



上海交通大學
SHANGHAI JIAO TONG UNIVERSITY



Key Laboratory for Laser Plasmas
Shanghai Jiao Tong University
Joint Seminar on Ultrafast Science

PROGRAM

2025.05.07





General Information

1. Time and Location

Time: 2025.05.07, 9:00-19:00 (All program times are in Beijing Time)

Location: Shanghai Jiao Tong University, No.2 Physics building, Room 402

2. Transportation Schedule

Guests:

- Prof. Kiyoshi Ueda
- Prof. Alexander Kuleff
- Prof. Marcus Dahlström

Morning Pickup:

- Time: 7:30 AM (2025/05/07)
- Location: ShanghaiTech University
- Destination: Shanghai Jiao Tong University

Evening Drop-off:

- Time: 7:00 PM (2025/05/07)
- Location: Shanghai Jiao Tong University
- Destination: ShanghaiTech University

Coordinator: Hui Jiang

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Program Overview

Wednesday, May 07

No.2 Physics building, Room 402, Shanghai Jiao Tong University.

9:00 - 9:10	Opening Ceremony • Feng He
9:10 - 10:10	Catching and steering electrons in action by light • Kiyoshi Ueda
10:10 - 11:10	Ultrafast non-adiabatic charge dynamics in molecules initiated by ionization or excitation • Alexander Kuleff
11:10 - 12:10	Progress on Attosecond time-delays in Photoionization • Marcus Dahlström
12:10 - 14:00	Group Photo • Lunch
14:00 - 15:00	Coherent control of atomic ionization in strong laser fields • Feng He
15:00 - 16:00	Ultrafast dynamics of strong-field ionization • Hongcheng Ni
16:00 - 17:00	High order harmonics generation from plasma surface irradiated by relativistic laser pulses • Feng Liu
17:00 - 19:00	Dinner

Catching and steering electrons in action by light

Kiyoshi Ueda

Abstract: The natural time scale of electrons in action is of the order of attoseconds (1 as=10⁻¹⁸ s). Recent developments of generating attosecond pulses both in the laboratories and free electron laser facilities make an intangible dream of watching electrons in action a tangible reality. The Nobel prize of physics in 2023 was awarded to this field of attosecond science. Generations of isolated attosecond pulses in the soft X-ray regime at LCLS in the USA opens a new route to measure molecular core-level photoionization time delays that occurs in the attosecond timescale [1]. Generations of two-colour attosecond pulses at LCLS opened the door to watch the electron (charge) in action in a molecule that occurs in the attosecond timescale [2]. Generating phase-coherent multi-colour pulses at FERMI, on the hand, provided a novel approach to coherently control the electronic wave-packet [3] and to read out the photoionization phase, or attosecond photoionization time delay [4]. The talk will also address the titled study with laboratory attosecond pulse train light sources, complementary to FELs, combined with combined with REMI/COLTRIMS [5,6,7]. I acknowledge all the collaborators in the authors list of [1-7] for fruitful collaborations.

[1] T. Driver *et al.* **Nature** 632, 762 (2024); J.-B. Ji *et al.* <https://arxiv.org/abs/2402.17685>

[2] T. Barillot *et al.* **PRX** 11, 031048 (2021); <https://arxiv.org/abs/2411.01700>

[3] K. Prince *et al.* **Nat. Photon.** 10, 176 (2016); D. lablonskyi *et al.* **PRL** 119, 073203 (2017); D. You *et al.* **New J. Phys.** 21, 113036 (2019).

[4] M. Di Fraia *et al.* **PRL** 123, 213904 (2019); D. You *et al.* **PRX** 10, 031070 (2020).

[5] X. Gong *et al.* **PRX** 12, 011002 (2022); W. Jiang *et al.* **Nat. Comm.** 13, 5072 (2022); **Nat. Comm.** 16, 381 (2025).

[6] M. Han *et al.* **Nat. Phys.** 19, 230 (2023); **Optica** 10, 1044 (2023); **Nat. Photon.** 18, 311 (2024); **Sci. Adv.** 10, eadj2629 (2024); **Ultrafast Sci.** (in press).

[7] J. Ji *et al.* **New. J. Phys.** 26, 093014 (2024); **J. Phys. B: At. Mol. Opt. Phys.** 57, 235601 (2024).

Author Biography: Professor Kiyoshi Ueda is an Emeritus Professor at Tohoku University, Japan, and a Visiting Professor at ShanghaiTech University. He earned his Ph.D. from Kyoto University in 1982 and held various academic positions at Tohoku University, including Professor from 2003 to 2020. His research focuses on electronic states and molecular structure dynamics in quantum systems, covering ultrafast molecular dynamics imaging, electron wavepacket dynamics, photoionization control, and novel spectroscopic techniques. He has published over 660 papers, including 2 in Nature, 6 in Nature Photonics, and 54 in PRL, with over 15,000 citations and an h-index of ~57. Recognized as a leading expert in atomic, molecular, and optical physics, he has delivered around 170 invited and keynote talks at international conferences.

