主办单位
HOST INSTITUTIONS

中国科学院物理研究所
松山湖材料实验室

Institute of Physics, CAS
Songshan Lake Materials Laboratory

NUQS-2024

第二届非平衡和超快量子物态国际会议

The 2nd International Conference on Nonequilibrium and Ultrafast Quantum States (NUQS-2024)

会议手册
Conference Brochure

2024年10月22-26日 中国·东莞
October 22-26, 2024 Dongguan, China

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Conference Notification

会议须知

欢迎参加第二届非平衡和超快量子物态国际会议，会议期间相关安排如下，如有任何问题，请联系会务组提供帮助，谢谢！

01 会议时间

2024年10月22-26日（10月22日报到）

02 会议地点

松山湖材料实验室C栋会议中心206报告厅

03 报到地点

松山湖材料实验室A1栋招待所

04 住宿地点

松山湖材料实验室A1栋/C栋

05 用餐地点

早餐： A1栋一层餐厅

午餐、晚餐： A1栋二层餐厅

06 会务组信息

田春璐（会场，+86 18811599152）

黄燕珑（用餐，+86 19860204148）

孔心怡（住宿，+86 18841424816）

武　豪（用车，+86 18810228607）

Welcome to the 2nd International Conference on Nonequilibrium and Ultrafast Quantum States (NUQS-2024). The relevant arrangements during the conference are as follows.

If you have any questions, please contact the conference team for assistance. Thank you!

01 Conference Date

October 22-26, 2024 (registration on October 22)

02 Conference Room

Lecture Hall 206, Conference Center, Building C of Songshan Lake Materials Laboratory

03 Registration

Hotel, Building A1 of Songshan Lake Materials Laboratory

04 Accommodation

Hotel, Building A1/C of Songshan Lake Materials Laboratory

05 Dining

Breakfast: Canteen on the first floor of Building A1

Lunch and dinner: Canteen on the second floor of Building A1

06 Contact us

Chunlu Tian (lecture, +86 18811599152)

Xinyi Kong (accommodation, +86 18841424816)

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Conference Kind Reminder
会议温馨提示

1.请您参阅本会议手册的日程安排，按时参会。
2.请您携带好会议手册及胸牌，本次会议凭胸牌后的餐券用餐，请妥善保管。
3.请报告人提前将报告交于会务组，以便进行会前调试。

1. Please refer to the schedule in this conference brochure and attend the meeting on time.

2.Please bring your conference brochure and name badge with you. Meals will be redeemed using the voucher attached to your name badge, so please keep it safe.

3.The reports PPT need to be submitted to the conference staff for preparation.

Campus Map
园区地图

Host Institutions and Conference Committee
主办单位及大会组委会

Host Institutions

Institute of Physics, Chinese Academy of Sciences

Songshan Lake Materials Laboratory

Conference Advisors


Lu Yu
Institute of Physics, CAS


Enge Wang
Institute of Physics, CAS


Tao Xiang
Institute of Physics, CAS

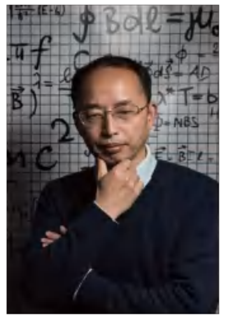

Zhong Fang
Institute of Physics, CAS

Local Organizing Committee


Sheng Meng/IOP


Yuan Wan/IOP

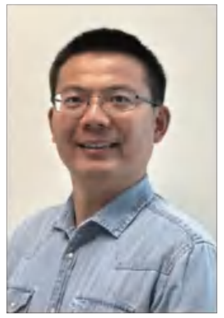

Jimin Zhao/IOP


Yuxiang Weng/IOP


Zhaohua Cheng/IOP


Jianqi Li/IOP


Peng Ye/IOP/SLAB


Pengju Zhang/IOP/SLAB


Feifan Wang/IOP/SLAB


Chao Lian/IOP/SLAB


Jiyu Xu/IOP/SLAB


Wei Lu/SLAB


Faran Zhou/IOP


Yaxian Wang/IOP


Sijie Zhang/IOP


Shuo Dong/IOP

Conference Schedule
会议日程

Day 1 - October 22nd, 2024 (Tuesday)	
9:00-22:00	Registration: Arrive in Dongguan and hotel check-in at Hotel of Songshan Lake Materials Laboratory （报到入住松山湖材料实验室招待所）
Day 2 - October 23rd, 2024 (Wednesday)	
8:20-8:30	Opening Remarks
8:30-12:20	Symposium: Morning Session （会议）
12:20	Lunch in A1 canteen （A1栋餐厅）
14:00-18:10	Symposium: Afternoon Session （会议）
18:10	Dinner in A1 canteen （A1栋餐厅）
Day 3 - October 24th, 2024 (Thursday)	
8:30-12:20	Symposium: Morning Session （会议）
12:20	Lunch in A1 canteen （A1栋餐厅）
13:20-14:00	Poster Section （Poster展示）
14:00-18:10	Symposium: Afternoon Session （会议）
18:10	Dinner in A1 canteen （A1栋餐厅）
Day 4 - October 25th, 2024 (Friday)	
8:30-12:20	Symposium: Morning Session （会议）
12:20	Lunch in A1 canteen （A1栋餐厅）
14:00-16:10	Symposium: Afternoon Session （会议）
16:10-17:30	Visit the Attosecond Science Center （参观阿秒科学中心）
18:00	Dinner in A1 canteen （A1栋餐厅）
Day 5 - October 26th, 2024 (Saturday)	
8:30-12:20	Symposium: Morning Session （会议）
12:20	Lunch in A1 canteen （A1栋餐厅）

October 23rd (Wednesday)

Time	Speaker	Affiliation	Talk Title
Chair : Sheng Meng			
8:20-8:30	Opening Remarks		
8:30-9:10	Peixiang Lu （陆培祥）	Huazhong University of Science and Technology	(Introductory Talk) Strong-field ultrafast optics and precision measurement of transient processes
9:10-9:40	Angela Montanaro	Friedrich Alexander University	Cavity electrodynamics of correlated materials in a Fabry-Pérot resonator
9:40-10:10	Marios Michael	Max Planck for the Structure and Dynamics of matter	Giant dynamical paramagnetism in the driven pseudogap phase of $YBa_2Cu_3O_{6+x}$
10:10-10:40	Coffee Break & Photo Taking		
Chair : Peixiang Lu			
10:40-11:20	Dongping Zhong （仲冬平）	Shanghai Jiao Tong University	(Introductory Talk) Optical quantum control of ultrafast protein electron transfer
11:20-11:50	Wentao Zhang （张文涛）	Institute of Physics, CAS	Identification of a metastable lattice-distortion-free charge density wave at a photoinduced interface revealed by TR-ARPES
11:50-12:20	Naotaka Yoshikawa	University of Tokyo	Light control of anomalous Hall conductivity in topological semimetal $Co_3Sn_2S_2$
12:20-14:00	Lunch Break		

Time	Speaker	Affiliation	Talk Title
Chair : Yuan Wan			
14:00-14:40	Theo Rasing	Radboud University	(Introductory Talk) Ultrafast control of magnetism thru strongly non-equilibrium states
14:40-15:10	Zhaohua Cheng (成昭华)	Institute of Physics, CAS	Anisotropic Terahertz Spin-Phonon Coupling Mode in Altermagnetic MnTe
15:10-15:40	Dominik Juraschek	TU Eindhoven	Phonon-induced chirality and multiferroicity
15:40-16:10	Banggui Liu (刘邦贵)	Institute of Physics, CAS	Theoretical study on some ultrathin 2D electron systems
16:10-16:40	Coffee Break		
Chair : Theo Rasing			
16:40-17:10	Weizhe Li	FAU Erlangen-Nuremberg	Lightwave-driven electrons in a Floquet topological insulator
17:10-17:40	Zi Cai (蔡子)	Shanghai Jiao Tong University	Nonequilibrium universality of quantum geometry
17:40-18:10	Jin Zhang (张进)	National Center for Nanoscience and Technology	Photoexcitation induced carrier and lattice dynamics in Nanoelectronic systems
18:10	Dinner		

October 24th (Thursday)

Time	Speaker	Affiliation	Talk Title
Chair : Hardy Gross			
8:30-9:10	Angel Rubio	Max Planck Institute for the Structure and Dynamics of Matter	(Introductory Talk) Novel non-equilibrium phenomena in two dimensional heterostructures
9:10-9:40	Simon Maier	University of Regensburg	Attosecond electron dynamics in atomic-scale scanning tunnelling microscopy
9:40-10:10	Dong Sun (孙栋)	Peking University	Tunable Chirality Couplings and Anomalous Photo-Nernst Effect in Magnetic Weyl Cones in $Co_3Sn_2S_2$
10:10-10:40	Coffee Break		
Chair : Angel Rubio			
10:40-11:20	Kazuhiro Yabana	University of Tsukuba	(Introductory Talk) Ab initio theory and computations for nonlinear/ nonlocal nano-photonics
11:20-11:50	Noejung Park	Ulsan National Institute of Science and Technology (UNIST), Department of Physics/ Max Plank Institute for the Structure and Dynamics of Matter	Density-functional-theory calculations of currents in real materials and the study of topological & geometrical nature of band states or other physical systems
11:50-12:20	Kaishu Kawaguchi	University of Tokyo	Time-, spin- and angle-resolved photoemission spectroscopy with 10.7-eV laser at 1-MHz repetition rate
12:20-13:20	Lunch Break		

Time	Speaker	Affiliation	Talk Title
13:20-14:00	Poster Section		
Chair : Kazuhiro Yabana			
14:00-14:40	Hardy Gross	Hebrew University of Jerusalem	(Introductory Talk) TDDFT simulations of electronic charge and spin dynamics and the birth of atto-magnetism
14:40-15:10	Xuebin Bian (卞学滨)	Innovation Academy for Precision Measurement Science and Technology, CAS	Theoretical study of high-order harmonic and THz generation in liquids
15:10-15:40	Chen Li (李晨)	Peking University	Molecular Geometric Phase Effects from the Perspective of Exact Effective Force
15:40-16:10	Wei Quan (全威)	Innovation Academy for Precision Measurement Science and Technology, CAS	Breakdown of one-to-one correspondence between the photoelectron emission angle and the tunneling instant in the attoclock scheme
16:10-16:40	Coffee Break		
Chair : Neojung Park			
16:40-17:10	Emil Viñas Boström	University of the Basque Country /Max Planck Institute for the Structure and Dynamics of Matter	Controlling magnetism with cavity vacuum fluctuations
17:10-17:40	Bing Huang (黄兵)	Beijing Computational Science Research Center	Manipulation of Nonlinear Optical Responses in Semiconductors
17:40-18:10	Xiaochun Gong (宫晓春)	Zhejiang University/ECNU	High Repetition Rate and High Energy Ultrashort Laser Pulse: The Next Light Source for Attosecond Spectroscopy
18:10	Dinner		

October 25th (Friday)

Time	Speaker	Affiliation	Talk Title
Chair : Limin Tong			
8:30-9:10	Xijie Wang	Uni. Duisburg-Essen & TU-Dortmund	(Introductory Talk) Imaging nonequilibrium and ultrafast quantum states with MeV electrons
9:10-9:40	Jin Zhao (赵瑾)	University of Science and Technology of China	***Ab Initio*** Investigations on the Quantum Dynamics of Excited Carriers in Condensed Matter Systems
9:40-10:10	Shunsuke Sato	University of Tsukuba	Quantum Electron Dynamics Calculation for Attosecond Phenomena
10:10-10:40	Coffee Break		
Chair : Xijie Wang			
10:40-11:20	Limin Tong (童利民)	Zhejiang University	(Introductory Talk) Confining an optical field to a single atom scale
11:20-11:50	Yanan Dai (戴亚南)	Southern University of Science and Technology	Ultrafast photoelectron imaging of plasmonic electron transport in the non-thermal regime
11:50-12:20	Zhensheng Tao (陶镇生)	Fudan University	Solid-state High-order Sideband Spectroscopy and Microscopy
12:20-14:00	Lunch Break		

