributions to neuromorphic photonics" from the ICO. He is a Senior Member of OSA and IEEE, recipient of the 2014 Banting Postdoctoral Fellowship from the Government of Canada, the 2012 D. W. Ambridge Prize for the top graduating Ph.D. student, an IEEE Photonics Society 2011 Graduate Student Fellowship amongst others awards.

**----Invited Talk----**

***Silicon photonics for AI and neuromorphic computing***

**Abstract—**Artificial intelligence enabled by neural networks has enabled applications in many fields (e.g. medicine, finance, autonomous vehicles). Software implementations of neural networks on conventional computers are limited in speed and energy efficiency. Neuromorphic engineering aims to build processors in which hardware mimic neurons and synapses in brain for distributed and parallel processing. Neuromorphic engineering enabled by silicon photonics can offer sub nanosecond latencies, and can extend the domain of artificial intelligence and neuromorphic computing applications to machine learning acceleration (vector-matrix multiplications, inference and ultrafast training), nonlinear programming (nonlinear optimization problem and differential equation solving) and intelligent signal processing (wideband RF and fiber-optic communications). We will discuss current progress and some challenges of neuromorphic photonics to scale to practical systems.

**11:30~12:00 | Invited Speaker: Tian Zhang**

Zhang Tian, got a Ph. D. from Huazhong University of Science and Technology in 2016, now works as an associate researcher at School of Electronic Engineering in Beijing University of Posts and Telecommunications. From November 2016 to January 2019, she worked as postdoctoral researcher in BUPT. At present, she is mainly engaged in the research of intelligent optical computing, inverse design of photonic devices, and micro-nano photonics. In recent years, she has published more than 50 SCI academic papers in Photonics Research, Optics Letters, Optics Express, Journal of Lightwave Technology, etc., and are cited more than 750 in Google Scholar. She is responsible for National Natural Science Foundation of China, General Program and Special Program of Chinese Postdoctoral Science Foundation, and is as a main participator in Beijing Municipal Science and Technology Project and other projects.

**----Invited Talk----**

***The combination of the micro/nanophotonics and artificial intelligence***

**Abstract**—Owing to the increasing of computing capability and the supporting of big data, artificial intelligence (AI) has stepped into a new era and influenced many other fields. The collision of AI and integrated photonics has brought new vitality to these two fields. On one hand, due to the separating of computing and store, traditional Von Neumann architecture can't meet current computing speed requirement. Although many different electronically architectures have been designed, including GPU, TPU, TrueNorth, and so on, their computing speed are limited by the electronic mobility, clock frequency and the slowing down of Moore law. While benefit from the advantage of integrated photonic information process system, which is with high bandwidth, low loss and low crosstalk, substituting electric means by optical means can greatly improve the computing speed and reduce computing power consumption. Therefore, employing integrated photonic devices to construct neural network is of great importance. On the other hand, the design and optimization of integrated photonic device are limited by computationally expensive and time-inefficient. AI provide a highly efficient way for exploiting the tremendous parameter space. This report will introduce our works on these two aspects.

**12:00~12:15 | G29118**

The Parallel Optoelectronic Reservoir Computing based Nonlinear Channel Equalization

**Xingxing Feng**, Lu Zhang, Xiaodan Pang, Xiazhen Gu, Xianbin Yu

Zhejiang University, China

**Abstract**—The optoelectronic reservoir computing (RC) is considered as a promising optical signal processing technique for nonlinear channel equalization. In this paper, a parallel optoelectronic RC scheme with a dual-polarization Mach-Zehnder modulator (DPol-MZM) is proposed and demonstrated numerically. The nonlinear channel equalization performance is greatly enhanced compared with the traditional optoelectronic RC scheme and Volterra-based DSP scheme, since the nonlinear dynamics of RC are enriched from the dual-polarization methodology. Besides, the system efficiency is improved with a single DPol-MZM.

## V09: Silicon Photonics

## Zoom Meeting Room 1

## ID: 979 0046 1385 | Time: 14:30~16:45

Session Chair: **Wei Jiang**, Nanjing University, China

**14:30~15:00 | Invited Speaker: Yating Wan**

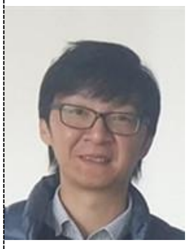
Yating Wan obtained received Ph.D. (2017) in the Department of Electrical and Computer Engineering from Hong Kong University of Science and Technology and was selected as the winner of the School of Engineering PhD Research Excellence Award 2016-17. She has published 32 first-author journal (22)/conference(10) papers, including 6 prestigious covers (Optica, Laser & Photonics Review(3), Applied Physics Letter, Photonics Research), 3 invited talks (2018 CLEO, 2018 PIERS, 2018 ACP), 1 postdeadline conference paper (2017 CLEO), and 1 book chapter (selected as the cover of 《Future Directions in Silicon Photonics》). She has also published 20 other co-authored papers and served as a referee for more than 37 peer-reviewed journals in IEEE, OSA, and the Nature Publishing Group (Google Scholar Citations on 07/20/2021: 1424, h-index: 21). For her pioneering work in integration of long wavelength quantum dot devices on Si, she received 2016-17 School of Engineering PhD Research Excellence Award in HKUST, 2021 CLEO Tingye Li Innovation Prize, 2018 PIERS Young Scientist Award, 2018 Rising Stars Women in Engineering Asia, and 2020 Rising Stars 2020 Women in EECS. She is now a Postdoctoral fellow at of University of California, Santa Barbara in Prof. John Bowers' group, and is in the process of being promoted to a scientist position. Her feature story was reported in http://pgnews.ust.hk/feb-2018-feature-stories-part-2. Her current research includes Si photonics, optical communications, photonic integrated circuits, and quantum photonics.

**----Invited Talk----**

***Advances in quantum dot lasers and integration with Si photonic integrated circuits***

**Abstract—**Si photonics has emerged as a disruptive opto-electronic device technology with a scaling capability on integration and energy efficiency. As the most promising integration platform, Si photonics demands on-chip laser sources that dramatically improve capability, while trimming size and power dissipation in a cost-effective way for volume manufacturability. The central theme of my research is to develop high-performance quantum dot (QD) lasers directly integrated on industry standard Si substrates for on-chip optical interconnects. A subset of recent advances includes record-long device lifetime on Si, isolator-free system demonstration, ultra-low dark current QD photodetectors, submilliamp threshold microcavity lasers, first tunable single wavelength QD lasers, a pathway towards high-volume, low-cost transceivers that can be scaled to beyond 1 Tbit/s, and device integration with waveguides, amplifiers, photodetectors, and lasers on a single chip. A number of breakthroughs have now made Si photonics an appealing platform for photonic integration from both the cost and the performance standpoint. The same forces that drove the evolution of discrete optical modules to photonic integration on a single chip will continue to shape the evolution of photonic integrated circuits to meet the ever-increasing demands on lower cost, size, weight, and power (cSWaP) while delivering equal or better performance than their predecessors.

## 15:00~15:30 | Invited Speaker: Huang Ying



Dr. Huang Ying has over 15 years of experience in silicon photonics research and product development. He has led the development of around 10 silicon photonics products entering the market, with some of them in volume production. He received the B.E. and Ph.D. degree in Electrical and Electronic Engineering from Nanyang Technological University (NTU), Singapore, in 2007 and 2011, respectively. From 2011-2017, he was with the Institute of Microelectronics, A*STAR, Singapore, as a research scientist for silicon photonics product development. He was the principal investigator for three research grants with more than SGD $10M cumulative fundings. In 2017, Dr. Huang co-founded Rain Tree Photonics, Singapore, a start-up leveraging silicon photonics technology to enable the next waves of computing (5G, IoTs, AI and Cloud). Within 2 years of its establishment, the company has rolled out multiple customer-qualified products in hyperscale data-center (400G) and 5G market. He has authored and co-authored more than 50 journal and conference publications, 7 U.S. patents. Dr. Huang is currently the vice-president for IEEE Photonics Society Singapore and used to hold Executive Committee member position in IEEE Singapore Section.

**----Invited Talk----**

***Challenges for Silicon Photonics as We Approach Terabit Modules and Co-Packaged Optics***

**Abstract—**As we approach terabit modules and co-packaged optics, solutions utilizing discrete optics become increasingly impractical. The industry consensus is that integrated photonics or silicon photonics will pave the way forward. This has given rise to a number of proposed solutions with somewhat diverse architectures. In order for a particular solution to be feasible, low power and high performance needs to be achieved at low cost. Besides technological advancement to meet the power and performance requirements, manufacturability is a key concern as it impacts cost and volume scalability. In this talk, we seek to examine the challenges and solutions from a pragmatic perspective.

## 15:30~16:00 | Invited Speaker: Xu Wang

Dr. Xu Wang is Senior Manager R&D at Ansys, leading the Lumerical Solutions Group. He has been focusing on integrated photonic design and simulation solutions. He also leads Lumerical's ecosystem partnerships with foundries, EDA companies, and strategic customers. He has authored more than 60 publications and delivered many invited talks at conferences. He received his Ph.D. from the University of British Columbia.

**----Invited Talk----**

***Silicon Photonics Design for Manufacturability***

**Abstract—**We will discuss the challenges in silicon photonic design with respect to foundry manufacturing, and how to address them with state-of-the-art design automation and simulation solutions.

## 16:00~16:30 | Invited Speaker: Wei Jiang

Wei Jiang is a professor of optical engineering at Nanjing University. Prior to working at NJU, he was an associate professor at Rutgers, the State University of New Jersey, USA. His research interests include silicon photonics and photonic crystals and their applications in optical interconnects, optical communications, LIDAR, and optical computing. He proposed novel waveguide superlattices and demonstrated high-density low-crosstalk waveguide integration with half-wavelength pitches, which opened the door to half-wavelength pitch optical phased arrays and high-performance solid-state lidars. He contributed to the fundamental understanding of silicon electro-optic and thermo-optic devices, slow light, superprism effects, and photonic crystal surface physics. In 2007, the first high-speed photonic crystal modulator was demonstrated on silicon through his research project. Prof. Jiang received the DARPA Young Faculty Award, IEEE Region I Outstanding Teaching Award, among other honors.

**----Invited Talk----**

***Waveguide Superlattice-Based Optical Phased Array***

**Abstract—**Optical phased arrays can steer light beams non-mechanically, which may open up new opportunities for a wide variety of applications such as lidars for self-driving cars, wireless optical communications, and biomedical imaging. Traditionally,

optical phased arrays suffer from large pitches for their emitters. This results in unwanted secondary beams (called grating lobes) that split energy from the main beam, and limits the beam steering angles to a small range. Theoretically, reducing the pitch to half wavelength would solve these problems, and this has been achieved in radio-frequency phased arrays decades ago and is widely used today. Yet achieving half-wavelength pitch for optical phased arrays has been difficult. We reported half-wavelength pitch waveguide superlattices with low crosstalk in 2015, which reveals a new path towards half-wavelength pitch optical phased arrays. We have continued to explore the fundamental properties of such a waveguide superlattice in beam forming through an optical phased array. It is found that low crosstalk and near-ideal beam forming can co-exist in a properly constructed waveguide superlattice. Recently, we have reported experimental demonstration of a waveguide superlattice-based optical phased array whose characteristics approach those of an ideal half-wavelength pitch optical phased array. High main beam energy ratio, low sidelobes and a wide beam steering angular range over 150 degrees have been achieved, with no secondary beams in the full 180-degree field.

### 16:30~16:45 | G29143

High sensitivity refractive index and temperature sensors with tunable multiple Fano resonances

**Yanping Xu**, Zetao Ou, Jianyun Chen, Gongli Xiao, Hongyan Yang
Guilin University of Electronic Technology, China

**Abstract—**In this paper, a susceptible sensor is offered, consisting of a ring-rectangular composite resonator and a metal-insulation-metal (MIM) waveguide coupled with a tube wall on the side. The transmission and sensing properties of the structure are investigated numerically by the finite element method (FEM), and the Fano resonance is found in the transmission spectrum. The results reveal several Fano resonance peaks in the transmission spectrum, and there is a linear relationship between resonant wavelength and refractive index. The Fano resonance peaks are maybe adjusted by modifying the geometric parameters of the structure. The refractive index sensitivity (S) can reach 914 nm/RIU by optimizing the structural parameters. In addition, we can obtain the temperature sensor with high sensitivity by filling ethanol in the medium, and the maximum sensitivity is 0.35 nm/℃. The sensing properties of the structure can be applied to promote the research of nanoscale optical sensors in the integrated photonic devices.

Keywords-Finite Element Method (FEM); MIM waveguide structure; Fano resonance; Refractive index and temperature sensors.

## V10: Technologies and Applications & Optical Fiber Upgrade
## Zoom Meeting Room 2
## ID: 930 3313 8929 | Time: 14:30~17:15

Session Chair: **Yunqi Liu**, Shanghai University, China

### 14:30~15:00 | Invited Speaker: Wei Yan

Dr. Wei Yan is a postdoc researcher with Prof. Yoel Fink (founder of Advanced Functional Fabric of America) at the Research Laboratory of Electronics, MIT, USA. He obtained his PhD from the École Polytechnique Fédérale de Lausanne (EPFL), Switzerland in 2017. His research interests focus on fiber-shaped flexible and stretchable electronics and optoelectronics for applications in sensing, actuation, robotics, smart textiles and neuroscience as well as fundamental study of in-fiber functional materials. He has been published over 20 research articles in top journals including 2 papers in Nature Nanotechnology, 2 Nature Communications and 4 Advanced Materials. He has been authorized 4 patents in the USA and EU. His PhD thesis was awarded 2019 Professor René Wasserman Award, EPFL, Switzerland (the only winner at EPFL). He won the OSA Best Student Paper award in 2017. His research work lead to the first monocrystalline semiconducting nanowire-based optoelectronic fiber and ultralong, complex structured nanoscale metallic glass fibers. He also invented an aerospace-grade textile for the detection of micrometeoroids and space debris that has been sent to the International Space Station in 2020. He is serving as a member of Youth Editorial Board of Advanced Fiber Materials (Springer Nature), a member of the Editorial Advisory Panel for "Nanotechnology" (IOP Science), an international reviewer for the Swiss National Science Foundation (SNSF), and a reviewer for 26 international journals, such as Nature Communications, Advanced Materials, Nature – npj Flexible Electronics, and ACS Photonics.