Ultrafast non-adiabatic charge dynamics in molecules initiated by ionization or excitation

Alexander Kuleff

Abstract: When molecules are exposed to ultrashort laser pulses, multiple electronic states can be coherently populated, triggering intricate ultrafast dynamics where electronic and nuclear motions are strongly coupled. The interplay between purely electronic charge migration and subsequent non-adiabatic dynamics leads to a rapid redistribution of charge within the system, ultimately shaping its long-term structural evolution. In this talk, I will present fully quantum simulations of ultrafast charge dynamics initiated by both ionization and excitation of polyatomic molecules. I will also discuss how these dynamics can be traced using attosecond transient-absorption spectroscopy. Key examples will highlight decoherence and coherence revival, as well as the transfer of electronic coherence through conical intersections. Additionally, I will explore the potential for laser control of electron-coherence times, offering new possibilities for steering charge migration in complex molecular systems.

Author Biography: Professor Alexander Kuleff is a Professor at Universität Heidelberg, Germany, specializing in ultrafast electron dynamics following ionization. He obtained his Ph.D. in Theoretical Physical Chemistry from Université Pierre et Marie Curie, Paris, and later conducted postdoctoral research as an Alexander von Humboldt Fellow at Heidelberg University. His career includes leadership roles in the Theoretical Chemistry department and the Heidelberg Center for Quantum Dynamics, as well as the Attosecond and Strong Field Science Division at ELI-ALPS. He has published over 100 research papers, including 1 in Nature, 2 in Nature Physics, 15 in PRL, and 9 in Nature Communications, and has delivered over 75 invited talks and lectures at international conferences and schools. His contributions to theoretical attosecond science and quantum dynamics have been widely recognized, earning him prestigious awards such as the Alexander von Humboldt Fellowship and the Promising Scientist Prize of CMOA, France.

Progress on attosecond time-delays in photoionization

Marcus Dahlström

Abstract: Attosecond pulses from high-order harmonic generation can be used to study photoionization dynamics in atoms, molecules and solids. In particular, electron-electron correlation effects can be studied in the time domain. This opens up for determination of previously unattainable scattering phases in atoms. In this seminar, various theoretical efforts will be reviewed, including the strong-field approximation [based on *Keldysh–Faisal–Reiss* (KFR) theory] for laser-assisted photoionization, the asymptotic approximation [based on *Wentzel–Kramers–Brillouin* (WKB) theory] for continuum–continuum transitions, and systematic approaches for many-body correlation effects [based on diagrammatic *Rayleigh–Schrödinger* perturbation theory]. Highlights of the seminar will include the description of Wigner delays in photoionization of neon 2s and argon 3s orbitals in space and time.

Author Biography: Dr. Jan Marcus Dahlström is a Senior Lecturer at the Mathematical Physics Division, Lund University, Sweden, specializing in attosecond light-matter interactions. He obtained his Ph.D. in Atomic Physics from Lund University in 2011, under the supervision of Prof. Anne L' Huillier, and has held research positions at Stockholm University and CFEL in Hamburg. His work focuses on high-order harmonic generation, photoionization time delays, nonlinear photoionization dynamics, and strong-coupling effects. A Wallenberg Academy Fellow since 2019, he has also been awarded a Swedish Foundations' Starting Grant and holds the title of Associate Professor at Lund University. With 59 peer-reviewed publications and over 4,500 citations, his contributions to attosecond science are widely recognized.

Coherent control of atomic ionization in strong laser fields

Feng He

Abstract: We explore anomalous photoelectron angular distributions in the resonance-enhanced multiphoton ionization of argon driven by intense ultraviolet laser fields. Utilizing the multi-configurational time-dependent Hartree-Fock theory, we reveal a synergy between two ionization pathways, wherein the exchange of orbital angular momentum between the photoelectron and the residual ion is prominent. Quantum interference between these pathways governs the photoelectron angular distribution through phase-dependent modulation of the probability for the photoelectron to carry zero or nonzero angular momentum projection, leading to striking deviations from conventional ionization patterns. Based on this mechanism, we further design a novel strategy for dynamically manipulating quantum entanglement in photoionization processes by employing resonance-enhanced (2+1') multiphoton ionization of argon atoms with two time-delayed ultraviolet pulses.