Time	Speaker	Affiliation	Talk Title
Chair : Gregory Fiete			
14:00-14:40	Simon Wall	Aarhus University	(Introductory Talk) Surface melting and polaron localization during the melting of orbital order
14:40-15:10	John McGuire	ShanghaiTech University	Exciton Decoherence in $Cd_{1-x}Mn_xSe$ Quantum Dots Probed by Multidimensional Fourier Transform Spectroscopy
15:10-15:40	Yuhai Jiang (江玉海)	ShanghaiTech University	Cold alkaline-earth atoms in the femtosecond strong laser filed
15:40-16:10	Yingying Peng (彭莹莹)	Peking University	Time-resolved resonant x-ray scattering study of charge and spin order dynamics
16:10-17:30	Visit the Attosecond Science Center		
18:00	Dinner		

October 26th (Saturday)

Time	Speaker	Affiliation	Talk Title
Chair : Simon Wall			
8:30-9:10	Hui Li (李辉)	East China Normal University	(Introductory Talk) Femtosecond dynamics of room-temperature polariton condensation
9:10-9:40	Fabian Scheiba	Uni Hamburg, DESY	Attosecond Pulse Generation in the Water Window using a Parametric Synthesizer with Sub-Cycle Optical Waveforms
9:40-10:10	Jun Zhang (张俊)	Institute of Semiconductors, CAS	Spin-charge-lattice interaction in 2D materials
10:10-10:40	Coffee Break		
Chair : Fabian Scheiba			
10:40-11:20	Gregory Fiete	Northeastern University	(Introductory Talk) Nonlinear optical probing and control of magnetic and electronic quantum geometry
11:20-11:50	Tao Dong (董涛)	Peking University	Dynamic interaction between Pseudogap and Superconductivity in Cuprates revealed by THz nonlinear spectroscopy
11:50-12:20	Jiyu Xu (徐纪玉)	Institute of Physics, CAS	Photoinduced ultrafast nonequilibrium dynamics in liquid water
12:20	Lunch		

Speakers and Abstract

报告人及报告摘要

Peixiang Lu（陆培祥）

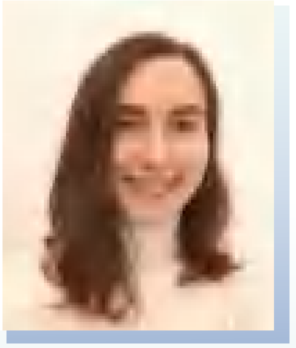
Huazhong University of Science and Technology

Prof. Peixiang Lu, is the Deputy Director of Wuhan National Laboratory for Optoelectronics, Director of the Academic Committee of the School of Physics, OPTICA Fellow, fellow of the Chinese Optical Society. Professor Lu serves as the leader of the Ministry of Education's innovation team "Laser Technology and Applications" and the leader of the National Natural Science Foundation's innovation research group "Strong-field Ultrafast Optics."

Since 1987, He has been engaged in experimental and theoretical research on strong-field ultrafast optics. He has published 600 papers in academic journals with over 10,000 SCI citations. He has received awards such as the first prize of the Hubei Natural Science Award in 2016 and 2022, the first prize of the Natural Science Award of the Chinese Academy of Sciences, and the IKEDA Research Achievement Award in Japan.

Strong-field ultrafast optics and precision measurement of transient processes

The emergence of ultrafast lasers has provided powerful tools for studying the dynamics of matter under extreme conditions, with significant applications in physics, chemistry, biology, and other fields. Since electron dynamics in atoms and molecules are typically on the attosecond timescale, traditional femtosecond detection techniques are no longer sufficient to detect these processes. Achieving attosecond resolution has always been an important topic in the field of ultrafast science. The generation of attosecond light source will provide powerful tools for attosecond time-resolved ultrafast dynamic detection. We will introduce the generation and manipulation methods of attosecond pulses based on high harmonic generation, as well as our application research on ultrafast process detection based on attosecond sources. In addition, we will also introduce our works of achieving high spatial-temporal precision measurement of ultrafast processes in atoms, molecules and solid materials using intense ultrafast laser fields. This includes a focus on the application of techniques such as high harmonic spectroscopy, strong-field photoelectron holography, and other ultrafast spectroscopic technologies.



Angela Montanaro

Friedrich Alexander University

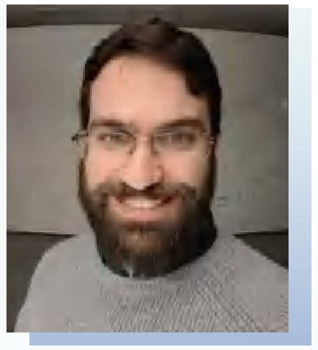
My research interests focus on studying and controlling quantum properties of complex materials exploiting light-matter interaction. In particular, I have experience in pump-probe setups combining visible, mid-infrared and terahertz pulses to selectively excite high-and low-energy degrees of freedom in matter and address the interdependence of their dynamical response. I mostly focus on the out-of-equilibrium study of cuprate superconductors, both in free space and in cavity-mediated environments, and layered van der Waals materials.

Cavity electrodynamics of correlated materials in a Fabry-Pérot resonator

The ability to engineer the macroscopic properties of bulk materials through cavity electrodynamics has been so far mostly explored in theoretical research and proposal-based experiments. Only recently, advancements in experimental platforms are starting to harness the full potential of cavity control in solid-state systems, opening up new pathways for light-matter interactions in confined environments.

In this seminar, I will discuss our recent study on the cavity-mediated thermal control of the metal-to-insulator transition in 1T-TaS_2, which demonstrates the feasibility of reversible cavity manipulation of phase transitions in a correlated material (***Nature*** 622, 487–492, 2023).

Moreover, I will elaborate on new possible schemes to push cavity resonant conditions to higher frequencies, thereby enabling the hybridization of electronic transitions in solid-state materials.



Marios Michael

Max Planck for the Structure and Dynamics of matter

Current Position: Alexander von Humboldt Fellow at the Max Planck Institute for the Structure and Dynamics of Matter, Germany.

Education: PhD in Physics from Harvard University, USA, with a dissertation on "Parametric Resonances in Floquet Materials." Bachelor's and Master's degrees from the University of Cambridge, UK.

Research Focus: Investigating photo-induced and cavity-induced phases of matter, with a particular emphasis on superconductivity. Broader interests include the non-linear and fluctuating dynamics of correlated systems.

Key Achievements:

1. Developed a multi-mode approach for computing photon fluctuations in optical and near-field cavity settings.

2. Established an analytical framework for advanced experimental techniques, such as 2D spectroscopy in condensed matter, on-chip THz spectroscopy for 2D systems, and time-resolved second harmonic generation driven by coherently oscillating fluctuations.

3. Discovered the phenomenon of giant dynamical paramagnetism in sine-Gordon systems.

Giant dynamical paramagnetism in the driven pseudogap phase of $YBa_2Cu_3O_{6+x}$

In this talk, I will discuss theory aimed at understanding recent experimental data on driven $YBa_2Cu_3O_{6.48}$ published recently in Nature: Fava, S., De Vecchi, G., Jotzu, G. et al. Magnetic field expulsion in optically driven $YBa_2Cu_3O_{6.48}$. ***Nature*** 632, 75–80 (2024). Experiments on optically pumped $YBa_2Cu_3O_{6.48}$ in the pseudogap phase far above Tc have shown evidence of dynamical Meissner effect. In our effort to understand the new experimental signatures, we have uncovered a universal instability triggered in Josephson junctions under a magnetic field that are strongly driven with an AC field. The instability leads to the generation of giant paramagnetic currents at the edges of Josephson junctions. For strong enough drive such instabilities ultimately lead to a soliton ratchet after driving. I will focus on why this instability of a generic Josephson junction is applicable to the pseudogap $YBa_2Cu_3O_{6.48}$ far above Tc and how it matches the experimental observations. Finally, I will discuss implications of driven giant paramagnetism for amplifying magnetic fields in other systems and in cold atoms.

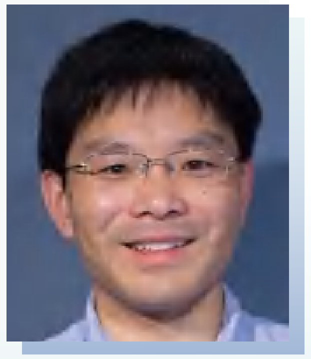
Dongping Zhong (仲冬平)

Shanghai Jiao Tong University

Dongping Zhong currently is the Chair Professor in Shanghai Jiao Tiong University. He received his B.S. in laser physics from Huazhong University of Science and Technology in China and his Ph.D. in chemical physics from California Institute of Technology in 1999 under the late Prof. Ahmed H. Zewail. For his Ph.D. work, Dr. Zhong received the Herbert Newby McCoy Award and the Milton and Francis Clauser Doctoral Prize from Caltech. He continued his postdoctoral research in the same group with focus on protein dynamics. In 2002, he joined The Ohio State University as an Assistant Professor, and he was Robert Smith Professor of Physics and Professor of Chemistry and Biochemistry. He is the Packard Fellow, Sloan Fellow, Camille Dreyfus Teacher-Scholar, Guggenheim Fellow, APS Fellow, AAAS Fellow, as well as the recipient of the NSF CAREER award and the Outstanding Young Research award from the International Organization of Chinese Physicists and Astronomers. He was the international Jury member in physical science for the L'Oréal-UNESCO awards for "Women in Science." His early work on femtochemistry and recent work on the dynamics of enzyme catalysis have been cited in the press release and Noble lecture of two Nobel Prizes (1999 and 2015). His research interests include photoenzyme, photoreceptor, biomolecular interactions, and ultrafast protein electron transfer dynamics using ultrafast photons and electrons.

Optical quantum control of ultrafast protein electron transfer

The optical control of a biological system has been challenging although the control of the energy transfer and isomerization reaction has been successfully demonstrated. Here, we report on the optical quantum control of electron transfer (ET) processes in a protein flavodoxin. With a transform-limited excitation pulse in 25 femtoseconds, we clearly observed the excited-state wavepacket dynamics in ET reactions with a dephasing time within 1 ps. By modulating the phase of the excitation pulses, the ultrafast ET dynamics was found to change from 100 to 300 fs due to the different wavepackets prepared by chirped pulses. We further found that the coherent control through the modulated wavepackets can propagate into the subsequent back ET reactions resulting in the dynamics varying from 500 to 800 fs. Such successful demonstration of coherent controlled ET reactions paves the way to control a variety of complex ET processes.



Wentao Zhang (张文涛)

Institute of Physics, CAS

Wentao Zhang focuses on the study of ultrafast electronic and lattice dynamics in condensed matter, with research interests including high-temperature superconductivity, charge density waves, excitonic physics, low-dimensional systems, and heterostructural physics. He utilizes time-resolved ARPES and other time-resolved techniques in his work.