**----Invited Talk----**

***Advanced Optoelectronic and Electronic Multi-material Fiber Devices and Textiles***

**Abstract—**Fibers, ancient yet largely underdeveloped forms, are the common building blocks of a broad spectrum of product forms from textiles to aircraft constructs. While ubiquitous, these fibers are produced at scale from essentially single materials. The integration of a variety of electronic and optoelectronic materials within thermally-drawn fibers has emerged as an unprecedentedly compelling platform for enabling fibers to evolve into functional devices and smart systems. This approach exploits the thermal drawing of a macroscopic preform, where functional materials or prefabricated devices are arranged at a prescribed position, yielding kilometers of functional fibers with a sophisticated architecture and complex functionalities in a very simple and scalable manner. A single strand of fiber that incorporates materials with disparate electronic, optoelectronics, thermomechanical, rheological and acoustic properties can see objects, hear sound, sense stimuli, communicate, store and convert energy, modulate temperature, monitor health and dissect brains. Integrating these fibers into fabrics, ancient yet largely

underdeveloped forms, is setting a stage for fabrics to be the next frontier in computation and Artificial Intelligence. In this presentation, I will show the fabrication of smart optoelectronic and electronic fiber devices, and elaborate their unique applications in the fields of sensing, healthcare, robotics, textiles and neuron science as well as their fundamental research in materials science and physics.

**15:00~15:30 | Invited Speaker: Yu Cheng**

Professor Yu Cheng received his PhD from Wuhan University of Technology.He is now a professor and master tutor of Guilin University of Electronic Science and Technology.Member of Chinese Optical Society, Member of Chinese Communication Society.He was a postdoctoral fellow at the University of Southampton and the University of Bath.At present, he has presided over one national scientific research project and participated in the national key research and development program projects.He has presided over 2 provincial projects, participated in 3 '863' projects, 1 national major project, 2 EPSRC projects, etc.He has published more than 18 papers in Optics Express, APL, JLT and other journals.We have applied and obtained more than 20 national patents.Research interests: communication fiber, special fiber, broadband fiber amplifier, fiber sensor, etc.

**----Invited Talk----**

***Recent progress in optical fiber technology and applications***

**Abstract—**Fiber optics, the 2009 Nobel Prize-winning technology, has been a hot topic of scientific research for years.In the field of communication, optical fiber connects nearly 6 billion people around the world, making the communication between people on a global scale at any time in any corner.However, the era of data explosion driven by mobile Internet calls for more transmission bandwidth. Therefore, the space division multiplexing technology arises at the right moment to increase the bandwidth of a single optical fiber to the Pbit/s level.In the sensing field, the Angle sensor represented by polarization maintaining fiber has been widely used.In the field of fiber amplifier and laser, rare earth doped fiber and specialty fiber for devices also attract many researchers and enterprises to struggle for them.In the aspect of scientific research, hollow core fiber, multi-core fiber, square core fiber, high nonlinear fiber is in full swing.All in all, although the research of optical fiber has passed 50 years, there are still many theoretical and application problems waiting for the majority of scientists to explore and solve.

**15:30~16:00 | Yunqi Liu**

Yunqi Liu received the Ph.D. degrees in Optics from Nankai University, China, in 2000. From 2000 to 2008, he worked as a Research Fellow in School of Electrical and Electronic Engineering, Nanyang Technological University, Singapore, in School of Engineering, City University London, U.K., and in Department of Electronic Engineering, City University of Hong Kong, Hong Kong, China, respectively. He joined the School of Communication and Information Engineering, Shanghai University, China, as a full professor in 2008. He was supported by the Program for Professor of Special Appointment (Eastern Scholar) at Shanghai Institutions of Higher Learning, China. He has published more than 200 papers on fiber gratings, fiber optic sensors and optical fiber communications.

**----Invited Talk----**

***Helical Long-Period Fiber Grating Mode Converter***

**Abstract—**We demonstrate the fabrication of helical long-period gratings (HLPGs) by using focused carbon dioxide laser. The mode coupling and characteristics of the HLPGs written in the specialty fibers were investigated experimentally. The generation and conversion of the orbital angular momentum (OAM) modes were achieved by the special designed gratings. The HLPGs could have promising application as all fiber mode converters for mode-division-multiplexing optical communications and high sensitivity optical sensors.

**16:00~16:30 | Invited Speaker: Xinyong Dong**

Xinyong Dong (SM'17) received the Ph.D. degree in optics from Nankai University, China, in 2002. He joined the Hong Kong Polytechnic University (HKPU) as a research assistant in 2001. Then, he became a research fellow at Nanyang Technological University, Singapore, in 2002, and came back HKPU as a post-doctoral fellow in 2006. From 2008 to 2018, he had been with China Jiliang University as a full professor and finally joined Guangdong University of Technology in 2019. He published three book chapters and over 400 technical papers with over 8000 citation times. His research interests include optical fiber sensors, amplifiers and lasers.

**----Invited Talk----**

***FBG-Based Wind Speed Sensor with Enhanced Sensitivity***

**Abstract—**A sensitivity-enhanced wind speed sensor based on a cladding-etched optical fiber Bragg grating (FBG) coated with a layer of silver film and optically pumped by using a 1480 nm laser diode is demonstrated. Wind speed measurement with sensitivity up to -1978 pm/(m/s) is achieved at wind speed of 0.1 m/s when the FBG cladding diameter is etched down to 71.6 μm. Sensitivity enhancement up to 61.2% in magnitude is realized if it is compared with the sensitivity of the reference sensor without cladding etching. The maximum wind speed, limited by the wind tunnel used in the testing, is 20 m/s.

**16:30~16:45 | G2957**

Mode Analysis and Characterization of Negative Curvature Hollow-core Fiber under Bending

**Donglai An**, Donglai An, Yingying Wang, Shoufei Gao and Xia Yu
Beihang University, China

**Abstract—**Negative curvature hollow-core fiber (NC-HCF) is a promising waveguide candidate for long haul transmission, high power laser delivery and macro-/micro-bend sensing. It is important to study in details of its bending characteristics, among which the critical bend radius is a crucial parameter. In this paper, a new semi-analytical model is reported to calculate the critical bend radius accurately. This model is then validated numerically and experimentally. Meanwhile, the influence of structural parameters and bend radius on the fundamental core mode effective index is discussed. The model can also be used to predict the peak values in loss spectrum under bending condition. Generally, it supports the design of NC-HCF and related devices to meet the requirements about broad bandwidth in telecommunication as well as high bending sensitivity in sensing application.

**16:45~17:00 | G29123**

Sensitivity-improved sensor for ultrasound detection and imaging of seismic physical model

**Yin Huanhuan**, Huanhuan Yin,Xi Yang, Zhihua Shao* and Xueguang Qiao*
Northwest University, China

**Abstract—**A sensitivity-improved fiber-optic ultrasonic sensor is proposed and employed for ultrasonic imaging of seismic physical models. The sensor consists of a single mode fiber (SMF) embedded into the hollow-core-fiber (HCF) bubble. Using gas pressure assisted arc discharge, the diameter of the bubble can be larger than 430 μm with a wall thickness of approximately 0.48 μm. Besides, by using the coating technique, the optical reflectivity and extinction ratio of the ultra-thin bubble are further improved. Fiber tails of SMF and the HCF are partly bonded to form an open-cavity sensor. When applied with ultrasonic waves, the compact bubble can balance the difference of air pressure between inside and outside. The fault topography is designed and the proposed sensor is used for ultrasonic detection and imaging.

**17:00~17:15 | G2999**

Fluorescence detection with a dual-core photonic crystal fiber

**Wenlin Luan**, Wenlin Luan, Jialin Chen, Zhouzhuo Tang, Wenzhuo Li, Hui Gao, Xia Yu
Beihang University, China

**Abstract—**In this work, an all-fiber fluorescence detection method was proposed based on wavelength division multiplexing (WDM) of dual-core photonic crystal fiber (DC-PCF). The air-hole region offers embodiment of fluorescence sample of 100 nL volume. On the other hand, the excitation light and fluorescence emission could be separated through the precise control of the dual-core fiber length. Finally, 11.23 dBextinction ratio between emission and excitation was achieved experimentally.

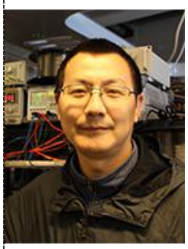
## V11: Near-infrared, Mid-infrared and Far-infrared Technologies and Applications

## Zoom Meeting Room 3

## ID: 827 9043 9167 | Time: 14:30~16:45

Session Chair: **Jiagui Wu**, Southwest University, China

**14:30~15:00 | Invited Speaker: Jiagui Wu**



Jiagui Wu is a Professor with the College of Artificial Intelligence, Southwest University and a visiting scholar in the University of California, Los Angeles, USA. He has authored or co-authored over 70 publications including about 50 journal papers. His research interests include Near-infrared, Mid-infrared and Far-infrared Technologies and Applications,micro-nanophotonic,information security.

**----Invited Talk----**

***Secure communication with quantum cascade laser chaos***

**Abstract—**Mid-infrared free-space optical communication has a large potential for high speed communication. The synchronization of chaos inspires in sciences and promises a broad range of engineering. Here, we show our group that two coupled quantum cascade lasers (QCL) operating in the chaotic regime and the synchronization between them allow for the extraction of informationn. This could be a important tool to implement a high degree of privacy directly on the physical layer. We realize a proof-of concept communication at a wavelength of 5.7 μm with a message encryption. it may opens new platform for physical layer secure communication.

**15:00~15:30 | Invited Speaker: Peng Wang**

Peng Wang, associated professor at Shanghai Institute of Technical Physics, Chinese Academy of Sciences. His main research interest is focus on the infrared photodetector. He has published 26 first author and corresponding author SCI papers in Nature Communications, Science Advances, Advanced Materials, ACS Nano, etc. He has also coauthored in more than 60 SCI papers, which has more than 4,000 times citations with h index of 33. He was selected for “Youth Innovation Promotion Association CAS” at 2021, “Youth talent promotion project of CAST” at 2020, and “Shanghai Sailing Program” at 2019. He awarded the Young Scientist Award of IEEE ICOCN 2019, Best Oral Award of 2DMAT 2019, and Outstanding Graduate Student Award of

Synergetic Innovation Center of Quantum Information & Quantum Physics in 2016. He is appointed as a member of young scientist committee of Chinese Physics Letters, Chinese Physics B, Acta Physica Sinica and Physics.

**----Invited Talk----**

***Recent progress of high-performance infrared photodetectors driven by local field***

**Abstract—**In the past decades, infrared (IR) photodetectors have been widely applied in remote sensing, medicine, communication and many other important fields. The smaller size, lighter weight, lower power, higher performance and lower price are expected in the next generation IR detection system. In recent years, many new types of advanced IR photodetectors with extraordinary designs, operating modes and materials come to the fore quickly. Here, we will introduce the progress and challenges of IR technology and give a report on our progress in the development of IR photodetectors driven by local field.

## 15:30~16:00 | Invited Speaker: Xiaoqiong Qi

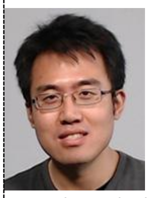
Xiaoqiong Qi received the B.E. degree and the Ph.D. degree in electrical engineering from Lanzhou University, China in 2003 and 2009, respectively. She conducted research at University of California at Los Angeles (UCLA) for two years during her Ph.D. studies. She joined the Institute of Semiconductors, Chinese Academy of Sciences (CAS) as a postdoctoral research fellow and in 2011 promoted as an Associate Professor. She visited Centre for Biophotonics and Laser Science at the University of Queensland (UQ) in 2013. She was awarded UQ Fellowship in 2015 and Advance Queensland Industry and Research Fellowship in 2020. She is currently a Research Fellow at UQ and her research interests are laser dynamics in semiconductor lasers, sensing and imaging by using terahertz quantum cascade lasers.

**----Invited Talk----**

***Optical feedback dynamics in terahertz quantum cascade lasers and the applications***

**Abstract—**The high ratio of photon-to-carrier lifetimes and small linewidth enhancement factor in terahertz (THz) quantum cascade lasers (QCLs) leads to absence of relaxation oscillations and negligible coupling from the amplitude to phase in this type of laser. It was widely accepted that THz QCLs are ultrastable against optical feedback. However, we experimentally observed and theoretically explanied the optical feedback dynamics in THz QCLs. We explored the periodic oscillations properties of the OF dynamics in THz QCLs and their applications as a novel THz sensing and imaging modality.

## 16:00~16:30 | Invited Speaker: Hairun Guo



Prof. Dr. Hairun Guo received his PhD at Technical University of Denmark (DTU) in 2014, and worked as a post-doc scientist in the laboratory of photonics and quantum measurements, led by Prof. Tobias J. Kippenberg at Swiss Federal Institute of Technology Lausanne (EPFL), where his research interests were centered on microresonator based optical frequency combs and cavity dissipative soliton physics, with a focus on mid-infrared frequency comb generations in nano-photonic chip-based devices. Since 2019, he joined the key laboratory of specialty fiber optics and optical access networks at Shanghai University, China. His group is now focusing on optical frequency comb techniques and ultra-fast nonlinear regimes in optical frequency metrology. Hairun has published more than 40 journal article, with an overall citation >2000.