Author Biography: Professor Feng He is a Distinguished Professor at Shanghai Jiao Tong University (SJTU) and the Executive Vice Dean of Zhiyuan College. He obtained his Ph.D. from the Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences in 2005 and conducted postdoctoral research at the Max Planck Institute in Germany and Kansas State University in the U.S. before joining SJTU in 2010. His research focuses on the interaction between ultrashort laser pulses and atoms and molecules, and he has published over 100 SCI papers. He has received numerous honors, including the National Science Fund for Distinguished Young Scholars and leadership roles in China's National Key R&D Programs. Additionally, he has been recognized with Shanghai's Pujiang Talent Program, the Baogang Outstanding Teacher Award, and SJTU's Teaching Excellence Awards.

Ultrafast dynamics of strong-field ionization

Hongcheng Ni

Abstract: We explore ultrafast electron dynamics during strong-field ionization. In above-threshold ionization, we establish a general framework for photon momentum transfer covering an arbitrary number of absorbed photons, and show that with each additional photon absorbed, the photoelectron acquires on average twice the momentum of the absorbed photon [1]. In tunneling ionization, we establish a conservation law between angular momentum and energy that is applicable down to the subcycle level [2]. Making use of this conservation law, we find that the electric field drives the quantum tunneling process, while the vector potential governs the subsequent continuum motion [3]. We further find that the saddle-point approximation needs a revision for atomic p orbitals [4]. In addition, we explore the tunneling time delay across different characteristic timescales. Our study reveals that when the probe timescale exceeds the characteristic timescale of the system, tunneling time delay is negligible. Conversely, for probe timescales shorter than the characteristic timescale of the system, a finite tunneling time delay results [5]. In over-barrier ionization, we realize its time resolution for the first time. We find that the transition from tunneling to over-barrier ionization depends not only on the field strength but also on the initial transverse momentum of the outgoing electron [6].

[1] X. Mao, et al., Nature Communications (under review).

[2] Y. Ma, H. Ni, Y. Li, F. He, and J. Wu, Ultrafast Science 4, 0071 (2024).

[3] Y. Ma, X. Mao, L. Kong, Q. Liu, H. Ni, and J. Wu, Physical Review A 111, 033103 (2025).

[4] X. Mao, K. Liu, H. Ni, and J. Wu, Physical Review A 111, 033113 (2025).

[5] J. Wang, et al., (in preparation).

[6] Y. Ma, Q. Liu, H. Ni, and J. Wu, Physical Review Letters (under review).

Author Biography: Professor Hongcheng Ni is a Research Professor at the State Key Laboratory of Precision Spectroscopy, East China Normal University, specializing in strong-field and ultrafast physics. He obtained his Ph.D. from the University of Colorado, Boulder, and conducted postdoctoral research at the Max Planck Institute for the Physics of Complex Systems in Germany (as a Humboldt Fellow) and TU Vienna (as a Meitner Fellow) before joining East China Normal University in 2019. His research focuses on strong-field ionization dynamics, attosecond time delays, and ultrafast molecular interactions, and he has received prestigious awards such as the National Overseas Excellent Young Scientist Program and the Shanghai Science&Technology 35 Under 35 Award. He has authored over 40 peer-reviewed papers, including publications in Nature Communications, Physical Review Letters, and Physical Review X.

High order harmonics generation from plasma surface irradiated by relativistic laser pulses

Feng Liu

Abstract: The generation of high-order harmonics by the interaction of relativistic lasers with solid targets offers an alternative approach to producing coherent short-wavelength radiation and attosecond pulses. This method can overcome the limitations on laser intensity imposed by harmonic generation from laser-gas interactions, making it possible to achieve coherent radiation with higher energy and shorter pulse durations. The pre-plasma density distribution plays a critical role in determining the generation efficiency and spatiotemporal characteristics of high-order harmonics. In this presentation, I will discuss our studies on high-order harmonic generation using relativistic plasma mirrors with the 200 TW laser system at SJTU. Specifically, we investigate the influence of plasma density distribution on the high-order harmonic generation process by optically shaping the plasma surface.

Author Biography: Professor Feng Liu is a Research Professor at the School of Physics and Astronomy, Shanghai Jiao Tong University, specializing in laser-plasma physics. He obtained his bachelor's degree from the University of Science and Technology of China in 2004 and his Ph.D. from the Institute of Physics, Chinese Academy of Sciences in 2010. From 2010 to 2012, he conducted postdoctoral research at the Institute for Laser and Plasma Physics, University of Düsseldorf, Germany, before joining Shanghai Jiao Tong University in 2012. His research focuses on high-power ultrashort intense laser technology, strong laser-driven ultrafast extreme ultraviolet/X-ray radiation, high-energy particle sources, and high-harmonic generation, contributing to advancements in laser-plasma interactions and ultrafast optics.