Identification of a metastable lattice-distortion-free charge density wave at a photoinduced interface revealed by TR-ARPES

The interplay between different degrees of freedom governs the emergence of correlated electronic states in quantum materials, with charge density waves (CDW) often coexisting with other exotic phases. Under thermal equilibrium, traditional CDW states are consequentially accompanied by structural phase transitions. In contrast, ultrafast photoexcitation allows access to exotic states where a single degree of freedom dominates in the time domain, enabling the study of underlying physics without interference. Here, I will talk about the realization of a long-lived metastable CDW state without lattice distortion at the photoinduced interfaces in GdTe3 using time- and angle-resolved photoemission spectroscopy. After optical excitation above the CDW melting threshold, we identified emerged metastable interfaces through inverting the CDW-coupled lattice distortions, with lifetimes on the order of 10 picoseconds. These photoinduced interfaces represent a novel CDW state lacking the usual amplitude mode and lattice distortions, allowing quantification of the dominant role of electronic instabilities in CDW order.This work provides a new approach to disentangling electronic instabilities from electron-phonon coupling using a nonequilibrium method.

Naotaka Yoshikawa

University of Tokyo

Assistant Professor, Department of Physics, Graduate School of Science, The University of Tokyo

Light control of anomalous Hall conductivity in topological semimetal $Co_3Sn_2S_2$

I will present our experimental research on the light control of $Co_3Sn_2S_2$, which exhibits the ferromagnetic Weyl and paramagnetic Dirac semimetal phases in equilibrium. In the ferromagnetic Weyl semimetal phase of $Co_3Sn_2S_2$, we demonstrated the all-optical magnetization and chirality switching using a circularly polarized mid-infrared (MIR) light pulse excitation. Magneto-optical imaging measurements reveal that the mechanism of the magnetization/chirality switching is attributed to the helicity dependent deterministic magnetization associated with the magnetic circular dichroism. In the paramagnetic Dirac phase of $Co_3Sn_2S_2$, we investigated the possibility of Dirac-Weyl conversion by light irradiation predicted by the Floquet theory. By conducting the mid-infrared pump-terahertz Faraday rotation probe spectroscopy, the transient anomalous Hall response was demonstrated. The field-strength and driving-frequency dependence of the light-induced anomalous Hall conductivity are well reproduced by the calculation based on the Floquet theory, indicating the demonstration of the band structure modification toward the Dirac-Weyl conversion.

Theo Rasing

Radboud University

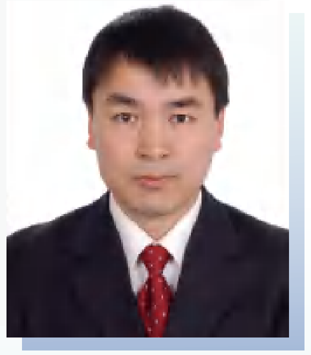
Theo Rasing is professor of physics at Radboud University, Nijmegen, the Netherlands, member of the Royal Dutch Academy of Arts and Sciences and Academia Europaea, honorary professor Wuhan University of Technology, honorary member of Ioffe Institute in St. Petersburg, recipient ERC Synergy Grant 2019, ERC Advanced Grant 2013, Prize for Science and Society 2008 and Spinoza Award 2008, the highest scientific award of the Netherlands. He has co-authored over 500 papers (*h*= *83*, GS), including 44 Physical Review Letters and 19 in Nature Group journals that were cited over 32000 times and is co-inventor on 4 patent applications. A Physical Review Letters of 2007 was mentioned as a Breakthrough of the year by Science.

Ultrafast control of magnetism thru strongly non-equilibrium states

Since our demonstration of magnetization reversal by a single 40 femtosecond laser pulse, the manipulation of spins by ultra-short laser pulses has developed into an alternative and energy efficient approach to magnetic recording. Though originally thought to be due to an optically induced effective magnetic field, later studies demonstrated that the switching occurred via a strongly non-equilibrium state, exploiting the exchange interaction between the spins. Recent work also show how magnetic textures like skyrmions are generated via a strongly non-equilibrium phase.

While for a long time, all-optical switching (AOS) was exclusively observed in ferrimagnetic alloys, more recent work demonstrated AOS in a broad range of ferromagnetic multilayer materials, albeit that in those examples a large number of pulses were required. By studying the dynamics of this switching process, we have discovered that this switching is a 2-step process of nucleation and switching, which has led to the subsequent demonstration that highly efficient AOS can be achieved by using pairs of femto/pico-second laser pulses, that are separated by a precisely tuned delay time. By combining optical laser excitation with in situ magnetic force microscopy, we recently found that the nucleation and switching process evolves via a stochastic network of domains.

Acknowledgement(s): Support from the Dutch Research Council (NWO) and the European Research Council ERC grant agreement no.856538 (3D-MAGiC) is acknowledged.



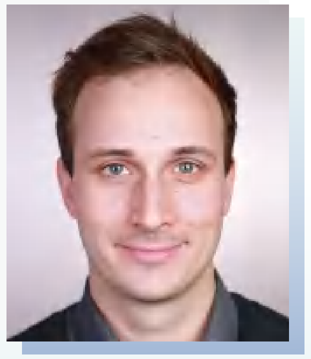
Zhaohua Cheng (成昭华)

Institute of Physics, CAS

His major research interest in the research of magnetic structures and femtomagnetism. He has published more than 300 academic papers in Adv. Mater. Nano Lett., Phys. Rev. Lett., PNAS, Appl. Phys. Lett, and Phys. Rev. B, etc. He got some awards, including 9th Science and Technology Awards for Chinese Young Scientists., Natural Sciences and Technology Award of Beijing, Natural Sciences Award of Chinese Council of Education. From 2008 to 2010, he served as the Advisory Editorial Board Member of Journal of Magnetism and Magnetic Material. Recently, he focused on the ultrafast spin dynamics of ferromagnet/topological insulators heterostructures.

Anisotropic Terahertz Spin-Phonon Coupling Mode in TAltermagnetic MnTe

Understanding spin-phonon coupling in antiferromagnet is crucial for advancing device functionalization with ultra-low power dissipation and ultrafast operations. Recently, the unconventional nature of altermagnets, characterized by the opposite-spin sublattices connected by crystal-rotation symmetries and a nonrelativistic spin-splitting band structure, can induce a spin-phonon coupling mode in Terahertz (THz) frequency region. However, the relationship between the THz spin-phonon coupling mode and the crystal-rotation symmetries has remained elusive. Here, we report the observation of an anisotropic spin-phonon coupled oscillation mode with a frequency reaching up to~3.5 THz, triggered by ultrafast optical excitation in an altermagnetic MnTe film. This coupled mode exhibits a pronounced sixfold symmetry (C_{6z}) in oscillation amplitude with respect to the angle between the linearly-polarized pump pulse and the Néel vector of MnTe. In contrast, the magnitude of the ultrafast demagnetization follows a twofold symmetry (C_2). These symmetries exactly print the spin group of MnTe ($[C_2||C_{6z}]$). Remarkably, the amplitude of the oscillation mode is negatively correlated with the band-splitting size determined from angle-resolved photoemission spectroscopy (ARPES). Our findings offer direct experimental evidence linking spin-phonon coupling with crystal symmetry, highlighting the potential of altermagnets for achieving ultrahigh speed and ultralow power dissipation via controlling magnons of altermagnetism by the linearly polarized light.



Dominik Juraschek
TU Eindhoven

I'm working at the interface between theoretical condensed matter physics and computational materials science. My group and I investigate how we can utilize collective vibrations of the atoms in a crystal, also called phonons, to control the functional properties of materials.

Phonon-induced chirality and multiferroicity

Chiral phononics is an emerging field that utilizes the angular momentum of circularly polarized lattice vibrations to manipulate the properties of quantum materials. When phonons are driven resonantly with an ultrashort circularly polarized laser pulse, light makes the ions in the material behave like electromagnetic coils, producing circular motions of the atoms around their equilibrium positions in the crystal. This induces real and effective magnetic fields that have been predicted and measured on the tesla scale, unlocking a new tool for the control of magnetic order. Here, I present our recent theoretical predictions of novel phenomena arising from chiral phonon driving, in particular light-induced magnetization in antiferromagnets through magnonic rectification [1] and light-induced transient multiferroicity in a nonmagnetic nonpolar material [2]. Furthermore, I will show how light can be used to make achiral materials chiral through a phononic rectification process that breaks all improper rotation symmetries of the crystal structure [3]. Finally, I provide suggestions of how to measure these phenomena in a variety of materials.

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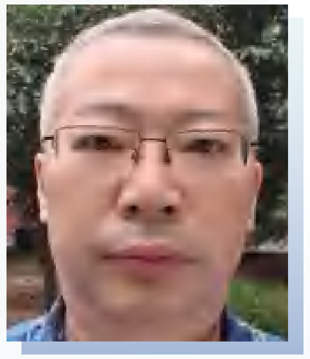
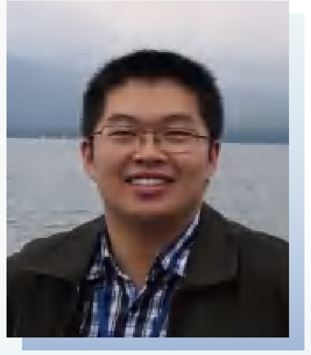


Banggui Liu (刘邦贵)
Institute of Physics, CAS

BG Liu received his Bachelor degree in 1982 in Xidian University, Xian; his Master's degree in 1986 in Sichuan University, Chengdu; his PhD in March 1989 in Northwest University, Xian. He performed his postdoc research between April 1989 and March 1991, and then works as Assistant (1991), Associate (1992), and Full (1999) Professor in Institute of Physics, Chinese Academy of Sciences. He published 160 papers and presented 50 invited reports, and received one national award and three CAS/Beijing awards. His research topic/fields include: Kinetic theory of adatoms on surfaces, Dynamic phase transition of surface reconstructions, Dynamic theory of nano magnets, Magnetism, Spintronic materials, 2D electron systems, 2D materials, and Effects of external fields.

Theoretical study on some ultrathin 2D electron systems

Ultrathin 2D electron systems can be realized in 2D materials and surfaces/interfaces of perovskite materials, featuring sub-nanometer scale of their thickness, in contrast to conventional 2DEGs. We performed DFT study on 2D materials such as GaTeCl, BiTeI, VSe2, RuBr2, BiN, and NiTe2 and their manipulated properties under external fields. On the other hand, we also studied on perovskite-based materials (KTaO3, SrTiO3, CaRuO3 etc.) for 2D monolayers and promising surface/interface 2D electron systems.



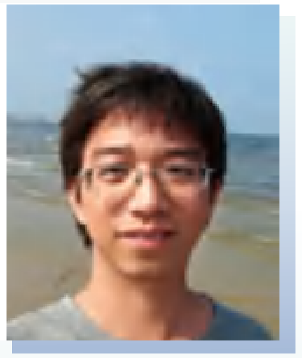
Weizhe Li

FAU Erlangen-Nuremberg

Phd candidate in the group of Prof. Peter Hommelhoff. Currently working on lightwave-driven topological effect in graphene. I got my bachelor degree in Shanghai Jiao Tong University, doing theory about high harmonic generation. I got my master degree in Karlsruhe Institute of Technology, doing spectroscopy of rare-earth ions.

Lightwave-driven electrons in a Floquet topological insulator

Topological insulators offer unique opportunities for novel electronics and quantum phenomena. However, intrinsic material limitations often restrict their applications and practical implementation. A time-periodic perturbation can generate out-of-equilibrium states known as Floquet topological insulators (FTIs), hosting topologically protected transport and anomalous Hall physics, and opening routes to optically tunable band-structures and devices compatible with petahertz electronics. Here we demonstrate coherent control of photocurrents in light-dressed graphene. Circularly-polarized laser pulses dress the graphene band structure to obtain an FTI, and phase-locked second harmonic pulses drive electrons in the FTI. This approach allows us to measure resulting all-optical anomalous Hall photocurrents, FTI-valley-polarized currents, and photocurrent circular dichroism, all phenomena that put FTIs on equal footing with equilibrium topological insulators. All measurements are supported by strong agreement with ab-initio and analytic theory. Remarkably, the photocurrents show a strong sub-cycle phase-sensitivity that can be employed for ultrafast control in topotronics and spectroscopy. Our work connects Floquet and topological physics with attoscience and valleytronics, and goes beyond band structure engineering by initiating lightwave-driven dynamics in FTI states.