**----Invited Talk----**

***Frequency metrology via coherent vector supercontinuum process in photonic waveguides***

**Abstract—**Supercontinuum generation has been well known for extending the bandwidth of mode locked lasers to perform *f-2f* self-referencing. Recently, this process in photonic integrated platforms has also been employed to access optical frequency combs in the mid-infrared as well as in the visible, with demonstrated no degradation in the coherence. Conventionally, the supercontinuum process is managed within one of the two fundamental *x*- and *y*-polarized modes in a photonic waveguide.

In this talk, we will review our recent advances in photonic supercontinuum serving for coherent and broadband mid-infrared optical frequency combs, including a proof-of-concept mid-infrared dual-comb spectrometer. More importantly, we will report a novel photonic supercontinuum dynamic that involves both of the two fundamental modes of the waveguide. We discover that in addition to simultaneous supercontinuum generations in both modes, light coupling is featured as a transfer function in the radio frequency (*rf*) domain, and a response spectrum in the optical domain can be retrieved. Physically, the retrieved response spectrum reveals a complete chart of wavelength-dependent coupling intensities in the photonic waveguide, and in practice, such an optical-to-microwave transfer can be employed to the implementation of optical frequency modulo operation, particularly that the frequency reminder can be with the light in the visible range where detectors are highly sensitive. This is highly desired in frequency metrology as well as in laser stability. Given the fact that two fundamental modes are orthogonal polarized, we term our observation as a vector supercontinuum process.

## 16:30~16:45 | G2951

A Fast Calculation Method of Gas Infrared Radiation Characteristics at High Temperature based on Radial Basis Function Neural Network

**Xiaying Meng**, Jun Du, Biao Wang, Yutao Zhang, Dandan Gu, Jian Qiu

Science and Technology on Electromagnetic Scattering Laboratory, China

**Abstract—**The radiation characteristics of high temperature gas are of great significance for infrared target detection. In this paper, a calculation method of high temperature gas radiation characteristics with high calculation efficiency is proposed. The

calculation model of CO2 absorption coefficient at 2001-2450 cm-1 band is established by using radial basis function neural network (RBFNN). In RBFNN model, the most accurate line by line (LBL) method is utilized to generate training samples. The input parameters are gas temperature, pressure and component concentration, and the output parameter is absorption coefficient. The results show that, compared with LBL method, RBFNN model has higher accuracy and is insensitive to input. After RBFNN training, RBFNN has higher computational efficiency while ensuring computational accuracy.

## V12: Optical Communication and Networks
## Zoom Meeting Room 4
## ID: 816 7808 8000 | Time: 14:30~17:15

Session Chair: **Chen Chen**, Chongqing University, China

### 14:30~15:00 | Invited Speaker: Chen Chen

Chen Chen (Member, IEEE) received the B.S. and M.Eng. degrees from the University of Electronic Science and Technology of China, Chengdu, China, in 2010 and 2013, respectively, and the Ph.D. degree from Nanyang Technological University, Singapore, in 2017. He was a Post-Doctoral Researcher with the School of Electrical and Electronic Engineering, Nanyang Technological University, from 2017 to 2019. He is currently a Research Professor with the School of Microelectronics and Communication Engineering, Chongqing University, Chongqing, China. His research interests include optical wireless communication, optical access networks, Internet of Things, and machine learning.

**----Invited Talk----**

***NOMA for LiFi-Enabled Bidirectional IoT Communication: An Energy Efficiency Perspective***

**Abstract—**In this talk, we will introduce an energy-efficient non-orthogonal multiple access (NOMA) scheme for light fidelity (LiFi)-enabled bidirectional Internet of Things (IoT) communication. In order to efficiently improve the energy efficiency (EE) of the bidirectional LiFi-IoT system, NOMA with a quality-of-service (QoS)-guaranteed optimal power allocation (OPA) strategy is first proposed, and then an adaptive channel and QoS-based user pairing approach is further designed. Analytical and simulation results demonstrate the superiority of NOMA with OPA in comparison to orthogonal multiple access (OMA) and NOMA with typical channel-based power allocation strategies.

### 15:00~15:30 | Invited Speaker: Fangzheng Zhang

Prof. Fangzheng Zhang received the B.S. degree from Huazhong University of Science and Technology, Wuhan, China, in 2008, and the Ph.D. degree from Beijing University of Posts and Telecommunications, Beijing, China, in 2013. He is currently a professor with the College of Electronic and Information Engineering, Nanjing University of Aeronautics and Astronautics. His current research interest includes microwave photonics, radar imaging, and machine learning.

**----Invited Talk----**

***Deep Learning based Signal Recovery for Broadband Radar over Fiber Transmission***

**Abstract—**Radar over fiber networks, or fiber distributed radar networks, is a good solution to extend the radar detection area. In such networks, a group of distributed radar stations covering different detection areas are connected to the central radar station by optical fibers. To simplify the system and save the cost, it is preferred that the radar echoes received by each radar station are transmitted through fiber links to the central station, where analog-to-digital conversion and digital signal processing are conducted. In this process, the radar echoes would suffer from noises and nonlinear spurs because of unideal E/O and O/E conversions as well as fiber dispersion and nonlinearities. To deal with the signal distortions, specially designed electro-optical modulation formats or optical signal processing modules can be applied, but the system is heavily dependent on the electro-optical devices and usually only one aspect of the impairments can be compensated. Some of the system defects, such as the in-band harmonic spurs, cannot be compensated using the traditional optical signal processing methods. In this report, a deep learning assisted radar signal recovery method is presented, in which a convolutional neural network (CNN) is applied to deal with the system defects and recover the radar signals. Performance of this method is experimentally investigated. The results can soundly verify the feasibility and effectiveness of the proposed method, which is a promising solution for broadband radar signal recovery in radar over fiber networks.

### 15:30~16:00 | Invited Speaker: Biao Chen

Biao Chen received the Bachelor and Master degrees in Industrial Electronics from Zhejiang University, Hangzhou, China, in 1984 and 1987 respectively, and the Ph.D. degree in Information & Communication Engineering from Zhejiang University in 2004. In 1987, he joined Zhejiang Institute of Technology, Hangzhou, China, where he was engaged in research on optical transmission systems, Instrumentation & control systems. In 1993, he partly joined Shenzhen Sanxin Photoeletronics Technology Co. Ltd., serving as Chief Engineer and the president later on. In 1994, he designed and implemented the optical CATV transmitters/receivers, which were the first models in China and commercialized successfully. Since 2000, he joined Zhejiang University, Hangzhou, China, where he has been engaged in research on metropolitan- and access-area network technologies. Recently He has successfully developed an advanced on-line automatic instrumentation system for ferrule fabrication industry and combination of optical and radio network systems for remote driving and operation. Currently, he is executive director of Optical Engineering division, Ningbo Research Institute Zhejiang University, and header of the Ningbo Advanced Photoelectric Technology Innovation Platform. His current research interest is in optical and radio Industrial communication systems and networks.

**----Invited Talk----**

***Hybrid FSO/RF for a mobile wireless link***

**Abstract—**The performance of free space optical (FSO) links can seriously be affected by fog and pointing errors and less subject to rain, while radio frequency (RF) wireless systems that use frequencies above 10 GHz are adversely impacted by rain and less impacted by fog and pointing errors. This motivates the design of hybrid RF/FSO systems for reliable wireless connection applications. We present a design of hybrid RF/FSO systems for a mobile wireless link which could be used in broadband industrial applications. A key issue in this design is how to effectively use RF and FSO links in parallel. We try to fix it at data link level.

## 16:00~16:30 | Invited Speaker: Xian Zhou

Xian Zhou received the Ph.D. Degree in electromagnetic field and microwave techniques from Beijing University of Posts and Telecommunications, China in 2011. She was a Hong Kong Scholar at the Department of Electrical and Information Engineering at the Hong Kong Polytechnic University from Feb. 2014 to Feb. 2017. She is currently professor at School of Computer and Communication Engineering at University of Science and Technology Beijing. Her current research interests include high-speed optical fiber transmissions and fiber sensing technologies. She collaborates extensively with industry and is currently the principle investigator of various governmental- and industry-funded research projects in various aspects of optical communications and sensor systems.

**----Invited Talk----**

***Coherent Detection for Data Center Interconnections***

**Abstract—**After 400G, Ethernet speed is envisioned to be 800G and/or 1.6T, which is projected to be deployed within 5 years. However, the limited spectral efficiency of the PAM-like IM-DD systems cannot support to scale the transport data rate up to terabit. Some cost-efficient solutions of coherent detection have started to attract attention in short reach transmission scenarios. This talk will review the recent progress of these simplified coherent optical schemes and provide a discussion about problems faced them.

## 16:30~16:45 | G2978

Machine Learning Assisted Hardware Fingerprint Identification for TDM-PON from Eye Diagram

**Huiyuan Gong**, Huiyuan Gong, Mengfan Cheng, Weidong Shao, Lei Deng, Qi Yang, Xiaojing Gao, Deming Liu

Wuhan Research Institute of Posts and Telecommunications, China

**Abstract—**Identity authentication management is a challenge in network security solutions. Especially, this issue becomes more prominent in passive optical network (PON) due to its broadcasting nature and point to multipoint (P2MP) topological structure. Unauthorized access, injection attack and identity spoofing are not difficult to implement.

From the authentication perspective, several encryption strategies have been reported in order to improve the security of PONs. However, this type of methods excessively depends on the keys, which have the risk of being leaked and cloned by certain illegal means. On the other hand, hardware device fingerprints are natural features with uniqueness and non-clonability at the physical layer, and they are caused by the tolerances of electronic and optic components of device. More specifically, manufacturing variability among electro-optical transmitters generates unique signature in the transmitted analogue waveform, which could be used as the fingerprint for ONU identification to achieve intrusion detection and resist identity spoofing attacks.

An identity authentication scheme for TDM-PON at physical layer is proposed. The schematic is shown in Fig.1. We use the received eye diagram as the source of fingerprint. A trained convolutional neural network (CNN) is utilized to directly learn and classify the features in the eye diagrams. A commercial FPGA evaluation board with 10G SFP+ port is used as the ONU. 10 in total 10G SPF+ transceiver modules are under test using the transmit pattern of pseudo random bit sequence (PRBS-15). An oscilloscope is used to detect the signal at the OLT-side. Experimental results show that the recognition rate can reach 99%. The proposed method can be used to enhance the security performance of TDM-PON at the physical layer in a compact manner.

## 16:45~17:00 | G2933

Network Design Models with Partial Protection Schemes Against Multiple Failures under Optical-Channel Data Unit Constraints

**Yiliu Tan**, Qian Wu, Yoshiki Nakano, Jiading Wang, Maiko Shigeno

University of Tsukuba, Japan

**Abstract—**In recent years, dependency on computer networks has been increasing due to the increasing speed and capacity of data transmission. To guarantee the quality of service in networks, new technologies are being developed. The use of optical-channel data unit (ODU) technology in optical networks can segment and combine the required traffic demands and make effective use of network resources so that more traffic demands can be satisfied. An algorithm for addressing multiple ODU switch failures is described in this paper. This paper proposes three models to prevent multiple failures and formulates them as

integer linear programming problems. The computer experiments compare their efficiencies. As a result, each traffic demand on the network is divided into plural paths, and less calculation time is required when the capacity allocated to each path is fixed. When the same method is used but the capacity allocated to each path is unfixed, the resource cost is relatively small.

### 17:00~17:15 | G2917

A 15 Gbps 520-nm GaN Laser Diode based Visible Light Communication System utilizing Adaptive Bit Loading Scheme

**Junhui Hu**, Chao Shen, Fangchen Hu, Guoqiang Li, Sizhe Xing, Wangwei Shen, Junwen Zhang and Nan Chi
Fudan University, China

**Abstract—**In this paper, we demonstrate a high-speed visible light communication system employing a 520-nm green laser diode. A recorded data rate of 15.004 Gbps is reported by utilizing an adaptive bit-loading discrete multitone (DMT) modulation scheme with a measured bit error ratio (BER) of $3.724 \times 10\text{-}3$, which satisfies the forward-error-correction (FEC) criteria. The results suggest the system has a high spectral efficiency of 5.456 bit/s/Hz at 2.75 GHz bandwidth.

# VIRTUAL SESSIONS / Sept. 18, 2021

**V13: Translational Photomedicine and Biophotonics**

**Zoom Meeting Room 1**

**ID: 979 0046 1385 | Time: 10:00~12:00**

Session Chair: **Wenbo Hu**, Northwestern Polytechnical University, China

## 10:00~10:30 | Invited Speaker: Huilin Shao

Dr. Huilin Shao is Presidential Young Professor, Department of Biomedical Engineering, and Principal Investigator, Institute for Health Innovation & Technology (iHealthtech), National University of Singapore. Dr. Shao received her BA from Cornell University, with a double major in Biological Sciences and in Physics. She completed her dual PhD (Biophysics) at Harvard University and PhD (Medical Engineering) from Harvard-MIT Health Sciences and Technology (HST). Her research focuses on developing integrated nanotechnology platforms for molecular analyses of novel biomarkers. She has pioneered multiple technologies to advance molecular diagnostics. Her work has been published in top journals such as Nature Biotechnology, Nature Nanotechnology, Nature Medicine, Nature Biomedical Engineering, Nature Communications and highlighted in major reviews and popular news media. In recognition of her achievement, Dr. Shao has received multiple awards, including James Mills Pierce Award, A*STAR Independent Fellowship, NUS Early Career Research Award, the L'Oreal For Women in Science National Fellowship, Springer-Nature MINE Young Scientist Award, and Singapore Presidential Young Scientist Award.