Zi Cai (蔡子)

Shanghai JiaoTong University

Prof. Zi Cai received his bachelor his PhD in theoretical Physics by the Institute of Physics, Chinese Academy of Sciences in 2010. He was postdoc in the University of California at San Diego, University of Munich and the Institute of quantum optics of information, Austria Academy of Sciences for six years until he joined Shanghai Jiao Tong University. He is now a full professor in Shanghai Jiaotong University. He work on several theoretical topics of quantum many-body physics focusing on open and non-equilibrium quantum systems, ultracold atoms as well as numerical strongly correlated physics. He published more than 50 papers in peer review journals, including 1 Science and 12 Phys.Rev.Lett.

Nonequilibrium universality of quantum geometry

In this talk, we show that the quantum critical point in the ground state of quantum many-body systems, can also govern the universal dynamical behavior when the systems are driven far from equilibrium, which can be captured by the evolution of the quantum geometry of the systems. By investigating quantum quench dynamics in a variety of quadratic fermionic models, we find that the quantum volume of these systems typically grows linearly over time, with a growth velocity demonstrating universal behavior: its first derivative over the control parameter exhibits a discontinuity at the quantum critical point, with an universal jump value that is independent of specific models, but is crucially determined by the system dimension. This result reveals universal dynamical properties of non-equilibrium quantum many-body systems.

Jin Zhang (张进)

National Center for Nanoscience and Technology

Jin Zhang joined National Center for Nanoscience and Technology in Apr. 2024. Before that, He stayed in Max Planck Institute (Hamburg) for about 5 years supported by Prof. Angel Rubio. His research focuses on the electronic structure and photoexcited ultrafast dynamics in photodetectors, photovoltaic devices, and nano electronic devices. So far, he has more than 50 peer-reviewed publications in high-impact journals. Jin Zhang's research interests includes: 1) photoinduced charge dynamics in energy application, 2) photoinduced magnetic dynamics in quantum materials, high harmonic generation in solid-state materials, 3)Theory of DFT, TDDFT and DFPT. He intends to delve into nano-optoelectronics and advance ultrafast dynamics methods for probing the electronic structure and light-matter interactions. This undertaking promises to yield valuable insights crucial for propelling the fields of nano-optoelectronics and information technology.

Photoexcitation induced carrier and lattice dynamics in Nanoelectronic systems

Interplay among different degrees of freedom (e.g., electrons, phonons and spins, plasmons) is of paramount importance in understanding and optimizing the properties of quantum materials. The synthesis of two-dimensional (2D) materials such as graphene and transition metal dichalcogenides has opened up new venues for designing novel optoelectrical and photovoltaic devices. Photoexcitation induced dynamics in two-dimensional materials (e.g., interfacial charger dynamics and photoinduced phase transition) has been a hot topic in condensed physics and material science. In this talk, I will introduce the photoexcitation induced dynamics and phase transitions in quantum materials, including phase transitions in charge density waves materials and nonlinear optics in layered materials using density functional theory and time-dependent density functional theory. These studies would make a contribution to the future application of low-dimensional materials and quantum systems in optoelectrical, photovoltaic and photocatalysis etc.

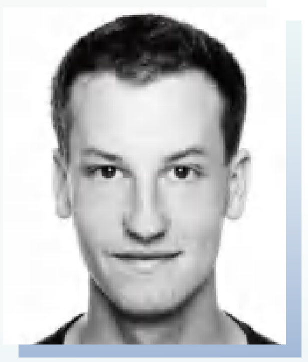
Angel Rubio

Max Planck Institute for the Structure and Dynamics of Matter

Angel Rubio is the Director of the Theory Department of the Max Planck Institute for the Structure and Dynamics of Matter since 2014. He is also Distinguish Research Scientist at the Simons Foundation's Flatiron Institute (NY, USA) and Professor/Chair for condensed matter physics at the University of the Basque Country in Donostia-San Sebastián, Spain. He is also External Scientific Member of the Fritz Haber Institute of Max-Planck-Gesellschaft in Berlin as well as Full Professor at the University of Hamburg (since 2016). He is one of the founders of the European Theoretical Spectroscopy Facility (ETSF) (http://www.etsf.es) and the originator of the widely used ab initio open-source project Octopus. His work has been recognized by several awards, including the 2018 Max Born medal and prize, 2016 Medal of the Spanish Royal Physical Society, the 2014 Premio Rey Jaime I for basic research, the 2006 DuPont Prize in nanotechnology, the 2005 Friedrich Wilhelm Bessel Research Award of the Humboldt Foundation, 1st National Prize for Graduated in Physics and two European Research Council advanced grants (2011 and 2016). He is Fellow of the American Physical Society and the American Association for the Advancement of Science, member of the Academia Europaea and European Academy of Sciences, and a foreign associate member of the National Academy of Sciences and Chinese Academy of Sciences.

Novel non-equilibrium phenomena in two dimensional heterostructures

We present our recent studies on the thermodynamical stability, mechanical, electronic, structural and optoelectronic properties of 2D materials. We will discuss new states of matter that are optically induced and have no equilibrium counterparts, and we will identify the fingerprints of these novel states that will be probed with pump-probe spectroscopies. A particular appeal of light dressing is the possibility to engineer symmetry breaking which can lead to novel properties of materials, e.g coupling to circularly polarized photons leads to local breaking of time-reversal symmetry enabling the control over a large variety of materials properties (e.g.topology). By controlling the Berry curvature in 2D layered materials (metal/insulator transition metal dichalcogenides, or TMD), a new class of quantum Hall states can be induced. In these states, the valley degree of freedom can be tuned with light.



Simon Maier
University of Regensburg

PhD student in the Group of Rupert Huber, "Ultrafast quantum physics and photonics", University of Regensburg

Attosecond electron dynamics in atomic-scale scanning tunnelling microscopy

Controlling ultrafast electronic dynamics in novel quantum materials and molecules is equally crucial for fundamental science and next-generation technology. Lightwave-driven scanning tunnelling microscopy (LW-STM) has enabled us to take atomic-scale slow-motion videos of single molecular orbitals and defect states directly on the intrinsic spatio-temporal scales [1,2]. Yet, the time resolution (~100 fs) has so far inhibited accessing dynamics within electronic wave packets. This could be overcome by single-cycle pulses with higher carrier wave frequencies also evidenced by sub-fs electron emission from metallic nanostructures with asymmetric field transients in the near infrared [3-5]. However, it is unclear if the picture of instantaneous field-driven tunnelling holds true at higher driving frequencies as multi-photon processes become more likely. In addition, at these extreme scales even the tiniest deviations in the distance of tip and sample, e.g. by thermal expansion, cause artefactual measurements. In this talk, I will introduce a novel method that ventures in this uncharted territory of near-infrared LW-STM eliminating thermal fluctuations by advanced field control. We use single-cycle near-infrared pulses to drive charge transfer between the tip of an STM and a metallic sample in an extremely well-controlled fashion. By modulating the waveforms of single-cycle pulses with an intensity envelope of only 5.2 fs, we gain a novel control mechanism for tunnelling which leaves the pulse energy almost untouched. This allows us to measure a current depending only on the carrier-envelope phase and the shape of the synthesized waveform. We see a characteristic and repeatable current for differently tailored waveforms. Moreover, the experimental data suggest a tunnelling process with an effectively reduced barrier height which indicates an electron distribution far out of equilibrium. By imaging a single Cu adatom we demonstrate the spatial confinement of the sub-fs tunnelling current to the atomic length scale. This next step in lightwave-controlled microscopy sets the stage for resolving atomic-scale dynamics on a sub-fs time scale, providing artifact-free insights into electron motion within single orbitals and their coherent superpositions.

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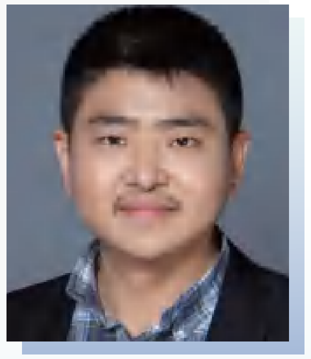


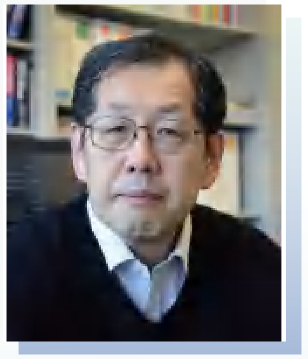
Dong Sun (孙栋)

Peking University

Dong Sun, currently Boya distinguish professor of the International Center for Quantum Materials (ICQM) at Peking University. He graduated with a bachelor's degree from University of Science and Technology of China in 2004, and a Ph.D degree from University of Michigan in 2009. He then worked as a postdoctoral scholar and research scientist at University of Michigan and the University of Washington, respectively. Since 2012, he worked in ICQM of Peking University as associated professor and full professor. He was recruited by the national overseas talent program in 2012 and received distinguished young scholars awards from both Beijing Nature Science Foundation and the National Science Fund of China, respectively. His main research direction is optical spectroscopy studies of quantum materials, novel optoelectronic devices based on quantum materials and related device physics.

Tunable Chirality Couplings and Anomalous Photo-Nernst Effect in Magnetic Weyl Cones in $Co_3Sn_2S_2$

In this talk, we present our scanning photocurrent microscopy studies of magnetic Weyl semimetal $Co_3Sn_2S_2$. In the first part of the talk, we demonstrate that we can use mid-infrared circular polarized light to inject chiral polarized Weyl Fermion. Our results reveal interesting coupling between the circularly polarized mid-infrared light and the magnetic Weyl cones when an external electric field is applied, through third order nonlinear optical response. The coupling builds up versatile tunable chiral polarized Weyl fermions, which manifests as measurable directional photocurrent generation. In the second part of the talk, we show observation of zero-field anomalous photo-Nernst effect in $Co_3Sn_2S_2$. Experimentally, clear edge photocurrent response is observed due the anomalous photo-Nernst effect, and the effect can be used to image the magnetic domains.



Kazuhiro Yabana

University of Tsukuba

I have developed my research across two fields, theoretical nuclear physics and theory for ultrafast phenomena in materials science. In both fields, I have developed methods of computational physics, in particular computational methods of quantum dynamics for Fermi many-particle systems. Recently, we have devoted to develop an open-source software SALMON (Scalable Ab initio Light-Matter simulator for Optics and Nanoscience) that is capable of describing the optical response of materials from the atomic scale based on first-principles time-dependent density functional theory. Applications of SALMON include the interaction of extreme pulsed light with solids and nanomaterials, such as attosecond ultrafast dynamics in solids, nonlinear phenomena such as higher harmonic generation and laser processing, and quantum effects on meta-surfaces.

Ab initio theory and computations for nonlinear/nonlocal nano-photonics

In recent nano-photonics, nonlinear and/or nonlocal light-matter interaction plays a key role in the discovery of new phenomena and in the development of new optics-device concepts. In ordinary photonics, propagations of light in nanostructures are described by macroscopic Maxwell equations using, e.g. FDTD method. However, interaction of strong and ultrashort laser pulses with nm-scale nano-structures, ordinary approaches are often not sufficient. Approaches directly combining electromagnetism for light propagation and quantum mechanics for electron dynamics become indispensable. We have been developing ab initio methods combining Maxwell equations and time-dependent density functional theory. In my presentation, I will explain basic framework and show several applications taking high harmonic generation and nano-plasmonics.

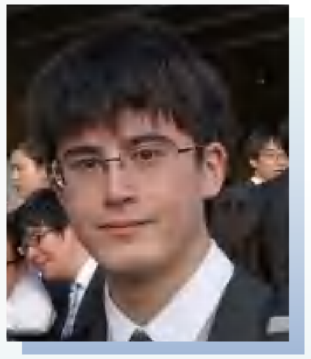
Noejung Park

Ulsan National Institute of Science and Technology (UNIST), Department of Physics/Max Plank Institute for the Structure and Dynamics of Matter

Professor Noejung Park, from UNIST (Ulsan National Institute of Science and Technology) in South Korea, graduated from Seoul National University and earned his Ph.D. in 2002. His research primarily centers on ab initio calculations of real materials using Density Functional Theory (DFT) and Time-Dependent Density Functional Theory (TD-DFT). He is particularly interested in how the topological and geometrical properties of band states manifest in the Hamiltonians of real materials. His ultimate goal is to develop first-principles methods to uncover charge and spin currents in real materials, with a specific focus on their topological characteristics.

Density-functional-theory calculations of currents in real materials and the study of topological & geometrical nature of band states or other physical systems

We have explored charge and spin currents in real materials using ab initio computational methods, grounded in Time-Dependent Density Functional Theory (TDDFT) and Time-Dependent Current Density Functional Theory (TDCDFT). While our research has examined various Berry curvature characteristics in solid-state systems, our primary focus is on uncovering the topological and geometrical properties of band states in the real-time dynamics of materials. For instance, we show that quantum anomalous Hall conductivity and quantum spin Hall conductivity in bulk topological insulators can be directly computed via ab initio evaluations of charge and spin currents, respectively. In this talk, we also present our recent advances in the study of one-dimensional topological structures, with a particular focus on how the intricate interplay between geometrical helicity, spin-orbit coupling, and conducting charges gives rise to unique spin dynamics, potentially linked to a spin-based counterpart of the Thouless pump.



Kaishu Kawaguchi

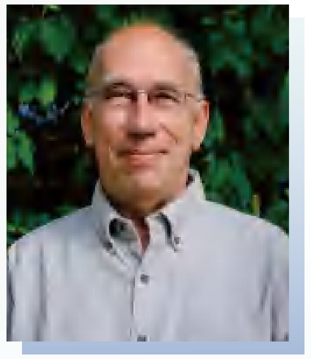
University of Tokyo

I am a researcher in experimental condensed matter physics and nonequilibrium physics, with a focus on time-, spin- and angle-resolved photoemission spectroscopy (trSARPES). My work involves developing advanced trSARPES setups to study ultrafast spin dynamics and non-equilibrium states. I aim to push the frontiers of opto-spintronics and quantum material research.

Time-, spin- and angle-resolved photoemission spectroscopy with 10.7-eV laser at 1-MHz repetition rate

Spin- and angle-resolved photoemission spectroscopy (SARPES) is a powerful experimental technique that enables the complete determination of the spin structure in energy and momentum space. Combining SARPES with pump-probe laser techniques allows for imaging optically excited electron populations in the unoccupied bands and tracking ultrafast charge and spin dynamics in the time domain.

Here, I present the state-of-the-art pump-probe SARPES setup. This apparatus is based on a SARPES system equipped with highly efficient very-low-energy-electron-diffraction (VLEED) spin detectors. We combine this with bright 10.7-eV laser pulses at a high repetition rate (1 MHz), driven by harmonic generation of a Yb-based chirped-pulse amplified laser. This setup enables us to obtain large SARPES signals sufficient to observe unoccupied spin-polarized bands in various materials and track their ultrafast electron and spin dynamics with the high-energy probe photon.



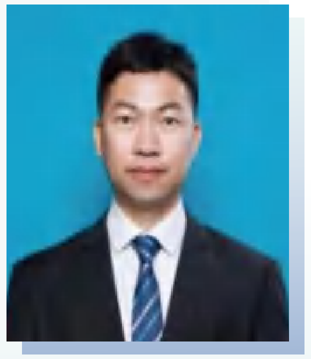
Hardy Gross

Hebrew University of Jerusalem

Eberhard Gross received his PhD in Physics in 1980 at the Goethe University in Frankfurt, Germany. After a postdoctoral stay at the same university, he joined the group of Walter Kohn at the University of California, Santa Barbara, first as a postdoc, then as a Heisenberg fellow. In 1990, he became Professor of Physics at the University of Wuerzburg, Germany. From 2001 he had the Chair of Theoretical Physics at the Free University of Berlin, and from 2009 to 2019 he was Director of the Max Planck Institute of Microstructure Physics in Halle, Germany. Since 2017, he is Professor of Chemistry at the Hebrew University of Jerusalem, Israel. Together with Erich Runge, he laid the foundation of time-dependent density functional theory. He furthermore developed the Ensemble DFT of excited states, and an ab-initio theory of phonon-driven superconductivity. In recent years, he developed the exact factorization, a novel methodology describing all aspects of non-adiabatic chemical dynamics, in particular electronic decoherence and the molecular Berry phase. His work has been recognized with several prizes and awards, including the 2016 Bernie Alder CECAM prize, the 2016 Tsungming Tu prize in Taipei, the Schlumberger Award with medal, and the CMOA senior medal. He is a member of the International Academy of Quantum Molecular Science, a Fellow of the American Physical Society and a Mercator Fellow of the German Science Foundation (DFG).

TDDFT simulations of electronic charge and spin dynamics and the birth of atto-magnetism

This lecture is about the motion of electrons on the femto- and atto-second time scale; how it can be monitored, analyzed and, ultimately, controlled with ultra-short laser pulses. Real-time simulations are performed employing the ab-initio approach of time-dependent density functional theory (TDDFT). We shall visualize the laser-induced formation and breaking of chemical bonds in real time, and we shall highlight non-steady-state features of the electronic current through nano-scale junctions. With the goal of pushing magnetic storage processes towards ever shorter time scales, we have predicted that in many materials the ***local*** magnetic moment can be manipulated with ultrafast laser pulses. The underlying mechanism is an optically induced spin transfer (OISTR) from one magnetic sub-lattice to another. As an all-optical process, OISTR is temporally limited by the duration of the laser pulse, which may be in the atto-second regime. OISTR was first predicted by real-time simulations and later confirmed experimentally.



Xuebin Bian (卞学滨)

Innovation Academy for Precision Measurement Science and Technology, CAS

Xuebin Bian received his PhD degree in Wuhan institute of physics and mathematics, CAS. He is a Professor at Innovation Academy for Precision Measurement Science and Technology, CAS. His research interests include theoretical study of ultafast dynamics from atoms and molecules to complex solid and liquid systems.

Theoretical study of high-order harmonic and THz generation in liquids

Ultrafast dynamics in complex systems is rarely studied. Here, we investigated the mechanism of laser-induced THz and high-order harmonic generation in liquids theoretically. We use an atomic chain model to simulate the bulk liquid system. The inter-nuclear distance obeys a normal distribution, reflecting the short-range order and long-range disorder of liquids. It is found that the maximum harmonic photon energy Ω is linked to the statistical parameters of the system, with a linear dependence on the laser field strength and finite coherence distance. The prediction of the wavelength-independent Ω by our theory has been confirmed by recent experiments. For the THz emission in liquids, we developed a shift-current model. It comes from the transition of localized bound states in disordered liquid systems. The energy difference of them is in the THz range. This model can quantitatively reproduce the THz dependence on the laser pulse duration and intensity measured in the experiments. It can also interpret the origin of unmodulated THz signals in the two-color laser fields. Nuclear quantum effect is found to play key roles.

Chen Li (李晨)
Peking University

Chen Li is an assistant professor at the College of Chemistry and Molecular Engineering, Peking University. He received his bachelor's degree in chemistry and math from Peking University in 2011. After that, he pursued his PhD study in density functional theory at Duke University under the supervision of Prof. Weitao Yang, and obtained his Ph. D. degree in 2016. In 2017, he joined the Max Planck Institute of Microstructure Physics in Germany as a postdoc research scientist and worked with Prof. Hardy Gross on the topic of time dependent density functional theory beyond Born-Oppenheimer approximation. In 2019, he followed Prof. Gross and moved to the Fritz Haber Center for Molecular Dynamics at Hebrew University of Jerusalem in Israel. In September 2020, He finished his postdoc and joined the chemistry department of Peking University as an assistant professor. Prof. Li is engaged in developing density functional theory methods, aiming at predicting properties of atoms, molecules and solid state materials, and capturing transition state intermediates in chemical reactions. Moreover, by developing time dependent density functional theory involving both electrons and nuclei and treating them quantum mechanically, he aims at describing nonadiabatic reaction mechanisms, particularly chemical reactions after photo-excitation and catalytic processes.

Molecular Geometric Phase Effects from the Perspective of Exact Effective Force

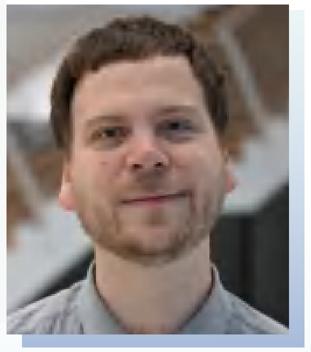
In this talk, I will discuss our recent application of the exact factorization equations for electron-nuclear time-dependent problems. Starting from the exact nuclear Schrödinger equation, we derive inter-subsystem Ehrenfest identities characterizing the energy, momentum, and angular momentum transfer between electrons and nuclei, we identify an effective electromagnetic force operator induced by the electromagnetic field corresponding to the effective scalar and vector potentials in all three identities. Through a case study of a two-state vibronic coupling model with a conical intersection in two dimensions, we show that one can understand the nuclear dynamics particularly for the molecular geometric phase effects in three equally valid perspectives: (i) destructive interference of the branching nuclear wave packet owing to the geometric phase; (ii) an energy-driven effect characterized by the dynamically generated spikes and barrier on the time-dependent potential energy surface; (iii) an effective force field that pushes the nuclear wave density away from the interference region. Particularly, the third perspective provides us new insight into the geometric phase effects and is potentially a new starting point for molecular dynamics simulations.

Wei Quan (全威)
Innovation Academy for Precision Measurement Science and Technology, CAS

Dr. Wei Quan is a professor from Innovation Academy for Precision Measurement Science and Technology, Chinese Academy of Sciences. He completed his PHD research in 2007 in the field of atomic and molecular physics. He spent 6 months visiting Max Born Institute in 2011 and 1 month visiting Jena University in 2014. His current research interest is the ultrafast dynamics of atoms and molecule subject to strong laser fields, especially the issues of the electron dynamics near the continuum threshold, investigation of tunneling delay problem based on attoclock procedure, the laser-induced electron inelastic diffraction imaging of atomic and molecular ultrafast dynamics. He has published more than 60 papers, which have been cited around 1000 times by SCI papers.