**----Invited Talk----**

***Nanosensor technologies for molecular analyses of circulating biomarkers***

**Abstract—**The growing emphasis on personalized medicine significantly increases the need to analyze key molecular markers. In comparison to tissue biopsies, circulating biomarkers (liquid biopsies) can be conveniently and repeatedly obtained from biofluids with minimal complications. In particular, exosomes have recently emerged as a promising circulating biomarker. Exosomes are nanometer-sized membrane vesicles actively shed off by cells and possess unique advantages: they abound in biofluids and harbor diverse molecular contents. In this talk, I will describe various nanosensor systems we have developed for quantitative analyses of diverse circulating biomarkers. These technologies integrate advances in device engineering, nanomaterial sciences and molecular biology. By enabling rapid, sensitive and cost-effective detection of circulating biomarkers, these platforms could significantly expand the reach of preclinical and clinical research, in informing therapy selection, rationally directing trials, and improving sequential monitoring to achieve better clinical outcomes.

## 10:30~11:00 | Invited Speaker: Wenbo Hu

Wenbo Hu received his Ph.D. degree from Nanjing University of Posts and Telecommunications in 2016. He carried out postdoctoral work at Nanjing Tech University (2017) and State University of New York at Buffalo (2018–2019). In 2020, he obtained full professorship at Northwestern Polytechnical University. His research focuses on the ultrafast excited-state dynamics in organic phototheranostic materials.

**----Invited Talk----**

***Manipulating the Dynamics of Dark Excited States in Organic Materials for Phototheranostics***

**Abstract—**Manipulating the dynamics of dark excited-states (DES) such as higher excited singlet or excited triplet states with no or small radiative decay, are of both fundamental as well as practical interests, an important application being photoactivated diagnosis and therapy (phototheranostic) which include photoacoustic (PA) imaging, photodynamic therapy (PDT), and photothermal therapy (PTT). However, the current understanding of DES in organic structures is rather limited, thus making any rational manipulation of DES in organic materials very challenging.

A DES decays primarily by radiationless transition through two pathways: (i) singlet-to-triplet intersystem crossing (ISC), and (ii) internal conversion (IC) relaxation. The deactivation of DES via ISC can generate cytotoxic reactive oxygen species (ROS) for PDT, while IC could convert photons into heat for PA imaging and PTT. Herein, we highlight our research on developing a fundamental understanding of structure-property relationship for manipulation of DES in organic materials in relation to phototheranostic. We describe the application of femtosecond transient absorption (fs-TA) spectroscopy for obtaining valuable insights into the DES dynamics. Afterwards, we present our work on DES in non-rigid molecules that revealed greatly enhanced ISC through geometry-twisting, which leads to an innovative pathway to develop organic materials exhibiting external stimuli-responsive reversible switching of ISC. This insightful understanding of ISC can lead to the development of more advanced photosensitizers for PDT. Two other emergent concepts from our work presented here are: 1) significantly enhanced IC producing strong local heating by combining two-photon absorption with excited state absorption for cumulative multiphoton absorption, thus greatly increasing the strength of the PA signal for nonlinear PA imaging; and 2) by an example of an organic molecule, BODIPY, we show nanoscale charge-transfer state mediated strong IC in aggregate nanoparticles resulting in exceptionally high photothermal conversion efficiency of 61% for both PA and PTT.

**11:00~11:15 | G2931**

Numerical Study on the Light Extraction Efficiency and Angular Energy Distribution of Micro-LEDs

**Zhengcong Fan**, Weihong Chen, Feifan Qiu, Canbin Fang , Bingxi Xiang , Dan Wu and Mingxia Qiu
Shenzhen Technology University, China

**Abstract—**Abstract—Micro light emitting diodes (Micro-LEDs) possess advantages of high optical efficiency, high resolution and long lifetime, leading to a very broad application prospect in the future. This study uses Monte Carlo ray tracing method to study the variation of the luminescence characteristics of light emitting diode (LED) chips including horizontal electrode chip, flip chip, and vertical electrode chip while the size of LED chip decreases from conventional high-power LED size to micro-meter size LED. As the size of LED chip gets smaller, the luminescence characteristics will be significantly affected. The changes of the chip's luminescence characteristics are simulated as a function of dam's angle or reflectivity. Through simulations, it is found that when the size decreases from 1000 to 20 μm, the light extraction efficiency (LEE) of the three structures has reached more than 200% of the conventional LED chips, while the side emission ratio (SER) has increased by more than 50%. The simulation also reveals that for Micro-LED with flip electrode structure, adding the dam brings the following changes: the LEE increases as the rise of reflectivity of the dam. The half-peak width of the angular energy distribution curve decreases firstly and then increases with the increase of the dam's angle. The dam's angle of 30 ° can not only optimize the angular energy distribution curve, but also have a higher LEE. The results of this numerical study have an important significance for optical design and future application of Micro-LEDs.

**11:15~12:00 | G2932**

Analysis of package factors affecting the light output efficiency of quantum dots-based micro-LEDs

**Yuhao Wu**, Hairui Xie, Yuxuan Zhang, Jianwen Li, Kai Wang, Zhili Zhao, Mingxia Qiu, Fan Yang, Dan Wu
Shenzhen Technology University, China

**Abstract—**As the demand for telecommuting, remote instruction, and non-contact testing increases, augmented reality (AR) and virtual reality (VR) are growing rapidly due to the ability to fulfill site constraints. The key component of AR/VR is the microsize light sources. Among various types of potential sources, light emitting diodes (micro-LEDs) are the one of the most promising candidates. Different packages have a significant impact on the light output characteristics of micro-LEDs, which in turn affects their application. In this work, Monte Carlo ray tracing method is used to study the luminous characteristics of quantum dots (QDs) based micro-LEDs in different package structures. The effects of various bank reflectance and tilt angle on the luminous characteristics are simulated to fit the different needs of practical applications. With the increase of reflectivity, the light efficiency is significantly improved, and the impact is the largest at the bank with the angle of 90 °, where the light efficiency increases from 11.73% to 100%. The effect of QDs with different thickness and concentration on light efficiency was analyzed. The effect of QDs on light efficiency is not significant. However, owing to the formation of total internal reflection inside the micro-LED and the scattering characteristics of QDs, the absorption characteristics, which make the loss severe, semi-spherical micro-lens were added to break the total internal reflection at the light emitting interface and the light efficiency was increased by about 30%. This study will provide guidance for micro-LED packaging of different applications.

## V14: Quantum Optics and Information

## Zoom Meeting Room 2

## ID: 930 3313 8929 | Time: 10:00~12:00

Session Chair: **Xuejian Wu**, Rutgers University-Newark, USA

**10:00~10:30 | Invited Speaker: Saijun Wu**

I graduated from Peking University in 2001, with M.S. degree in Optics, from Harvard University in 2007 with Ph.D degree in Appiled Physics. From 2007-2011 I worked with Prof. J. V. Porto at NIST and Univeristy of Maryland. From 2011-2014 I was a (senior)lectuer at Swansea University, UK. Since 2014 I was a professor at Fudan University. My research area are primarily on atomic physics and quantum optics. I am interested in developing new methods for controlling of atoms with light and vice versa. Current research projects in my Fudan Physics lab primarily are focused on developing methods for coherent control of atomic states and interactions with wideband shapable laser pulses, and for atomic spectroscopic imaging with holographic microscopy.

**----Invited Talk----**

***Geometric control of dipolar spin-waves unraveling microscopic interaction at a cold-atom photonic interface***

**Abstract—**Interaction between light and macroscopic ensemble of motionless atoms is a complex phenomenon featuring many-body resonant dipole interactions. An essential step toward possibly exploring the quantum resources of the system is to suppress the macroscopic light propagation, to allow the microscopic correlations to build up and to be analyzed in a background-free fashion. In this talk I will discuss a few recently developed optical techniques to precisely control strong transitions with geometric phases and to reversibly suppress propagation of light in a cold atomic ensemble. By transiently

suppressing the macroscopic dynamics, we unravel and precisely characterize a microscopic dipolar dephasing effect that generally limits the lifetime of the optical spin-wave order in ensemble-based atom-light interfaces.

### 10:30~11:00 | Invited Speaker: Yogesh S. S. Patil

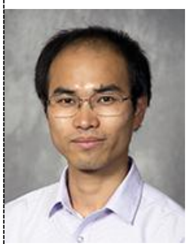
Bachelors in Engineering Physics at IIT, Bombay 2011;
PhD in Physics at Cornell University, 2018 working in AMO Physics studying open quantum systems with cold atoms and optomechanics;
Post-doc at Yale University working on quantum optomechanics since 2018

**----Invited Talk----**

***Measurements of High-Order Phonon Correlations in an Optomechanical System via Single-Photon Detection***

**Abstract—**We use single photon detectors to probe the motional state of a superfluid Helium resonator. The arrival times of Stokes and anti-Stokes photons (scattered by the resonator's acoustic mode) are used to measure the resonator's phonon coherences up to the fourth-order. These measurements are found to be consistent with predictions that assume the acoustic mode to be in thermal equilibrium with a bath through a Markovian coupling. By post-selecting on photon detection events, we also measure coherences (up to the third-order) of phonon-subtracted or -added thermal states of the resonator.

### 11:00~11:30 | Invited Speaker: Tongcang Li



Prof. Tongcang Li is an associate professor of physics and astronomy, and an associate professor of electrical and computer engineering at Purdue University. Before joining Purdue University in 2014, he did postdoctoral research at the University of California, Berkeley during 2011-2014. He obtained his Ph.D. degree from the University of Texas at Austin in 2011. Prof. Li is a pioneer in levitated optomechanics. He has won multiple awards including the NSF CAREER Award in 2016. Prof. Li has published one book and many high-impact papers in Science, Nature Physics, Nature Nanotechnology, Nature Communications, Physical Review Letters, and other leading journals. His recent work on GHz rotation of an optically levitated nanoparticle was selected as one of the "Highlights of the Year" of 2018 by the American Physical Society (APS) website Physics.

**----Invited Talk----**

***Quantum sensing with levitated nanoparticles and spin defects in 2D materials***

**Abstract—**Recently, we optically levitated nanoparticles in vacuum and driven them to rotate at a record-high speed of 300 billion rpm (5 GHz) [J. Ahn, et al. Nature Nanotechnology 15, 89 (2020)]. We demonstrated ultrasensitive torque detection with an optically levitated nanoparticle in vacuum. This system will be promising to study quantum surface interactions. We have also created shallow spin defects in hexagonal boron nitride (hBN), which is a van der Waals material. We observed a record-high optically detected magnetic resonance (ODMR) contrast of 46% at room temperature, and simultaneous enhancement of the photoluminescence of hBN spin defects by up to 17-fold by the surface plasmon of a gold-film microwave waveguide. Our results support the promising potential of hBN spin defects for nanoscale quantum sensing.

### 11:30~12:00 | Invited Speaker: Jiafeng Cui

Jiafeng is working as a Postdoctoral Researcher at Indiana University, Bloomington. His current research group is working on forming a radial 2D ion crystal in a linear Paul trap which is especially well-suited for studies of highly frustrated quantum spin models. Prior to Indiana, he has been working on using ion trap to probe quantum chemistry at Northwestern University for a short amount of time as a Postdoc.

**----Invited Talk----**

***Radial two-dimensional ion crystals in a linear Paul trap***

**Abstract—**We experimentally study two-dimensional (2D) Coulomb crystals in the "radial-2D" phase of a linear Paul trap. This phase is identified by a 2D ion lattice aligned entirely with the radial plane and is created by imposing a large ratio of axial to radial trapping potentials. Using arrays of up to 19 171Yb+ ions, we demonstrate that the structural phase boundaries and vibrational mode frequencies of such crystals are well-described by the pseudopotential approximation, despite the time-dependent ion positions driven by intrinsic micromotion. We further observe that micromotion-induced heating of the radial-2D crystal is confined to the radial plane. Finally, we verify that the transverse motional modes, which are used in most ion-trap quantum simulation schemes, remain decoupled and cold in this geometry. Our results establish radial-2D ion crystals as a robust experimental platform for realizing a variety of theoretical proposals in quantum simulation and computation.

## V15: AI Photonics

## Zoom Meeting Room 3

## ID: 827 9043 9167 | Time: 10:00~12:00

Session Chair: **Jianqiang Li**, Kuaishou Technology, China

### 10:00~10:30 | Invited Speaker: Hsuan-Tung Peng

Hsuan-Tung Peng received the B.S. degree in physics from National Taiwan University, Taipei, Taiwan, in 2015 and the M.A. degree in electrical engineering in 2018 from Princeton University, Princeton, NJ, USA, where he is currently working toward the Ph.D. degree. His current research interests include neuromorphic photonics, photonic integrated circuits, and optical signal processing.

**----Invited Talk----**

***A Photonic-Circuits-Inspired Compact Network: Toward Real-time RF fingerprinting***

**Abstract—**Machine learning (ML) methods are ubiquitous in wireless communication sys- tems and have proven powerful for applications including radio-frequency (RF) fingerprinting, automatic modulation classification, and cognitive radio. However, the large size of ML models can make them difficult to implement on edge devices for latency-sensitive downstream tasks. In wireless communication systems, ML data processing at a sub-millisecond scale will enable real-time network monitoring to improve security and prevent infiltration. In addition, compact and integratable hardware platforms which can implement ML models at the chip scale will find much broader application to wireless communication networks. Toward real-time wireless signal classification at the edge, we propose a novel compact deep network that consists of a photonic-hardware-inspired recurrent neural network model in combination with a simplified convolutional classifier, and we demonstrate its application to the identification of RF emitters by their random transmissions. With the proposed model, we achieve 96.32% classification accuracy over a set of 30 identical ZigBee devices when using 50 times fewer training parameters than an existing state-of-the-art CNN classifier. Thanks to the large reduction in network size, we demonstrate real-time RF fingerprinting with 219 µs latency using a small-scale FPGA board, the PYNQ-Z1.