Breakdown of one-to-one correspondence between the photoelectron emission angle and the tunneling instant in the attoclock scheme

Attoclock is a promising chronoscopy of the ultrafast dynamics of atoms and molecules in intense laser fields. The attoclock procedure is established based on the one-to-one correspondence between the photoelectron emission angle and the tunneling instant at each photoelectron kinetic energy for ionization of atoms and molecules subject to elliptically polarized strong laser fields. In this work, our joint theoretical and experimental study demonstrates that this correspondence could be broken down for photoelectrons emitted in a direction close to the minimum yield. Two trajectories with different tunneling instants and different initial velocities are found to correspond to a specific final momentum of the photoelectron in this direction, and a multi-peak structure appears in the photoelectron kinetic energy spectrum that can be attributed to interference between these two trajectories. Our work is essential for a deeper understanding and further development of the attoclock scheme.



Emil Viñas Boström

University of the Basque Country /Max Planck Institute for the Structure and Dynamics of Matter

Dr. Emil Viñas Boström received his doctorate degree from Lund University, Sweden, where he worked with Prof. Claudio Verdozzi on developing diagrammatic many-body methods to simulate the photo-induced dynamics of atomic, molecular and condensed matter systems. He then moved to the Max Planck Institute for the Structure and Dynamics of Matter in Hamburg, Germany, to work as a postdoctoral researcher with Prof. Angel Rubio. During this time, he has worked on developing theoretical methods to understand the interaction between low-dimensional magnetic materials and quantized electromagnetic fields. He is currently a postdoctoral researcher with Prof. Angel Rubio at the University of the Basque Country in San Sebastian, Spain, where his research focuses on how the interaction between quantum electromagnetic fields and correlated quantum matter can be used to stabilize exotic magnetic phases supporting non-abelian excitations, and how the enhanced light-matter interaction facilitated by an optical cavity can be used to construct all-optical schemes to read-out matter correlations.

Controlling magnetism with cavity vacuum fluctuations

Two-dimensional magnetic materials have recently recieved much attention, both as a possible arena to realize exotic phases of matter, and for their potential in the development of next-generation information processing devices. Due to a combination of geometric frustratation, strong spin-orbit interactions and enhanced fluctuations, two-dimensional magnetic materials display a large variety of magnetic orders, while also being susceptible to material engineering techniques such as moiré twisting, non-linear phononics and cavity embedding. In this talk, I will discuss how cavity vacuum engineering can be combined with non-linear phononics, to control matter by stretching selected phonon modes in thermal equilibrium [1]. Specifically, we will demonstrate how the recently discovered ferromagnetic state of the van der Waals antiferromagnet $FePS_3$ [2], induced by subjecting the material to intense THz radiation, can be reached also by coupling the system to fluctuations of a paraelectric surface. In the former case, the THz field drives a net displacement of a specific Raman active phonon mode, while in the later case the same mode is stretched via its coupling to local electric field fluctuations of surface phonon polaritons. Crucially, the cavity effect is highly non-resonant, and involves the modification of the entire mode structure of the cavity. The temperature dependence of the magnetic state is captured by an effective Ginzburg-Landau theory that can be derived from a microscopic spin-phonon model, and demonstrates that it originates from the coupling between the ferromagnetic order and critical fluctuations of the dominant antiferromagnetic order. Since the effect only depends on the stretching of a Raman phonon mode, and the form of the effective Ginzburg-Landau theory, this work opens the door to stabilizing exotic magnetic phases in systems with intertwined orders in thermal equilibrium.

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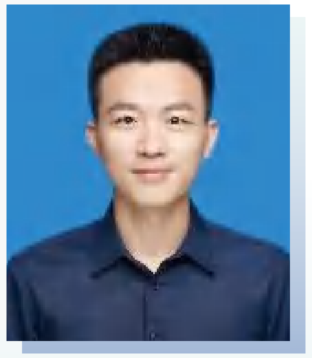


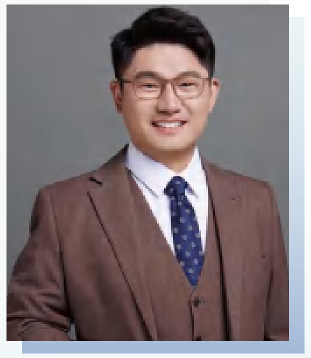
Bing Huang (黄兵)

Beijing Computational Science Research Center

Dr. Huang is now a professor at Beijing Computational Science Research Center (under Chinese Academy of Engineering Physics). He received his Ph.D. degree in 2010, under the supervision of Prof. W. H. Duan at Tsinghua University. After finish his Postdoc at NREL and ORNL at US, he joined the CSRC as an assistant professor at 2015 and tenured at 2020. His research focuses on computational semiconductor physics. He has published over 140 papers, including Nature、 Nature-brand journals、 PRL and PNAS.

Manipulation of Nonlinear Optical Responses in Semiconductors

Realization of effectively tunable second-order nonlinear optical responses, e.g., second-harmonic generation and bulk photovoltaic effect, is critical for developing modern optical and optoelectronic devices. In this talk, we will introduce our recent studies on this topic. We have applied a simple atomic transmutation to design new Deep-UV nonlinear optical materials. We have demonstrated the bulk electrophotovoltaic effect in heteronodal-line systems, where an effective electric field can greatly tune the shift current conductivity. We have revealed the simple origin of large second-harmonic generation in $NbOX_2$ (X = Cl, Br, and I). We achieve a reversible ferroelectric-to-antiferroelectric phase transition in NbOCl2 under a certain region of external pressure, accompanied by the greatly tunable nonlinear optical responses. We propose a scheme to achieve an ultra-sensitive bulk piezophotovoltaic effect in a single-valley topological alloy system, as demonstrated in NaBa(P,Bi) system.



Xiaochun Gong (宫晓春)

Zhejiang University/ECNU

Dr. Xiaochun Gong mainly focuses on the fundamental research area of ultrafast pulse generation and its application in probing attosecond electron motion from atoms, molecules, to condensed phase. Due to his contribution to the development of attosecond coincidence spectroscopy, he was awarded the Fresnel prize for fundamental aspects by EPS- QEOD in 2023.

High Repetition Rate and High Energy Ultrashort Laser Pulse: The Next Light Source for Attosecond Spectroscopy

We briefly summarized the development of the post pulse compression techniques in Yb-lasers including hollow-core fibers, multiple thin plates, and multipass cells. Our recent results of a high temporal contrast pulse compression to 22 fs and its application in attosecond time resolved solid high harmonic generation spectrosocpy was shortly introduced.

Xijie Wang

Uni. Duisburg-Essen & TU-Dortmund

Prof. Xijie Wang is a leading expert in Ultrafast Science and Technology, holding a joint professorship at both the University of Duisburg-Essen and the Technical University of Dortmund. With over 30 years of experience in accelerator physics, free electron lasers, ultrafast electron scattering for material and chemical science, Prof. Wang has made groundbreaking contributions to the fields.

He pioneered the use of mega-electron-volt electrons in ultrafast electron diffraction (MeV-UED) and ultrafast electron microscopy (MeV-UEM), significantly advancing the world-wide development of ultrafast electron scattering techniques. His group has achieved world-firsts in ultrafast science and technologies, including single-shot ultrafast diffuse electron scattering, micro-diffraction, operando and in-situ measurements, and femtosecond gas and liquid phase UED. These pioneering techniques have opended new frontiers in ultrafast science and material research under extreme conditions, yielding critical insights into the ultrafast structural dynamics of 2D materials, the control of topological properties of matter, and atomic-scale visualization of complex materials, including perovskites, as well as fundamental chemical processes in gases and liquids.

In 2019, Prof. Wang established the world's first ultrafast electron scattering user facility at Stanford Linear Accelerator Center (SLAC), the SLAC MeV-UED.

Xijie Wang completed his undergraduate studies at Shaanxi Normal University (陕西师范大学) in Xi'an, China, and earned his PhD in Physics from UCLA in 1992. Xijie has co-authored more than 350 publications, including 8 in ***Science***, 4 in ***Nature***, 8 in ***Science Advances***, 16 in ***Nature*** family journals, and 24 in ***Physical Review Letters*** (PRL).

Imaging nonequilibrium and ultrafast quantum states with MeV electrons

Understanding and controlling the behavior of quantum states far from equilibrium, particularly on ultrafast timescales, is one of grand challenges in material, chemical and biological sciences. Mega-electron-volt ultrafast electron diffraction (MeV-UED) [1] is one of the unique tools capable of imaging nonequilibrium and ultrafast quantum states on femtoseconds scale with the high spatial resolution and sensitivity [2]. The science enabled by MeV-UED includes imaging fundamental photochemical processes [3-4] and hydrogen bond dynamics in liquid water [5], capturing light-induced transient states of quantum materials [6-8]. Furthermore, MeV electrons experience less multiple-scattering, the least perturbation, and possess "real" flat Ewald-sphere; MeV-UED is an "ideal" tool to image nonequilibrium and ultrafast quantum states using total scattering technique.

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Jin Zhao（赵瑾）

University of Science and Technology of China

Jin Zhao received her B.S. degree from University of Science and Technology of China (USTC) in physics in 1998. After that she joined the research group of Prof. Hrvoje Petek at the University of Pittsburgh in 2004. In March 2010, she returned to USTC as a Professor. The focus of her research is ab initio investigation on the dynamics of excited carriers in condensed matter systems. Jin Zhao has been recognized with the National Science Fund for Distinguished Young Scholars of China (2021), China Young Women in Science Award (2023). She was selected as a Fellow of the American Physical Society (APS) in 2023.

Ab Initio Investigations on the Quantum Dynamics of Excited Carriers in Condensed Matter Systems

The ultrafast dynamics of charge carriers in condensed matter systems plays an important role in charge transport, optoelectronics and solar energy conversion. Although ab initio calculation is widely applied to understand the electronic structure of different materials, it is challenging to track the quantum dynamics of charge carriers in solide materials in mult-dimensions including time and energy domains, as well as real and momentum spaces. Our research goal is develop ***ab initio*** simulation approach to achieve a state-of-the-art understanding of multi-dimensional carrier dynamics in solid materials. We have developed Hefei-NAMD code, which can be applied to study i) the excited electron or hole dynamics based on the single-particle picture in real space and momentum space; ii) Spin-orbital Coupling (SOC) induced spin dynamics; and iii) exciton dynamics using GW + real-time BSE. In this talk, I will simply review the theoretical framework of Hefei-NAMD and introduce its application to the exciton dynamics, polaron dynamcis and exciton-polaron dynamcis.

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Shunsuke Sato
University of Tsukuba

Prof. Shunsuke A. Sato is an associate professor at the Center for Computational Sciences, University of Tsukuba, Japan. He received his Ph.D. from the University of Tsukuba in 2016. Afterward, he worked at the Max Planck Institute for the Structure and Dynamics of Matter as a postdoctoral researcher and visiting scholar under the supervision of Prof. Angel Rubio. He is currently conducting research on first-principles calculations related to attosecond phenomena in solids at the University of Tsukuba.

Quantum Electron Dynamics Calculation for Attosecond Phenomena

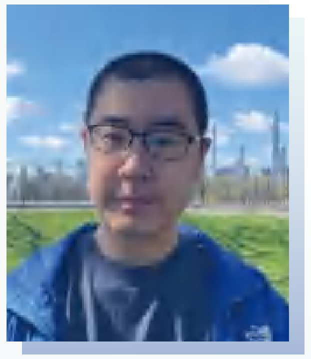
Recent developments in attosecond technologies have enabled the investigation of light-induced electron dynamics in solids with attosecond time resolution, offering valuable insights into the quantum and nonequilibrium dynamics of matter. However, interpreting the results of attosecond experiments is often challenging due to the complex electronic structures of solids. First-principles electron dynamics calculations, based on time-dependent density functional theory, are a powerful tool for investigating such complex nonequilibrium dynamics from a quantum perspective. In this talk, I will introduce a numerical approach to studying ultrafast electron dynamics in solids using first-principles electron dynamics calculations. I will also present applications of this approach to attosecond transient absorption spectroscopy in solids, providing microscopic insights into light-induced attosecond phenomena.