### 10:30~11:00 | Invited Speaker: Nan Hua

Dr. Nan Hua is an associate professor at Tsinghua University, Beijing, China. He received his B.S and Ph.D. degrees from Tsinghua University, in 2003 and 2009, respectively. In 2008, he went to the Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute (HHI) in Germany to conduct research studies. Since 2011, he joined the Department of Electronics Engineering, Tsinghua University and worked on optical switching networks. His areas of research include large-scale optical network control, all-optical switching technology, data center optical network, satellite optical network and high-precision network time synchronization. He has obtained more than 20 patents and published over 100 academic papers.

**----Invited Talk----**

***The Impact of Data Acquisition Inconsistency and Time Sensitivity on Digital Twin for AI-Driven Optical Networks***

**Abstract—**We focus on the causes and impact of noise and distortion in the digital twin for AI-driven optical networks, which is the cornerstone of convergence of resources for perception, transmission, storage and computing. Some possible solutions are put forward to reduce or eliminate the influence of the above two factors as well.

### 11:00~11:30 | Invited Speaker: Ching Eng PNG

Ching Eng (Jason) Png is Director of the Electronics and Photonics Department at Institute of High Performance Computing (IHPC), A*Star, Singapore. He received his PhD degree from the University of Surrey, UK (2004), MBA from INSEAD, France (2014) and Tsinghua University, China (2014). Dr. Png joined IHPC in 2005 with research interests spanning from quantum and high-speed photonics/plasmonics to electromagnetics.

He received numerous awards including the prestigious Royal Academy of Engineering Prize, Vebleo Fellow, Vebleo Scientist Award, IET Innovation Award - Software Design (highly commended), Skolkovo Prize at INSEAD Venture Competition, and Spring TECS Proof-of-Value grant. Dr. Png sits on SPIE Photonics West technical program and is Founding Chair for URSI Singapore Chapter.

**----Invited Talk----**

***AI in Computational Photonics***

**Abstract—**Photonic component modeling and design tasks mainly involves solving two challenges; firstly we address the forward problem where the goal is to seek optical response for a given photonic geometry. This is accomplished by hard computing methods in which Maxwell equations are numerically evaluated. In hard computing, it is extremely challenging to manage computational resources when evaluating large simulation domains and large simulation batches. This is a significant bottleneck in the forward modeling, limiting the full exploration of the parameter space. Secondly, we solve the inverse problem to derive appropriate photonic geometries for given optical responses. The solution to the inverse problem cannot be directly evaluated and is challenging to solve because the solution space is non-convex, meaning there exist many local optima. Although great efforts have been made in solving the inverse problem, identifying the best overall device given a desired objective and

constraints remains challenging. Machine learning – a soft computing approach, has high potential to revolutionize photonic design and technologies. It is a proven method for the capture, interpolation, and ultrafast optimization of highly complex phenomena in many fields. Thus, the amalgamation of traditional photonic hard computing methods with machine learning algorithms ignites a new promising direction to accelerate the design cycle and generate innovative photonic geometries (with state-of-art performance excellence) that are beyond physical intuitions. In this invited talk, we demonstrate via modeling our recent works in this field. These includes optical mode solving using machine learning, group index predictions, and deep learning discovered power dividers. The use of the Bayesian inference methods to design photonics devices will also be demonstrated in this talk. We will also illustrate the use of the Bayesian inference method to estimate the waveguide geometry parameters of a fabricated optical filter device.

## V16: THz Metamaterials and Device Applications

## Zoom Meeting Room 4

## ID: 816 7808 8000 | Time: 10:00~11:30

Session Chair: **Jingbo Wu**, Nanjing University, China

### 10:00~10:30 | Invited Speaker: Yihao Yang

Yihao Yang is a tenure-track professor at the College of Information Science & Electric Engineering, Zhejiang University. He received a PhD degree in Electronics Science and Technology from the Department of Information Science and Electronic Engineering, Zhejiang University, China, in 2017. He was a research fellow at the Centre for Disruptive Photonic Technologies (CDPT), Nanyang Technological University, Singapore, from 2017 to 2020. His main research interests include topological photonics/acoustics, invisibility cloaks, and metamaterials. He has published more than 50 peer-reviewed papers in leading scientific journals. He, as first or corresponding author, has published more than 30 articles in Nature, Nature Photonics, Nature Physics, Nature Communications, Physical Review Letters, Advanced Materials, and Light, Science & Applications. His works were highlighted by Physics, Physics World, Physorg, IEEE Spectrum, and many others, and selected as PRL Editors' Suggestion twice. His researches were selected as China's Top 10 Optical Breakthroughs (2019), Top 10 Breakthroughs at Zhejiang University (2019). He won the Excellent Doctoral Dissertation awarded by the Chinese Institute of Electronics (2019). He is one of the MIT Technology Review 'Innovators Under 35 China' (2020).

**----Invited Talk----**

***Terahertz Topological Photonics for on-chip Communications***

**Abstract—**The realization of integrated, low-cost and efficient solutions for high-speed, on-chip communication requires terahertz-frequency waveguides and has great potential for information and communication technologies, including sixth-generation (6G) wireless communication, terahertz integrated circuits, and interconnects for intrachip and interchip communication. However, conventional approaches to terahertz waveguiding suffer from sensitivity to defects and sharp bends. Here, building on the topological phase of light, we experimentally demonstrate robust terahertz topological valley transport through several sharp bends on the all-silicon chip. The valley kink states are excellent information carriers owing to their robustness, single-mode propagation and linear dispersion. By leveraging such states, we demonstrate error-free communication through a highly twisted domain wall at an unprecedented data transfer rate (exceeding ten gigabits per second) that enables real-time transmission of uncompressed 4K high-definition video. Terahertz communication with topological devices opens a route towards terabit-per-second datalinks.

### 10:30~11:00 | Invited Speaker: Jingbo Wu

Jingbo Wu received the B.S. degree in Electronic Information Science and Technology in 2005, the M.S. degree in Radio Physics in 2008, and the Ph.D. degree in Electromagnetic Field and Microwave Technology in 2012 from Nanjing University, China. He was a Radio Frequency Engineer in Huawei Company from 2008 to 2009. From 2012 to 2016, he was a Postdoctoral Researcher in University of Leeds and University of Cambridge, UK. From 2016, he joined School of Electronic Science and Engineering, Nanjing University and is an associate professor currently. His research interest includes terahertz metamaterials, superconductor electronics and terahertz spectroscopy.

**----Invited Talk----**

***Terahertz Coding and Programmable Metasurface for Beam Steering***

**Abstract—**Terahertz (THz) technology has shown prospects in wireless communication, radar, imaging, and other fields. The THz devices capable of controlling THz beam arbitrarily and dynamically are in great demand. However, the phased array widely used at microwave frequencies encounters technical challenges at THz frequencies. Here we report our recent progress on coding and programmable THz metasurface for THz beam control. We developed 1-bit coding metasurfaces on the flexible substrate. The THz beam deflection angle could be altered by controlling the coding sequences of “0” and “1” elements. The tunable materials of liquid crystal and vanadium dioxide ($VO_2$) were adopted to realize the dynamic control of the spectral response. Utilizing the

tunable Brewster effect of VO2 film on the dielectric substrate, we realized the reconfigurable and broadband THz beam deflection control. Our work offers a new path of THz beamforming.

### 11:00~11:30 | Invited Speaker: Kaveh Delfanazari

James Watt School of Engineering, University of Glasgow, UK
Electrical Engineering Division & Cavendish Lab. University of Cambridge, UK

**----Invited Talk----**

***Superconducting Quantum Terahertz Electronics: from superconducting coherent THz light sources to ultracompact waveguides and photonic integrated nano-circuitry***

**Abstract—**Current compact emitter and receiver technologies are generally inefficient and impractical at terahertz (THz) frequencies between 0.1 and 10 THz. Hence, a gap exists between mature microwave and developed optical technologies. On-chip, integrated broadly tunable and
powerful quantum sources that coherently radiate THz waves between 0.1 and 11 THz (potentially extendable to 15 THz) can be achieved based on quantum tunneling of electron pairs across the stack of intrinsic Josephson junctions (IJJs) naturally present in a single crystal
of the layered high-temperature superconducting BSCCO. Such devices have been found to be especially promising solid-state THz sources capable of bridging the entire THz gap, as their wide-frequency tunability range is superior to that obtained from their semiconducting-based
rivals, either single resonant-tunneling diodes (RTDs) or THz-quantum cascade lasers (QCLs).
Due to the unique electrodynamics of BSCCO, they can also be operated as switching current THz detectors and quantum sensors.
We will propose that integrated IJJ THz devices with sub-centimeter-sized modules are easy to use in various applications, and they can be regarded as pocket quantum THz torches. We will conclude by demonstrating low-loss microwave-THz photonic integrated nanocircuitry to develop a fully integrated superconducting THz system.

## V17: Perovskite Materials and Optoelectronic Applications
## Zoom Meeting Room 1
## ID: 979 0046 1385 | Time: 14:30~17:15

Session Chair: **Aung Ko Ko Kyaw**, Southern University of Science and Technology, China

### 14:30~15:00 | Invited Speaker: Wei Lin Leong

Dr. Wei Lin Leong received her Bachelor degree in Electrical and Electronic Engineering and Doctor of Philosophy in Materials Science and Engineering from Nanyang Technological University (NTU) in 2004 and 2009 respectively. She performed her postdoctoral fellowship under Nobel Laureate Professor Alan Heeger in University of California, Santa Barbara (UCSB), working on polymer and small molecule solar cells, where she was part of the team to achieve world record efficiency. In 2012, she joined Institute of Materials Research and Engineering (IMRE), Singapore, working in the area of photovoltaics and printed electronics. In July 2016, she joined the School of Electrical and Electronic Engineering (EEE) as an Assistant Professor. Currently, she is also the Deputy Director at the Centre for Micro- and Nano-Electronics at EEE NTU. Her research focuses primarily on developing nanomaterials (organic and hybrid) and implementing electrical device engineering for ubiquitous electronics and energy harvesting, such as flexible memory, solar cells and tactile sensors.

**----Invited Talk----**

***High Efficiency Scalable Perovskite Solar Cells using Slot-Die Coating Process***

**Abstract—**While impressive efficiency progress has been achieved for perovskite-based solar cells, process upscaling represents one of the main remaining hurdles to commercial applications. In this talk, we show that slot-die coating technique combined with synergistic gas quenching and substrate heating can produce compact, homogenous and reproducible perovskite films. The versatility of this crystallization strategy, which eliminates the need for complex solvents or additive engineering, was studied using planar SnO2- and TiO2-coated FTO substrates. Our study provides greater insights into achieving controlled coating and homogeneous crystallization of perovskite films over large-area substrates (~10 × 10 cm2) necessary for the commercialization of this technology.

## 15:00~15:30 | Invited Speaker: Vincenzo Pecunia

Prof. Vincenzo Pecunia, PhD Cantab., is the founder and leader of the "Pecunia Research Group – Thin-Film Optoelectronics" (www.pecunialab.com). Pecunia's research covers environmentally-friendly, printable semiconductors (e.g., organic semiconductors, lead-free perovskite derivatives, amorphous metal-oxides, and carbon nanotubes), their optoelectronic properties, and their applications in printable optoelectronics and photovoltaics. Prior to establishing his group, Pecunia worked for over six years at the Cavendish Laboratory, University of Cambridge, UK. Whilst there, he earned his PhD in Physics and worked as a Postdoctoral Research Associate under the supervision of Professor H. Sirringhaus. Pecunia has published in highly reputable journals such as Nature, Advanced Materials, Advanced Energy Materials, Nano Energy, Advanced Functional Materials, and ACS Nano. Drawing from his research experience, he has also authored the books 'Organic Narrowband Photodetectors' (Institute of Physics Publishing) and 'Organic and Amorphous-Metal-Oxide Flexible Analogue Electronics' (Cambridge University Press).

**----Invited Talk----**

***Tailoring Antimony-Based Perovskite Derivatives for High-Performance Indoor Photovoltaics and Self-Powered Photodetection***

**Abstract—**Lead-free perovskite derivatives are capturing ever-growing attention in photovoltaics and optoelectronics research, driven by their promise to replicate the properties of the lead-based counterparts but without the same toxicity limitations.1,2 An attractive approach involves the replacement of lead with antimony.

To contribute to the realization of the potential of A3Sb2X9 absorbers (A+: monovalent cation; X-: halide anion), we focused on solution-deposited two-dimensional (2D) embodiments, given their attractive higher dimensionality compared to the mainstream zero-dimensional (0D) counterparts. We first developed deposition strategies that enhanced the microstructure and charge transport properties of Rb3Sb2I9, boosting its photoconversion to 65%.3 Further, we demonstrated a low-temperature synthetic route enabling the 0D-to-2D structural conversion of the Cs3Sb2X9 system, leading to superior charge transport properties and a peak photoconversion efficiency of 63%.4 Importantly, the photoconversion efficiencies attained in both cases are the highest to date for all A3Sb2X9 absorbers and bismuth-based analogues.

Capitalizing on these results, we investigated for the first time the capabilities and potential of antimony-based perovskite derivatives for indoor photovoltaics (IPV), an area of considerable commercial value in relation to the rapidly growing demand for energy-autonomous smart devices for the Internet of Things (IoT).1 We showed that the IPV efficiency of 2D Cs3Sb2I9-xClx is up to four times higher than its solar photovoltaic efficiency and is already within the range of mainstream commercial IPV.5 Additionally, optoelectronic characterization pointed to strategies for future performance improvements.5 Finally, we demonstrated that millimeter-scale 2D Cs3Sb2I9-xClx IPV devices are already capable of powering printed circuitry.5

Furthermore, we investigated, for the first time, the impact of the structural dimensionality of A3Sb2X9 absorbers on their performance as the active layers of self-powered photodetectors,6 which are in high demand for low-cost, ubiquitous light sensing for IoT applications. We revealed that 2D Cs3Sb2I9-xClx and Rb3Sb2I9 deliver cutting-edge self-powered photodetector performance, with a more-than-tenfold increase in external quantum efficiency (EQE), speed of response, and linear dynamic range compared to all prior self-powered implementations based on A3M2X9 absorbers (M3+: Sb3+ or Bi3+).6 Detailed characterization allowed us to reveal that such a performance boost originates from the superior carrier lifetimes and reduced exciton self-trapping enabled by the 2D structure.6

By illustrating the impact of microstructure, dimensionality, and optoelectronic properties on their photovoltaic and photodetection capabilities, our findings highlight the attractive opportunity that 2D A3Sb2X9 absorbers provide for lead-free perovskite-inspired photovoltaics and light sensing for the ongoing IoT revolution.

## 15:30~16:00 | Invited Speaker: Yuxi Tian

Yuxi Tian received his B.S. from Peking University in 2003 and his PhD in 2008 from Institue of Chemistry, Chinese Academy of Science. Then he continued postdoctoral research in Lund University, Sweden and Leiden University, Netherlands. In 2015, he joined Nanjing University as a professor in School of Chemistry and Chemical Engineering. He is main research interest is single molecule spectroscopy, including single molecule devices, photophysics in optoelectric materials and development of new technologies.

**----Invited Talk----**

**Quenching Defects in Perovskite Materials Revealed by Microscopy**

**Abstract—**Organometal halide perovskite materials have attracted broad interest during the last twelve years due to their special optoelectric properties including high charge separation efficiency, long carrier diffusion, tunable band gap energy and so on. However, the controllable fabrication of these materials is still challenging due to the fast crystallization process. Different defects are formed randomly during the crystallization determining the properties of the materials and the performance of the devices which are still far from understood. By using microscopy, we could investigate the dynamics of charge carries in these materials with high spatial resolution. We tried to reveal the chemical natures of the quenching defects in these materials by investigating the photoluminescence intensity, spectra, lifetime and variation dependence on electric field or atmospheres together with theoretical calculation.

## 16:00-16:30 | Invited Speaker: Bo Xu

Prof. Bo Xu is currently leading a research group working on Organic Electronics at the Department of Materials Science and Engineering, Nanjing University of Science and Technology, China. He obtained Ph.D. degree at the Department of Chemistry, KTH-Royal Institute of Technology, Stockholm, Sweden in 2015. Subsequently, he worked as a postdoctoral researcher (from 2015 to 2020) at the University of Washington, USA, Uppsala University and KTH, Sweden, respectively. He has been awarded the "King Carl XVI Gustaf Anniversary Award in 2019, Sweden" and selected for the "National High-level Young Talent Program in 2020, China". His research interests are mainly focusing on organic electronic materials with controlled chemical and physical properties for applications in optoelectronic devices, like photovoltaics and light-emitting diodes.

**----Invited Talk----**

***Advanced p-Type Organic Semiconductors for Perovskite Optoelectronics***

**Abstract—**Organic p-type semiconductors play an important role in device performance and stability of perovskite optoelectronics, typically, perovskite solar cells (PSCs) and perovskite light-emitting diodes (PeLEDs). The development of high-performance new generation p-type organic semiconductors is of great importance for perovskite optoelectronic devices for future industrial application. In this talk, Xu will introduce his work on the development of new p-type organic semiconductors for application in PSCs and PeLEDs.

## 16:30-17:00 | Invited Speaker: Zhanhua Wei

Zhanhua Wei is a full-time professor at the Institute of Luminescent Materials and Information Displays, College of Materials Science and Engineering, Huaqiao University, China. He received his B.S. degree in 2011 from the Department of Chemistry, Xiamen University, China, and his Ph.D. degree in 2015 from Prof. Shihe Yang's group, Department of Chemistry, Hong Kong University of Science and Technology, China. After postdoc research with Prof. Qihua Xiong at Nanyang Technological University, he joined Huaqiao University as a principal investigator in May 2016. His current research focuses on the synthesis of perovskite materials, perovskite light-emitting diodes, perovskite solar cells, and other optoelectronic devices. He has published ~50 peer-reviewed papers in scientific journals like Nature, J. Am. Chem. Soc. and Angew. Chem. Int. Ed.

**----Invited Talk----**

***Fabrication of High-Performance Perovskite Optoelectronic Devices***

**Abstract—**Metal halide perovskite materials are an emerging class of solution-processed semiconductors with considerable potential for use in optoelectronic devices. For example, light-emitting diodes (LEDs) based on these materials could see the application in flat-panel displays and solid-state lighting, owing to their potential to be made at low cost via facile solution processing, and could to provide tunable colors and narrow emission linewidths at high photoluminescence quantum yields. However, the highest reported external quantum efficiencies of green- and red-light-emitting perovskite LEDs are still well behind the performance of organic LEDs and inorganic quantum dot LEDs. Here we describe visible-light-emitting perovskite LEDs that surpass the quantum efficiency milestone of 20%. This achievement stems from a new strategy for managing the compositional distribution in the device—an approach that simultaneously provides high luminescence and balanced charge injection. Specifically, we mixed a pre-synthesized CsPbBr3 perovskite with a MABr additive (where MA is CH3NH3), the differing solubilities of which yield sequential crystallization into a CsPbBr3/MABr quasi-core/shell structure. The MABr shell passivates the nonradiative defects that would otherwise be present in CsPbBr3 crystals, boosting the photoluminescence quantum efficiency, while the MABr capping layer enables balanced charge injection. The resulting 20.3% external quantum efficiency represents a substantial step towards the practical application of perovskite LEDs in lighting and display.

## 17:00~17:15 | G29159

Efficient CsPbBr3 Nanoplatelets-based Blue Light-Emitting Diodes Enabled by an Intermediate Phase Strategy

Haoran Wang, Fanghao Ye, Jiayun Sun, Zhaojin Wang, Wei Chen, Pai Liu, Xiaowei Sun, Weiwei Zhao, Kai Wang
Southern University of Science and Technology & Harbin Institute of Technology, Shenzhen, China

**Abstract—**Quantum-confined CsPbBr3 nanoplatelets (NPLs) with very narrow emission linewidth are promising candidates for color-saturated blue emitters, but their electroluminescence performance is limited by inferior carrier transport. Here, we realize short-ligands capped-CsPbBr3 NPLs with improved photoluminescence quantum yield by introducing an intermediate phase to control the crystal growth. CsPbBr3 NPLs with short ligands exhibit enhanced charge transport ability and give rise to a remarkable electroluminescence efficiency of 2% (at 464 nm), a record for blue perovskite NPLs-based light-emitting diodes.

## V18: Quantum Optics and Information

**Zoom Meeting Room 2**

**ID: 930 3313 8929 | Time: 14:30~17:30**

Session Chair: **Yong-Chun Liu**, Tsinghua University, China

## 14:30~15:00 | Invited Speaker: Shau-Yu Lan

Shau-Yu Lan received his PhD from Gaorgia Tech in 2009 and worked as a postdoc scholar at UC Berkeley from 2009 to 2013. He is now a Nanyang Assistant Professor at Nanyang Technological University. His research focuses on quantum sensing and engineering with cold atoms.

**----Invited Talk----**

***Large array of Schrödinger cat states facilitated by an optical waveguide***

**Abstract—**Quantum engineering using photonic structures offer new capabilities for atom-photon interactions for quantum optics and atomic physics, which could eventually lead to integrated quantum devices. Despite the rapid progress in the variety of structures, coherent excitation of the motional states of atoms in a photonic waveguide using guided modes has yet to be demonstrated. Here, we use the waveguide mode of a hollow-core photonic crystal fibre to manipulate the mechanical Fock states of single atoms in a harmonic potential inside the fibre. We create a large array of Schrödinger cat states, a quintessential feature of quantum physics and a key element in quantum information processing and metrology, of approximately 15000 atoms along the fibre by entangling the electronic state with the coherent harmonic oscillator state of each individual atom. Our results provide a useful step for quantum information and simulation with a wide range of photonic waveguide systems.

## 15:00~15:30 | Invited Speaker: Xuejian Wu

Dr. Xuejian Wu is an assistant professor in the department of physics at Rutgers University-Newark. His research aims to develop new atomic inertial sensors based on light-pulse atom interferometry. Before that, he did postdoctoral research at the University of California, Berkeley, and received his Ph.D. at Tsinghua University.

**----Invited Talk----**

***Gravity surveys using a mobile atom interferometer***

**Abstract—**Mobile gravimetry is important in metrology, navigation, geodesy, and geophysics. Atomic gravimeters could be among the most accurate mobile gravimeters but are currently constrained by being complex and fragile. Here, we demonstrate a mobile atomic gravimeter, measuring tidal gravity variations in the laboratory as well as surveying gravity in the field. The tidal gravity measurements achieve a sensitivity of 37 μGal/√Hz (1 μGal=10 nm/s2) and long-term stability of better than 2 μGal, revealing ocean tidal loading effects and recording several distant earthquakes. We survey gravity in the Berkeley Hills with an accuracy of around 0.04 mGal and determine the density of the subsurface rocks from the vertical gravity gradient. With simplicity and sensitivity, our instrument paves the way for bringing atomic gravimeters to field applications.

## 15:30~16:00 | Invited Speaker: Wei Zhang

Wei Zhang received his Bachelor's degree in 1998 and Ph. D in 2003, respectively, from Electronic Engineering Department, Tsinghua University, China. Then he joined Institute of Information Optoelectronic Technology, Electronic Engineering Department, Tsinghua University. At present, he is a tenured professor of Tsinghua University and the vice director of the Institute of Information Optoelectronic Technology. His research interests include Micro/nano-photonic devices, integrated photonic quantum devices, photonic quantum information technologies, especially quantum communications and quantum imaging.

**----Invited Talk----**

***Fully Connected Quantum Networks based on Spontaneous Four-Wave-Mixing Quantum Light Sources***

**Abstract—**Spontaneous four wave mixing (SFWM) is an important way to develop telecom band quantum light sources, which are crucial photonic quantum devices required for fiber-based quantum communications. This talk introduces our recent works on SFWM in silicon photonic quantum circuits, and its applications on quantum key distribution (QKD) networks.

## 16:00~16:30 | Invited Speaker: Chunlei Qu

Dr. Chunlei Qu is currently an assistant professor in the Department of Physics, Stevens Institute of Technology. He received his Ph.D. from the University of Texas at Dallas. Before joining Stevens, Dr. Qu was a postdoctoral researcher at the BEC Center, University of Trento in Italy, and a research associate at JILA, University of Colorado at Boulder. His research focuses on exploring novel quantum phases and dynamics that are useful for quantum information science in atomic, molecular, and optical systems.

**----Invited Talk----**

***Spin Squeezing with Short-Range Spin-Exchange Interactions***

**Abstract—**Spin squeezed states are known to be a useful resource for quantum metrology. Although there have been many proposals on how to generate spin squeezing, most of the dynamical generations involve collective Ising interactions via the so-called one-axis-twisting (OAT) model. In this talk, I will present our recent results on spin squeezing generation in the XXZ model with power-law interactions. Despite the inhomogeneous character of the spin couplings, we find this system can exhibit a level of spin-squeezing similar to that generated by the OAT model. I will report on our systematic investigation of this model and explain the mechanism responsible for the large spin squeezing generation. Our results are useful for state-of-the-art ultracold

polar molecular experiments where pinned molecules in an optical lattice can interact with each other by long-range dipolar interactions and for trapped ion crystals featuring long-range interactions mediated by the phonon modes of the crystal.

### 16:30~17:00 | Invited Speaker: Victoria Xu

Victoria Xu completed her PhD at UC Berkeley, where she studied fundamental physics using atom interferometry in the group of Professor Holger Müller. Her research focused on developing a trapped atom interferometer in an optical cavity with ultra-long coherence times, for applications in precise quantum metrology, gravitational physics, and searches for new physics. She is now a postdoctoral associate at the Massachusetts Institute of Technology, working with the MIT LIGO group on quantum measurement and gravitational wave detection.

**----Invited Talk----**

***Lattice atom interferometry in an optical cavity***

**Abstract—**Atom interferometers are powerful tools for both measurements in fundamental physics and inertial sensing applications. Their performance, however, has been limited by the available interrogation time of atoms freely falling in a gravitational field. I will present our realization of an intra-cavity trapped atom interferometer with 20 seconds of coherence, which extends the coherent interrogation time of spatially-separated quantum superpositions of massive objects by nearly an order of magnitude. I will also discuss how this trapped geometry differs from traditional free-fall atom interferometers by allowing potentials to be measured by holding, rather than dropping, atoms.

### 17:00~17:30 | Invited Speaker: Yong-Chun Liu

Yong-Chun Liu is an associate professor at Department of Physics, Tsinghua University. He received his PhD degree in physics from Peking University. His research interests include quantum optics and quantum precision measurement. He has published over 60 papers (including 7 in PRL), with a total citation of over 2000 and H index of 28.

**----Invited Talk----**

***High-performance optical nonreciprocity using atomic ensembles***

**Abstract—**Optical nonreciprocity is an essential property for a wide range of applications, such as building nonreciprocal optical devices that include isolators and circulators. The realization of optical nonreciprocity relies on breaking the symmetry associated with Lorentz reciprocity, which typically requires stringent conditions such as introducing a strong magnetic field or a high-finesse cavity with nonreciprocal coupling geometry. Here we discover that the collision effect of thermal atoms, which is undesirable for most studies, can induce broadband optical nonreciprocity. By exploiting the thermal atomic collision, we experimentally observe magnet-free and cavity-free optical nonreciprocity, which possesses a high isolation ratio, ultrabroad bandwidth, and low insertion loss simultaneously. The maximum isolation ratio is close to 40 dB, while the insertion loss is less than 1 dB. The bandwidth for an isolation ratio exceeding 20 dB is over 1.2 GHz, which is 2 orders of magnitude broader than typical resonance-enhanced optical isolators. Our work paves the way for the realization of high-performance optical nonreciprocal devices and provides opportunities for applications in integrated optics and quantum networks.