Limin Tong (童利民)
Zhejiang University

Limin Tong is a professor of the College of Optical Science and Engineering at Zhejiang University. His research focuses on nanophotonics and fiber optics. He received the National Science Foundation for Outstanding Young Scholars (China) in 2004, the WANG Daheng Optics Prize (Chinese Optics Society) in 2007, the Chang Jiang Scholars (Ministry of Education, China) in 2012. He is a fellow of Optica, and a New Cornerstone Investigator.

Confining an optical field to a single atom scale

Confining light to a scale comparable to a single atom (spatial and temporal) is of great importance for studying light-matter interaction at the bottom. However, due to the huge mismatch of photon momentum and energy, atom-scale optical confinement remains challenging. Here we introduce our recent work in generating atom-scale optical field in a nanoslit waveguiding mode, in which a sub-nm-size optical field in a diffraction-limited optical mode can be significantly enhanced with a peak-to-background ratio up to 20 dB, resulting in an extremely confined optical field with a spatial size down to 0.2 nm. Moreover, based on such a field, we propose to generate deep-sub-cycle attosecond pulses via inverse Compton scattering of spatially confined photons by relativistic electrons, with a pulse width down to 100 as and a peak frequency of 2 PHz (UV spectral range). Such extremely confined optical fields may open new opportunities for exploring and utilizing light-matter interactions on the single atom/molecule level.



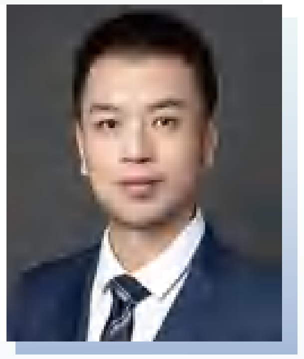
Yanan Dai (戴亚南)

Southern University of Science and Technology

Yanan Dai is an associate professor in the department of physics, Southern University of Science and Technology (SUSTech). He obtained his B.S. degree at Shandong University in 2013, and Ph.D degree in physics at the University of Pittsburgh in 2019. Before joining SUSTech in Aug. 2022, he worked as a postdoctoral research scientist in the department of chemistry at the Columbia University. His group at SUSTech now is developing advanced ultrafast optical and photoelectron spectroscopies and microscopies, to achieve multi-dimensional probing of excited state dynamics and vectorial Floquet engineering of quantum materials on the nano-femto scales.

Ultrafast photoelectron imaging of plasmonic electron transport in the non-thermal regime

In this talk, I will describe ultrafast nonlinear photoemission electron microscopy (PEEM) imaging of plasmon-assisted electron dynamics in semi-continuous gold films. By engineering the surface topography of the gold film, we effectively modify the interaction between the dipolar and higher order plasmonic modes of the film, which leads to both delocalized and strongly localized dark plasmons having orders of magnitude stronger field enhancement compared to that of planar gold surface. Using nonlinear PEEM imaging, we reveal the strongly enhanced photoelectron emission of both dark plasmonic excitations, as well as the ballistic transport dynamics of the associated electrons in the non-thermal regime, with nanometer and femtosecond spatiotemporal resolutions. Our results provide a new platform for ultrasensitive molecular sensing, efficient energy harvesting, and could potentially lead to plasmonic Anderson localization.



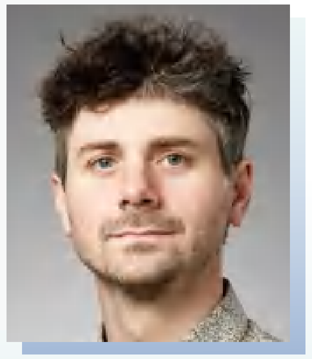
Zhensheng Tao (陶镇生)

Fudan University

Zhensheng Tao is a professor and Ph.D. advisor in the Department of Physics at Fudan University. In 2014, he obtained his Ph.D. from Michigan State University in the United States, followed by postdoctoral research at the JILA Institute of the University of Colorado Boulder. His primary research focuses on ultrafast strong-field optics and ultrafast light-matter interactions. He has published over 40 papers in journals such as Science, PRL, Light: Science & Applications, and Science Advances. He has been honored with several academic awards, including the Shanghai "Oriental Scholar" Distinguished Professor, Humboldt Fellowship in Germany, and the "Xide Youth Professorship" of the Department of Physics at Fudan University.

Solid-state High-order Sideband Spectroscopy and Microscopy

Ultrafast manipulation of electronic states in quantum materials is essential for quantum-state engineering and ultrafast optical modulation. Recently, strong-field driven materials have exhibited fascinating tailored properties, including modification of topological states, modulation of optical properties and band-structure engineering. However, experimental methods for accessing the properties of strong-field dressed quantum states are lacking. In this talk, I will present our recently developed high-order sideband spectroscopy and microscopy techniques, which enables energy-, time- and space-resolved measurements on strong-field dressed quantum states or near-field wave phenomena. We present the first measurement on the dephasing rates of strong-field dressed exciton states, and resolve the strong-field exciton dissociation as the major dephasing mechanism. Furthermore, we realize the first 3D tomographic near-field tomographic imaging of a mid-infrared anapole resonant field in a micrometer-thick silicon resonator. These results highlight the high-order sideband spectroscopy and microscopy as a powerful tool for studying ultrafast manipulation of quantum materials.



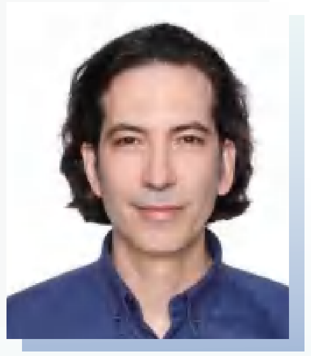
Simon Wall

Aarhus University

Simon Wall obtained his PhD at the University of Oxford and was an Alexander von Humboldt fellow at the Fritz Haber Institute of the Max Planck Society. He started his own research group at ICFO, in Barcelona, Spain in 2012 and was tenured in 2019. In 2020 he moved to Aarhus University.

Surface melting and polaron localization during the melting of orbital order

In this talk I will discuss our use of ultrafast X-ray surface scattering and conventional Bragg scattering to measure the melting of orbital order at the surface of the manganite $La_{0.5}Sr_{1.5}MnO_4$. We find the surprising result that the orbital Bragg peak narrows on photoexcitation. However, measurements of the surface order show a broadening. We reconcile these contradictory responses via the fact that the sample is in an inhomogeneous initial state, which strongly influences how we interpret the data. In addition, by measuring the diffuse scattering around the Bragg peak, we find evidence for the formation of incoherent polarons, which are first delocalized but rapidly localize to the order of a unit cell within a few picoseconds.



John McGuire

ShanghaiTech University

John McGuire joined the faculty of the School of Physical Science and Technology at ShanghaiTech University in 2018 after eight years on the faculty of the Department of Physics and Astronomy at Michigan State University. His research interests range from orientational and vibrational dynamics of interfacial water to exciton interactions and dynamics in low-dimensional systems (colloidal semiconductor and graphene quantum dots and layered materials). His experimental approaches range from incoherent probes of population dynamics such as transient absorption and time-resolved photoluminescence to coherent processes such as sum-frequency and second harmonic generation and multidimensional Fourier transform spectroscopy.

Exciton Decoherence in $Cd_{1-x}Mn_xSe$ Quantum Dots Probed by Multidimensional Fourier Transform Spectroscopy

Interest in dilute magnetic semiconductors (DMS) developed more than half a century ago due to the giant magneto-optical effects observed in Mn-substituted II-VI semiconductors, especially the observation of effective exciton g factors two orders of magnitude larger than the g factors measured in bare semiconductors. Wave function engineering in DMS quantum dots allows for enhancement of the ***sp-d*** exchange interactions giving rise to such effects. Traditionally, these interactions have been probed by steady-state and transient photoluminescence, but such incoherent processes primarily reflect mean field dynamics. In contrast, exciton decoherence is sensitive to the fluctuations of the exciton-Mn^{2+} spin orientation. However, exciton decoherence is obscured by the inhomogeneous dephasing originating in inhomogeneities in quantum dot size, shape, and Mn^{2+} content and distribution. I will describe our use of femtosecond multidimensional Fourier transform electronic spectroscopy to probe the homogeneous linewidth in ensembles of $Cd_{1-x}Mn_xSe$ colloidal quantum dots. Compared to Mn-free CdSe quantum dots, at temperatures $T \lesssim 10$ K the lowest energy bright excitons exhibit about a fourfold increase in homogeneous dephasing rate as the Mn content increases from x=0.00 to x=0.10. We interpret these results in terms of phonon-induced spin flips of the hole angular momentum relative to the net spin of the Mn^{2+} ensemble, which is non-zero due to fluctuations on timescales slower than the hole fluctuations.

Yuhai Jiang (江玉海)

ShanghaiTech University

In 2006, Prof. Dr. Yuhai Jiang graduated from Free University Berlin, Germany. He has successively engaged in experimental and theoretical studies in atomic and molecular strong-field physics at the Max Planck Institute for Nuclear Physics in Heidelberg, Shanghai Advanced Research Institute of Chinese Academy of Sciences, and ShanghaiTech University. He has made a series of achievements in the fields of atomic and molecular physics at free electron lasers, ultrafast strong-field physics of cold atoms, and terahertz generation and application in nanomaterials.

Cold alkaline-earth atoms in the femtosecond strong laser filed

We developed, for the first time in the world, a magneto-optical trap reaction microscope (MOTREMI) for strontium atoms by combining multi-particle coincident detection with laser cooling technique. Present compact injection system enables the production of cold Sr atoms in three modes of 2D MOT beam, molasses and 3D MOT, providing adjustable densities and ratios of the ground state 5s2 ($^1S_0$) and the excited states 5s5p $^1P_1$ and 3PJ. The momentum resolution for coincident Sr^+ and e along the time-of-flight direction are achieved up to 0.12 a.u. and 0.02 a.u., respectively. Detecting complete vector momenta of two-electrons and recoil ions in coincidence display clearly dominating non-sequential above threshold double ionization and frustrated double ionization, paving a way for further investigation of two-electron correlation dynamics and multi-electron effects with alkaline-earth atoms.

Yingying Peng (彭莹莹)

Peking University

Yingying Peng is an assistant professor at the International Center for Quantum Materials, Peking University. She received her BS from Wuhan University in 2008 and PhD from the Institute of Physics, Chinese Academy of Sciences in 2013. She worked as a postdoc at the Polytechnic University of Milan and at the University of Illinois at Urbana-Champaign. Her research interests include studying the elementary excitations of correlated materials and the mechanism of unconventional superconductivity using advanced X-ray scattering methods. She has published more than 70 papers, including Science, Nature journals, Physical Review Letter, etc, with citations more than 5000 times.

Time-resolved resonant x-ray scattering study of charge and spin order dynamics

$Na_2Co_2TeO_6$ exhibits versatile magnetic transitions, manifesting 2D and 3D magnetic orders at distinct temperatures. Time-resolved studies of magnetism on ultrafast timescales offer the possibility to trace the evolution of magnetism and provide an exciting opportunity for ultrafast optical manipulation of magnetic order. Using time-resolved resonant X-ray scattering, we uncover the magnetic dynamics in$Na_2Co_2TeO_6$. Our results unambiguously demonstrate that light excitation can suppress spin order in a nonthermal way while barely perturbing structural order. Intriguingly, the decay time extends beyond several tens of picoseconds, while the recovery time reaches several nanoseconds, notably longer than observed in other magnetic materials. Our results underscore the potential of time-resolved resonant X-ray scattering for probing small spin gaps that conventional techniques find challenging to access.