## V19: Fiber-Based Technologies and Applications

## Zoom Meeting Room 3

## ID: 827 9043 9167 | Time: 14:30~16:30

Session Chair: **Xia Yu**, Beihang University, China

### 14:30~15:00 | Invited Speaker: Wonkeun Chang

Dr Wonkeun Chang received the BTech in Optoelectronics and MSc in Physics from the University of Auckland, and subsequently his PhD in Physics from the Australian National University. He then joined the Max Planck Institute for the Science of Light, where he developed expertise in ultrafast light-matter interactions in hollow waveguides. In 2013, Dr Chang was granted a Discovery Early Career Researcher Award from the Australian Research Council, and led a project on complex pulse dynamics and extreme events in ultrafast laser systems at the Australian National University. He is currently a Nanyang Assistant Professor at the School of Electrical and Electronic Engineering in Nanyang Technological University. His research interests are in specialty optical fibres, novel light source development and femtosecond laser systems.

**----Invited Talk----**

***A fiber-based platform for ultraviolet frequency combs***

**Abstract—**Frequency comb refers to an optical spectrum which consists of a series of discrete frequecy lines that are spaced equally across its bandwidth, offering an unprecedented level of accuracy in frequency metrology. We introduce a fiber-based approach to generate ultraviolet frequency combs by exploiting the phase-matched nonlinear frequency conversion in a gas-

filled small-mode-area hollow-core fiber.

**15:00~15:30 | Shifeng Zhou**

Shifeng Zhou received his PhD degree (2008) in Materials Science and Engineering from Zhejiang University. He spent one year at the Hong Kong Polytechnic University as a research assistant (2007). Subsequently, he joined Hokkaido University as a postdoctoral researcher (2008-2009), and then moved to Kyoto University as a JSPS postdoctoral fellow (2009-2011). He was an associate professor in Zhejiang University (2011-2013). Since 2013, he is a full professor in South China University of Technology. He is the recipient of the Motoharu Kurata Award of the Ceramic Society of Japan and Gottardi Award of International Commission on Glass. His primary research area is glass fibers and devices.

**----Invited Talk----**

***Multicomponent Photonic Glasses and Fibers***

**Abstract—**Multicomponent glasses and fibers are considered to be the fundamental building blocks of the next-generation fiber photonics. In this talk, the recent progress in designs, fabrications and applications of selected materials for multicomponent optical glasses and fibers is introduced. In the first part of the talk, the typical microstructures in multicomponent glass system represented by topological features, heterogeneities and locally crystallized domains are discussed. The preliminary results about the relation between the glass microstructure and its optical properties are introduced. In the second part, glasses and glass-ceramics with various optical functions, including photon generation, amplification, modulation and detection are highlighted. Especially, multicomponent glasses and fibers with attractive properties such as tunable, broadband and flat emission are introduced. Their potential applications as gain matrix of broadband fiber amplifier are discussed. In addition, the glasses and fibers with strong radiation blocking ability and intense radiation induced luminescence are introduced. The fiber derived device for radiation detection is highlighted.

**15:30~15:45 | G2961**

Optical Manipulation through Tapered Optical Fiber in Microfluidic System

**Wu Zhang**, Weiqian Chen, Jiahan Lin, Yusong Gao and Yanxiao Lin
Guangzhou University, China

**Abstract—**Optical force is effectively used to manipulate microparticles, usually realized in a bulk optical system with a high numerical aperture objective lens and complex optical control modules. Here we will report our working progress on the optical manipulation in a miniaturized, low cost and integrated microfluidic chip based on tapered optical fiber trapping. In the integrated system, we aim to measure the optical force amplitude, fulfill of optical trapping function and control the movement of microparticles. Optical fibers with different tapered structures were designed to trap microparticles in different distances. A tunable trapping distance was also realized in real time by changing the environment liquid in the microfluid chip. In addition, The trapping force was characterized in the microfluidic system with a controlled microflow rate.

**15:45~16:00 | G2940**

Instantaneous Frequency Measurement Using Optical Power Monitoring Based on a DP-DPMZM

**Yulin Zhu**, Beilei Wu, Jing Li, Muguang Wang, Zixiao Wang, Shiying Xiao, Fengping Yan
Beijing Jiaotong University, China

**Abstract—**We demonstrate an instantaneous frequency measurement (IFM) scheme using optical power monitoring based on a dual-parallel dual-polarization Mach-Zehnder modulator (DP-DPMZM). The amplitude comparison function is related to the input microwave frequency and electrical time delay, which is achieved by monitoring the optical power of orthogonal polarization signals. The principle of the scheme is theoretical analyzed, and the simulation of the IFM system is performed to verify the mechanism.

**16:00~16:15 | G2948**

OAM Modes Amplifier based on Erbium-doped Ring-core Fiber

**Shuaishuai Liu**, Liang Zhang, Jianxiang Wen, Wei Li, Cheng Du, Huanhuan Liu and Fufei Pang
Shanghai University, China

**Abstract—**We experimentally demonstrated orbital angular momentum (OAM) mode fiber amplifiers by the utilization of erbium-doped ring-core fiber. For the power amplification of OAM modes with topological charge $|l| = 1$, the maximum output power of up to 16.1 dBm is achieved. Furthermore, the signal gain is about 26.5 dB at the communication spectral window.

**16:15~16:30 | G2928**

Generation of Controllable High-Order Modes in Mode Selective Coupler

**Yan Wu**, Jianxiang Wen, Fufei Pang, Xianglong Zeng, Tingyun Wang
Shanghai University, China

**Abstract—**We fabricated a kind of mode selective coupler with a homemade ring-core fiber, which can generate different high-order modes by controlling the pre-stretched length of the single-mode fiber. This coupler can be used as a mode converter and is of potential interest for increasing channel capacity in optical telecommunications.

## V20: AI Photonics

**Zoom Meeting Room 4**

**ID: 816 7808 8000 | Time: 14:30~17:00**

Session Chair: **Chaoran Huang**, Chinese University of Hong Kong, China

### 14:30~15:00 | Invited Speaker: Xin Yuan

Dr. Xin Yuan (Senior Member, IEEE, xinyuan@ieee.org) is currently a video analysis and coding lead researcher at Bell Labs, Murray Hill, NJ, USA. Prior to this, he had been a Post-Doctoral Associate with the Department of Electrical and Computer Engineering, Duke University from 2012 to 2015, where he was working on compressive sensing and machine learning. He develops compressive sensing techniques for high-dimensional imaging with applications to videos, hyperspectral, microscopy and x-ray imaging. Before joining Duke, Dr. Yuan obtained his Ph.D. from the Hong Kong Polytechnic University in 2012. He has published more than 140 journal and conference papers and holding dozens of international patents. In 2020, one paper he coauthored has won the best paper runner up award in IEEE International Conference on Multimedia and Expo (ICME).

**----Invited Talk----**

***Deep Learning for Snapshot Compressive Imaging***

**Abstract—**We consider deep learning methods for snapshot compressive imaging (SCI), where a single 2D detector is used to capture the high-dimensional data-cube. This work reviews the recent advances of deep learning based inversion algorithms for SCI.

### 15:00~15:30 | Invited Speaker: Jianning Lu

Jianing Lu was born in Zhejiang Province, China, in 1993. He received the B.Eng. and the M. Eng. degrees in optical and electrical information engineering, in 2015 and 2018, from Huazhong University of Science and Technology, Wuhan, China. From June 2017 to January 2018, he was a Research Associate with the Department of Information Engineering, Chinese University of Hong Kong. He is currently working toward the Ph.D. degree in Photonics Research Centre, Department of Electronic and Information Engineering, The Hong Kong Polytechnic University, Hong Kong. His research is focused on digital coherent optical communication, optical performance monitoring and digital signal processing algorithms.

**----Invited Talk----**

***Completely automatic generation and collection of ultra-large scale experimental training dataset for machine-learning-based quality of transmission estimation***

**Abstract—**Applications of machine learning (ML) models in optical communications and networks have been extensively investigated. For an optical wavelength-division-multiplexing (WDM) system, the quality of transmission estimation (QoT) generally depends on many parameters including the number and arrangement of WDM channels, the launch power (LP) of each channel, the number and distribution of fiber spans, the attenuation, dispersion, and nonlinearity parameters and length of each fiber span, the noise figure (NF), gain and the gain tilt of EDFA, transceiver noise, digital signal processing (DSP) performance, and so on. In recent years, ML-based QoT estimation schemes have gained significant attentions. However, nearly all relevant works are conducted through simulations because it is difficult to obtain sufficient and high-quality dataset for training ML models. In this talk, we demonstrate a completely automated generation and collection of ultra-large scale experimental training dataset for ML model-based QoT estimation by automating of transceivers and optical link parameters, as well as data transfer and DSP. Implementation details and key codes of automation are presented. Artificial neural network (ANN) models with 1 and 2 hidden layers are trained by the collected dataset and brief QoT estimation results are evaluated and discussed to verify the performance and stability of the established automated system.

### 15:30~16:00 | Invited Speaker: Chaoran Huang

Chaoran Huang is an assistant professor at the Chinese University of Hong Kong (CUHK). Before joining CUHK in 2021, she was a postdoctoral research associate at Princeton University. Her ongoing work is dedicated to developing integrated photonic hardware for artificial intelligence (AI) computing and related applications. She was the recipient of the 2019 Rising Stars Women in Engineering Asia. She has published more than 50 peer-reviewed research papers. Her research work has been presented as a postdeadline paper at 2020 OFC, was featured in the special issue of Optical Neural Networks by OSA Optics and Photonic News, and was selected as Spotlight articles by several journals.

**----Invited Talk----**

***Neuromorphic photonics and its applications in optical communications***

**Abstract—**Neuromorphic photonics creates processors 1000× faster than electronics while consuming less energy. We will discuss the role of neuromorphic photonics in optical communications, review existing approaches, and outline the required

technologies to evolve this field.

### 16:00~16:30 | Yan Shi

Yan Shi, PhD, Senior Engineer of China Unicom Research Institute, studies on the SDN and intelligence research of optical network.

----Invited Talk----

***Research and Applications of Optical Transport Network Intelligence***

**Abstract—**A healthy and high-performance optical and packet network serves as the foundation for all application scenarios of 5G. Traditional approaches are facing great difficulties to automatically and efficiently analyze network data, solve network faults, as well as optimize network performance. Therefore, it is concerned to utilizize machine learning to construct an intelligent, healthy and high-performance optical network, or to enhance the operator experience through the use of machine learning. In this report, the requirements and applications of intelligent network management for telecom operators will be introduced.

### 16:30~17:00 | Yubin Zang

Yubin Zang was born in Nanjing, Jiangsu Province, China, on May 17, 1995.
He received the B.E degree in information engineering from the College of Electronic and Information Engineering, Nanjing University of Aeronautics and Astronautics, Nanjing, China, in 2017. He is now a PhD candidate of the Department of Electronic Engineering, Tsinghua University, Beijing, China. His current research interests include optical systems for AI and AI-assisted optical system modeling.

----Invited Talk----

***AI based Fiber Transmission Models***

**Abstract—**Fiber optical communications has been widely researched and utilized in today's society. In predicting signal transmission so as to better design the communication systems, traditional models based on split-step Fourier method (SSFM) are adopted which can numerically solve the nonlinear Schrödinger equation (NLSE). Though this kind of models can obtain results with acceptable precision, relatively large requirements for storage must be catered. Besides, calculation complexity may increase intensely as the distance increases. With the help of artificial intelligence (AI), these costs can be alleviated or even eliminated. In this report, developments of AI based optical fiber communication optimization in optical performance monitoring, fault detection will be firstly illustrated. Then, AI based fiber transmission models will be focused and their prediction performances will be shown. More discussions on probable future research trends will be developed at the end.

## V21: Liquid Crystal Photonics

## Zoom Meeting Room 5

## ID: 896 3784 6459 | Time: 14:30~16:30

Session Chair: **Jiangang Lu**, Shanghai JiaoTong University, China

### 14:30~15:00 | Invited Speaker: Jiangang Lu

Dr. JianGang Lu, professor of department of electronic engineering, Shanghai JiaoTong University, chair of LCT committee of SID China, and Committee Member of SID, received his B.S. of electrical engineering in 1995 and a Ph.D. degree of electronic engineering in 2003 from Zhejiang University, Hangzhou, China. He was a senior researcher at Liquid Crystal research Lab, Next generation LCD Research Center, Samsung Electronics in Korea. Dr. Lu worked as the project leader for 3-D display, blue phase liquid crystal, Charge Share SPVA LC mode, and OCB mode Field Sequential LC Display, et, al. After He joined Shanghai JiaoTong University, Dr. Lu focused his research on liquid crystal material and photonic device, flexible integrated sensor, three-dimensional display system, and Micro & Nano Structure integrated optoelectronics. Dr. Lu has published more than 100 papers and has more than 60 licensing patents. And he has charged for the projects of NSFC, 863, 973, and National Key R&D Program.

----Invited Talk----

***Photonic Devices of Templated Twist Structure Liquid Crystals***

**Abstract—**Twist structure liquid crystals (LCs) consist of cholesteric liquid crystal (CLC) with one dimensional twist structures, blue phase liquid crystal (BPLC) consisted of double twist cylinders (DTCs) and the disclination lines, and sphere phase liquid crystal (SPLC) composed of three-dimensional twist structures (3-DTSs) and disclination lines among them. The template effects on stability of twist structure LCs were investigated. A multi-wavelength filter with Templated-BPLCs was demonstrated that it may get much narrower reflection bandwidth, more stable wavelength and bandwidth with the temperature shift compared with the CLC filters. Furthermore, the central wavelength and bandwidth can be easily controlled by the fabrication process and the optimization of the material concentration. A bandwidth tunable CLC filter were fabricated with the multi-templating technology

which shows simple fabrication process, good stability and extensibility. By template processing, a wavelength tunable random lasing was demonstrated with dye doped SPLC. With different polymer concentrations, the reconstructed sphere phase random lasing may achieve more than 40nm wavelength continuous shifting by electrical field modulation. The templated twist structure LCs show great potential applications in optical communication, display, and lasing.

### 15:00~15:30 | Invited Speaker: Lishuang Yao

In order to break the situation that the processing of the key liquid crystal correction devices of liquid crystal adaptive optics relies on foreign countries, the design and processing technology of the driver chip is studied, and the only domestic development platform of silicon-based liquid crystal devices is built. Aiming at the problem of uniform response for high-precision liquid crystal devices, new technologies such as super thin alignment film optimization and over-driving are proposed. Otherwise the research on liquid crystal control technology with pure optical driving and without any electronic control components we carried out. This technology will further expand the direction and road of the application field of liquid crystal optical control. The representative papers published were about 40 SCI, including more than 13 patents.

**----Invited Talk----**

***Systematic development of fast and high accuracy liquid crystal light modulator***

**Abstract—**Our research mainly focused on systematic development of fast and high accuracy liquid crystal light modulator. In order to break the situation that the processing of the key liquid crystal corrector of liquid crystal adaptive optics relying on foreign countries, the design and processing technology of the silicon chip is studied, and the only domestic development platform for silicon-based liquid crystal devices is built. Aiming at the problem of uniform response of high-precision liquid crystal devices, new technologies such as cell thickness optimization and over- driving technique are proposed. A high-precision liquid crystal spatial light modulation device with liquid crystal layer thickness of only 1.8μm, thickness accuracy of better than 0.1 μm and spatial non-uniformity of PV better than 80 nm is developed. In detail,in order to solve the problem of dielectric voltage drop caused by the traditional rubbing orientation layer in LCoS devices, photo-sensitive alignment film based on self-assembled multi-layer technology is proposed. The thickness of the orientation layer is reduced from 100 nm to less than 10 nm. The voltage drop of the orientation layer is eliminated and the response speed of the device is further improved. Aiming at the application potential of optical driving liquid crystal modulator in high energy field in the future, we carried out the research on liquid crystal device with pure optical driving and without any electronic components.

### 15:30~16:00 | Invited Speaker: Yong Xie

Dr. Yong XIE（谢勇）is an Associate Professor & Doctoral Supervisor at the School of Physics, Beihang University. He is heading a research group of liquid crystalline nanomaterials and soft condensed matter with 7 group members and with a broad spectrum of research interests, ranging from nanoparticles self-assembly to photoelectronic device applications, from magnetic soft matter to smart actuators, and from synthesis of porous materials to water treatment. He published over 30 papers in journals such as Nat. Comm., ACS Nano, ACS Appl. Mater. & Interfaces, etc.

**----Invited Talk----**

***Morphological and Orientational Controls of Gold Nanorods Self-Assembly Directed by Evaporative Microflows***

**Abstract—**Evaporative self-assembly of noble metal nanoparticles into ordered structures holds great promise for fabricating optical and plasmonic devices by virtues of low cost, high efficiency, and ease of operation. However, only few kinds of well-defined assembly structures have been realized so far. Poor control of Marangoni flows during the droplet evaporation is one of the challenges accounting for the limited assemblies. Herein, based on the Bernoulli principle we design simple but reliable flow-field-confinement platforms to control the evaporative microflows and to work concur-rently with the depletion forces to enable the ordered self-assembly of gold nanorods. On this basis, we realized orientationally-ordered assemblies by designed strong unidirectional microflow in a capillary, and device-scale assembly monolayer membranes by created weak convection in home-made glass cells. Morphologically diversified assembly superstructures, such as spherulite-like, boundary-twisted, chiral spiral assemblies and merging membranes with a π-twisted domain wall, were obtained due to spontaneous symmetry breaking or in the presence of defects, such as surface steps and screw dislocations. Optical anisotropy and polarization-dependent behaviors of these assemblies were further revealed. Understanding of these entropy-driven assembly behaviors and control of the evaporative microflows to guide the self-assembly of gold nanorods provide insights into the general bottom-up approach that would be helpful for constructing complex, yet robust nanostructural units.

### 16:00~16:30 | Invited Speaker: Jingxia Wang

Jingxia Wang received her PhD degree in Materials Science from Tsinghua University in 2004. She worked as a postdoctoral fellow in Prof. Lei Jiang's group at the Institute of Chemistry, Chinese Academy of Sciences (CAS), between 2004 and 2006. Acting as an associate professor, she then joined Prof. Yanlin Song's group at the Institute of Chemistry, CAS, between 2006 and 2014. In 2014, being a full professor, she moved to the Technical Institute of Physics and Chemistry, CAS. Her research interest is focused on the fabrication and applications of colloidal PCs with superwettability, phase change characterization of blue phase liquid crystal, soft actuator and etc. She has published more than 100 SCI Journal papers in the field.

----Invited Talk----

### *Comprehensive Characterization of the Diffusionless Transformation of Blue Phase liquid Crystals*

**Abstract—**Blue phase liquid crystals (BPLCs) are typical soft cubic phases that combine the order of solid molecular crystals and the fluidity of the liquids, exhibiting potential applications in adjustable lasers, displays, and nonlinear optical devices. Typically, BPLCs are obtained by slow cooling from the isotropic state, and a phase transformation occurs from blue phase III (BPIII) to blue phase II (BPII, simple cubic lattice) or blue phase I (BPI, body-centered cubic lattice), in which BPIII is thought to consist of a spaghetti-like tangle of DTCs. The DTCs, which are analogous to the atoms of the atomic crystals, whose microstructures have been observed using confocal laser scanning microscopy, transmission electron microscopy (TEM), and corresponding simulations. However, the phase transition process has yet to be observed at the submicrometer scale owing to the poor stability of the transition states, and thus the transition mechanism remains unclear. A full understanding of the phase transition processes of the soft cubic superstructure is expected because it is highly important not only for fundamental science but also for practical applications, and will provide important insights into the design and fabrication of functional materials and devices.

In this work, the intermediate stages with core-shell configurations are fast polymer-stabilized to achieve ultra-high thermal stability from -190 to 340 °C for further characterization. TEM, synchrotron small-angle X-ray diffraction (syn-SAXS), and angle-resolved microspectroscopy (ARM) were used to dynamically track the phase transformation process of BPLCs: including diffusionless phase transformations (DLPTs) of BPIII → BPII, BPIII → BPI, and reversible thermoelastic martensitic of BPII → BPI. Here the DTCs are considered as structural units that do not diffuse during the DLPTs. In particular, DTCs in BPII→BPI show a diffusionless, collective, and highly coordinated motion, which is a hallmark of a reversible thermoelastic martensitic transformation. Besides, diffusionless behaviors of DTCs are also proven in BPIII→BPI, BPIII→BPII. In addition, three types of core-shell configurations are formed: BPIII/BPI, BPIII/BPII, and BPIII/BPII/BPI. In light of our findings, several applications based on the core-shell configurations have been achieved, such as temperature-switchable binary and ternary QR codes, micro-area lasing, and fabrication of blue phase liquid crystals with large domain sizes.

Keywords: Blue phase liquid crystals; Diffusionless phase transformations; martensitic transformation; Micro-area lasing.

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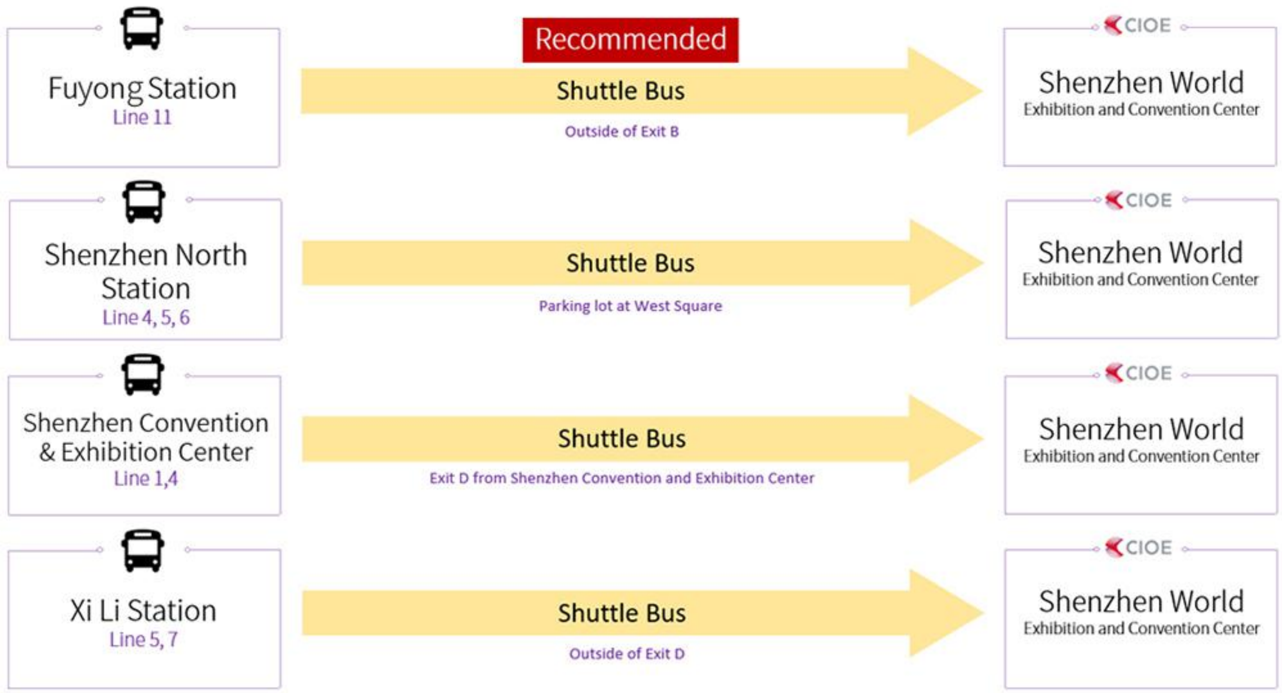


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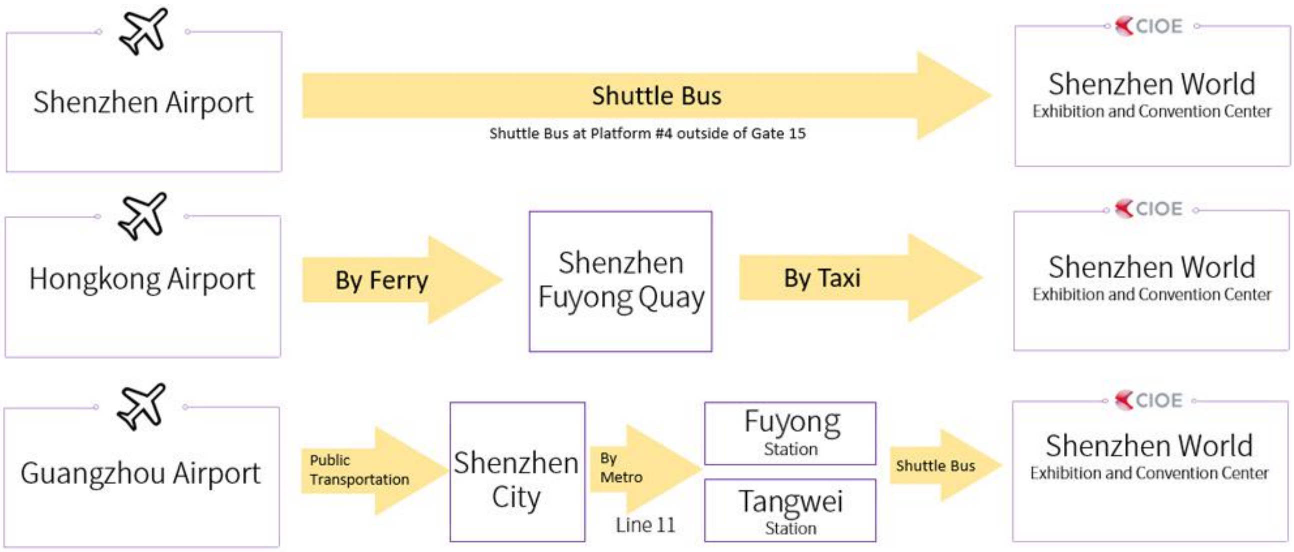


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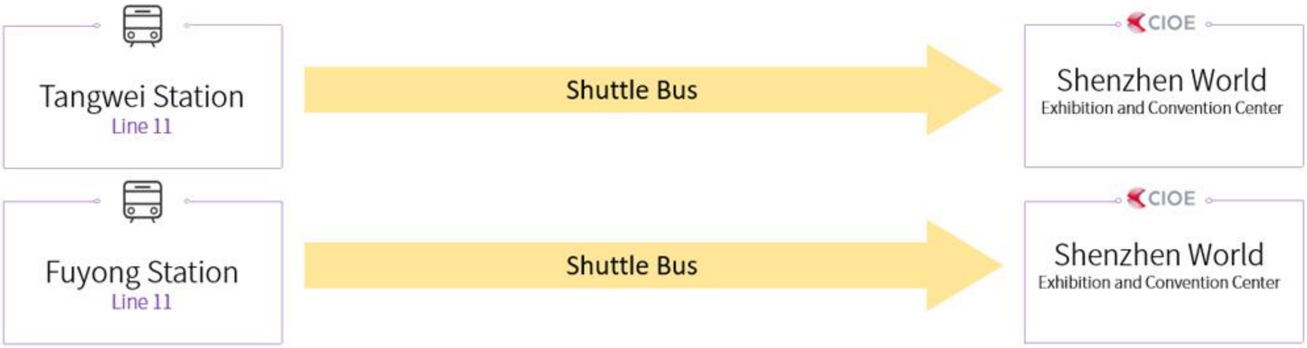


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