Charge orders (CO) are considered a significant competitor of high-temperature superconductivity in underdoped cuprates. In contrast, overdoped cuprates have traditionally been viewed as conventional Fermi liquids without collective electronic order. Determining the extent of CO across different doping and temperature ranges can help disentangle the relationship between superconductivity, pseudogap, and CO phases, which is critical to understanding high-temperature superconductivity. We have employed time-resolved resonant X-ray scattering to examine CO dynamics on heavily overdoped cuprates. We found that the charge order dynamics were distinct from those observed in underdoped cuprates under 800 nm and 400 nm laser pumps, suggesting that the origins of CO in underdoped and overdoped cuprates differ from each other.

Hui Li（李辉）

East China Normal University

Dr. Hui Li has obtained her PhD from Max Planck Institute for Quantum Optics (MPQ) and Ludwig Maximilian Univeristy of Munich (LMU), Germany, within the group of attosecond science leaded by Prof. Ferenc Krausz (The Nobel Physics Prize winner in 2023). She joined the State Key Laboratory of Precision Spectroscopy at East China University in 2016. Her current research interests lie in the ultrafast dynamics in molecular, nano- and micro-systems. She has developed various advanced techniques on ultrafast light field manipulation and high-precision time-resolved measurements. She is one of the recipients of the Women in Ultrafast Science Global Award (2024).

Femtosecond dynamics of room-temperature polariton condensation

Study on ultrafast dynamics is an important foundation for revealing microscopic physical mechanisms and achieving effective property control. Focusing on the ultrafast dynamics of microcavity exciton polariton (EP) condensates at room temperature, we have developed the femtosecond angle-resolved spectroscopic imaging (FARSI) techinique which enables multidimensional, time-resolved measurements of photoluminescence with femtosecond resolution. We have investigated the ultrafast dynamics of macroscopic quantum states of EP condensates, revealed the formation, relaxation and parametric scattering dynamics of the condensates under non-resonant excitation [1,2] and observed the bosonic cascading dynamics in EPs [3]. Further, we have proposed novel schemes based on precision control in the temporal domain to achieve ultrafast polariton device functionalities. We have achieved femtosecond switching in room-temperature polariton BEC with ultra-high extinction ratio based on manipulating the parametric process of the photonic part in EPs [4]. A full set of polaritonic logical gates including AND, OR, and NOT gates have been realized through temporal manipulation on the localized polariton condensate [5]. Our work allows for revealing the novel mechanisms of room-temperature polariton condensation and manipulating the fundamental processes in strongly coupled systems, which will be beneficial towards basic studies and potential applications of polariton systems.

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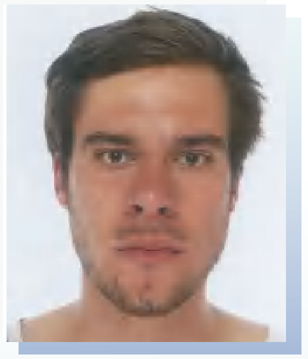


Fabian Scheiba

Uni Hamburg, DESY

Fabian Scheiba studied Physics at the University of Oldenburg and finished his B.Sc. on the topic of THz based electron acceleration at CFEL/DESY in 2013. After an internship at Akustikbüro K5 GmbH and studies at TU Berlin, he changed to University of Hamburg for the Master degree. Within his Master studies he spent the winter term 15/16 in Paris at university Paris-Sud and finished with his thesis on two-dimensional spectral shearing interferometry, a method to characterize ultrashort laser pulses in the group of Franz X. Kärtner. In November 2017 he continued in the group of Franz X. Kärtner as PhD student with focus on pulse characterization, waveform synthesis and High Harmonic Generation for attosecond science. After finalizing the waveform synthesis and attosecond beamline, he is continuing his PostDoc on the development of attosecond pump-probe experiments.

Attosecond Pulse Generation in the Water Window using a Parametric Synthesizer with Sub-Cycle Optical Waveforms

With ultra-broadband waveform synthesis, we target the advancement of isolated attosecond pulse (IAP) generation via High Harmonic Generation from sub-cycle driving pulses and an improvement of the IAP yield by controlling the pump pulses' electric field transients. We demonstrate a direct link between the non-sinusoidal, 2.8 fs infrared driving pulse and the generated HHG continua. Advanced in-situ pulse characterization techniques allow us to run detailed simulation in order to explain the HHG emission for every half cycle of the driving field and to decouple single-atom from macroscopic phase matching effects. After all, our current implementation of the parametric waveform synthesizer spans from 650 nm to 2200 nm, that is used to drive HHG with photon energies up to 450 eV. We observe an yield increase of a factor fo x10 when compared to few cycle sinusoidal IR pulses at comparable energy.

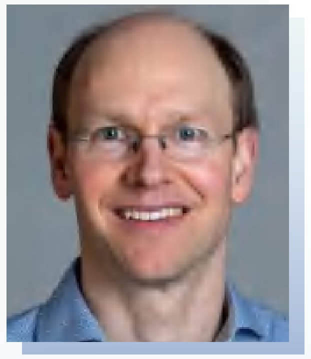
Jun Zhang (张俊)

Institute of Semiconductors, CAS

Zhang Jun, is a professor at the Institute of Semiconductors, Chinese Academy of Sciences, and the University of Chinese Academy of Sciences. He has made a series of original achievements in semiconductor optical refrigeration, exciton phonon coupling, spin phonon coupling, etc., and has published more than 120 academic papers in journals including Nature, Nature Photonics, Nature Communications, etc., which have been cited more than 10,000 times, with an H-factor of 48. In 2015, he was selected into the National Overseas High-level Young Talent Program, in 2018, he was funded by the Beijing Outstanding Youth Fund, and in 2021, he won the Young Scientist Award for Nano Research.

Spin-charge-lattice interaction in 2D materials

Phonon is the element-excitation of lattice vibration in solids, and the interaction between phonon and other degrees of freedom has a very important impact on the electron transport, optical response, and thermal conduction of materials. As the dimension decreases, the effects of phonon physics and electro-phonon coupling on device performance are more significant. In this report, we introduce our recent research progress in the detection and regulation of phonon-electron, defect, and spin interactions in low-dimensional semiconductors, including phonon-exciton coupling, phonon-spin coupling, and laser cooling of phonons.



Gregory Fiete

Northeastern University

Gregory A. Fiete is a Professor of Physics at Northeastern University in Boston, Massachusetts. He received his PhD in physics from Harvard University, and did postdoctoral work at the Kavli Institute for Theoretical Physics at UC Santa Barbara. He was a Lee A. DuBridge Prize Fellow in Theoretical Physics at Caltech. He is a recipient of the NSF CAREER Award, the DARPA Young Faculty Award, a DARPA Director's Fellowship, the Presidential Early Career Award for Scientists and Engineers (PECASE), a Simons Fellowship in Theoretical Physics, and a Bessel Research Award from the Alexander von Humboldt Foundation. He is an elected Fellow of the American Physical Society.

Nonlinear optical probing and control of magnetic and electronic quantum geometry

Illuminating a material with light can reveal both interesting aspects of electronic and lattice degrees of freedom, as well as drive phase and topological transitions in the material itself. In this talk, I will focus on three distinct responses of a material to light: (1) Nonlinear phononic control of magnetism in bilayer CrI3, MnBi2Te4, and MnSb2Te4. (2) The non-linear photogalvanic response of Weyl semimetals with tilted cones and chiral charge up to 4, and (3) The nonlinear optical response of the topological superconductor candidate 4Hb-TaS2 and ABC stacked rhombohedral trilayer graphene. I will review relevant experimental results before turning to the theory and conclude the talk with an outlook on outstanding problems in light-matter interaction in quantum materials.

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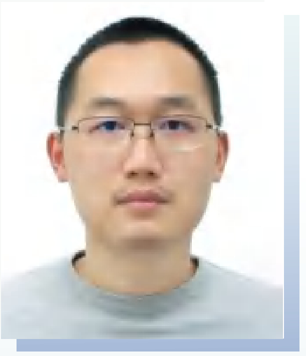
Tao Dong (董涛)

Peking University

Tao Dong is now a research associate professor at the International Center for Quantum Materials, Peking University. He got his Ph.D. from the Institute of Physics (IOP), Chinese Academy of Science, in January 2014. Then he worked in Prof. Nanlin Wang's group as a research associate. One year later, he moved to Peking University. During 2018.07-2020.03, he did this postdoc research in Prof. Jure Demsar's lab at the Mainz University in as a Humboldt postdoctoral fellow.

Dynamic interaction between Pseudogap and Superconductivity in Cuprates revealed by THz nonlinear spectroscopy

The superconducting (SC) state can be described by a complex order parameter with spontaneously broken U(1) symmetry, whose free energy is given by the Mexican hat potential. The advent of a strong field terahertz (THz) source enables the detection of the Higgs mode of the superconductivity order parameter either with a free oscillation in a monocycle THz quenching or with a forced oscillation in a multicycle driving. The Higgs modes of superconductivity also can serve as a sensor for studying the interaction between the superconductivity and exotic orders in unconventional superconductors. In this talk, I will present our recent work on Higgs mode detection and its interaction with the pseudogap phase in cuprate superconductors by THz nonlinear spectroscopy.



Jiyu Xu (徐纪玉)

Institute of Physics, CAS

Jiyu Xu is an associate professor at the Institute of Physics, Chinese Academy of Sciences and the Attosecond Science Center of Songshan Lake Materials Laboratory. He received a B.S. degree from Beijing Normal University and a Ph.D. degree from the Institute of Physics, Chinese Academy of Sciences, then he continues to work as a postdoctoral researcher and research assistant in Chinese Academy of Science. His research focuses on first-principles simulations of complex systems and non-equilibrium processes, such as photoinduced nonequilibrium electronic and lattice dynamics in condensed matter systems, charge transfer and molecular transport at heterogeneous interfaces.

Photoinduced ultrafast nonequilibrium dynamics in liquid water

Understanding photoexcitation dynamics in liquid water is of crucial significance for both fundamental scientific explorations and technological applications. However, the ultrafast nonequilibrium dynamics are hard to track due to extreme complexity of laser-water interaction and the ultrafast timescale. In this talk, I will present the theoretical simulations of photoinduced nonequilibrium electronic and structural dynamics in liquid water, including water plasma generation, high-harmonic generations and hydrogen productions. I) The photoinduced water plasma generations are observed in experimental measurements, while the the initial atomistic movements and associated energy transfer pathways following laser irradiation are still unclear. We found that intense laser pulses violently excite liquid water and lead to severe molecular dissociation and plasma generation during the laser pulses. The laser-induced water plasma is characterized by a high fraction of free protons (~50%), nonequilibrium ionic and electronic distributions and a metallic electronic density of states. II) The oscillating electric fields also drive the periodic oscillations of electronic currents in liquid water, and the extreme nonlinear processes give rise to the high-harmonic generations (HHG) in liquid systems. Especially, the photoinduced water plasma generation can be directly tracked via time-resolved HHG with a femtosecond resolution. The plasma generation leads to the decrease of cutoff energy E_c and enhanced decoherence in HHG. III) The water plasma in warm-dense state constitutes a superior reaction environment for hydrogen production, and the cooling of water plasma is demostrated to lead to the generation of various molecules, e.g., H_2, O_2, and H_2O_2 molecules. Annealing rate and laser wavelength are shown to modulate the product ratio, and the energy conversion efficiency can reach ~9.2% with an annealing rate of 1.0 K/fs.

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