ICAP2026 Summer School

The 29th International Conference on Atomic Physics

Summer School

Program Handbook

Organized by:
Innovation Academy for Precision Measurement Science and Technology
Chinese Academy of Sciences
June 10-13, 2026

中国科学院精密测量科学与技术创新研究院
INNOVATION ACADEMY FOR PRECISION MEASUREMENT SCIENCE AND TECHNOLOGY, CAS

Summer School Overview

The 29th International Conference on Atomic Physics (ICAP29) Summer School will be held at the Innovation Academy for Precision Measurement Science and Technology (APM) in Wuhan, China, from June 10 to 13, 2026 (registration on June 10, summer school starts June 11).

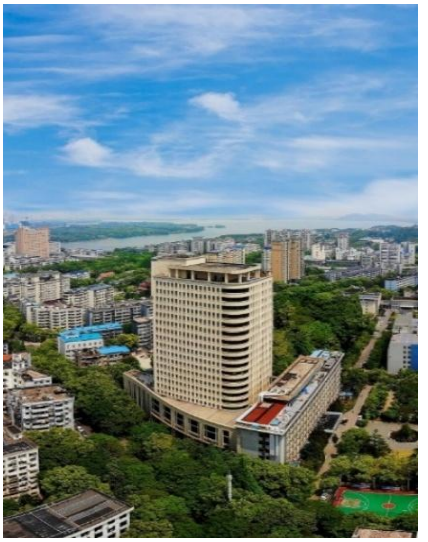
This summer school aims to systematically introduce students to several frontier and active research areas in contemporary atomic, molecular, and optical (AMO) physics, covering both experimental and theoretical topics including ultracold atoms, cavity QED systems, lattice models, impurity problems, quantum field theory, precision measurements, quantum information, and integrable models.

Innovation Academy for Precision Measurement Science and Technology, Chinese Academy of Sciences

The Innovation Academy for Precision Measurement Science and Technology (APM) of the Chinese Academy of Sciences (CAS) was established through the merger of the Wuhan Institute of Physics and Mathematics (founded in 1958) and the Institute of Geodesy and Geophysics (founded in 1957), both under CAS. With approval from CAS, the construction of APM began in September 2017, and following authorization by the State Commission Office of Public Sectors Reform (SCOPSR), APM was officially founded in April 2019.

The establishment of APM marks an important step by CAS in carrying out the "Pioneer Initiative" and advancing the development of a robust science and technology management system in China. Rooted in precision measurement science and technological innovation, APM is dedicated to meeting the nation’s critical needs.

APM conducts cutting-edge, cross-disciplinary research in areas such as atomic and molecular precision measurement physics, magnetic resonance, geodesy and geophysics, and mathematical computation. The academy actively promotes the development of disciplines centered on atomic frequency standards, atomic interferometry, magnetic resonance, gravity measurement, seismic detection, and other precision measurement technologies. Through these efforts, APM has formed three major research directions: precision atom, precision molecule, and precision earth.



Summer School Local Organizing Committee

Convener: Xi-Wen Guan (xwe105@wipm.ac.cn)

Committee Members:

●Yanping Zhu (ypzhu@wipm.ac.cn)

●Xuxia Cai (caixuxia@wipm.ac.cn)

●Yuzhu Jiang (jiangyuzhu@wipm.ac.cn)

●Min Liu (mliu@wipm.ac.cn)

Summer School Website

https://www.icap29.com/summer-school-1.html

General Information

Summer School Venue

The summer school venue is located inside Atour Hotel.
Venue: Conference Room (共语厅), 11th Floor, Atour Hotel.

Welcome to visit the Innovation Academy for Precision Measurement Science and Technology, Chinese Academy of Sciences (APM CAS, 中国科学院精密测量科学与技术创新研究院). Please refer to the map below for the location of Main Building M.

Registration and Accommodation

Registration:
The registration desk will be open at the Atour Hotel Wuhan University Bayi Road during 14:00-21:00, June 10, 2026. You can also register outside the workshop venue during June 11-13.
Accommodation:
Accommodation has been reserved for the invited speakers and some participants according to their registration information at:
Atour Hotel Wuhan university Bayi Road. Address: Floor 1 and 7-11, No. 102, Bayi Road, Wuchang District, Wuhan City, Hubei Province, Wuchang District, Wuhan, Hubei, China (武汉市武昌区八一路 102 号嘉嘉悦大厦)

Program at a Glance

June 10		June 11	June 12	June 13
	9:00-9:45	**H. Müller (1)**	**Hui Zhai (1)**	**A. Smerzi (1)**
	10:00-10:45	**H. Müller (2)**	**Hui Zhai (2)**	**A. Smerzi (2)**
	11:00-11:45	**A. Browaeys (1)**	**Hui Zhai (3)**	**A. Smerzi (3)**
14:00-21:00 Local Registration (at Atour Hotel)	**14:30-15:15**	**H. Müller (3)**	**H.-C. Nägerl (1)**	**D. Vasilyev (1)**
	15:30-16:15	**A. Browaeys (2)**	**H.-C. Nägerl (2)**	**D. Vasilyev (2)**
	14:30-17:15	**A. Browaeys (3)**	**H.-C. Nägerl (3)**	**D. Vasilyev (3)**

Program

June 10			
14:00-21:00		Local Registration (at Atour Hotel)	
June 11, AM			
9:00-9:45	**Holger Müller**	TBA	UCB USA
9:45-10:00		Tea break	
10:00-10:45	**Holger Müller**	TBA	UCB USA
10:45-11:00		Tea break	
11:00-11:45	**Antoine Browaeys**	Arrays of Atoms for Q Simulation & Computing (1)	CNRS France
June 11, PM			
14:30-15:15	**Holger Müller**	TBA	UCB USA
15:15-15:30		Tea break	
15:30-16:15	**Antoine Browaeys**	Arrays of Atoms for Q Simulation & Computing (2)	CNRS France
16:15-16:30		Tea break	
16:30-17:15	**Antoine Browaeys**	Arrays of Atoms for Q Simulation & Computing (3)	CNRS France
June 12, AM			
9:00-9:45	**Hui Zhai**	Quantum Thermalization, Chaos and Information Scrambling (1)	THU China
9:45-10:00		Tea break	

10:00-10:45	**Hui Zhai**	Quantum Thermalization, Chaos and Information Scrambling (2)	THU China
10:45-11:00		Tea break	
11:00-11:45	**Hui Zhai**	Quantum Thermalization, Chaos and Information Scrambling (3)	THU China
June 12, PM			
14:30-15:15	**Hanns-Christoph Nägerl**	TBA	UIBK Austria
15:15-15:30		Tea break	
15:30-16:15	**Hanns-Christoph Nägerl**	TBA	UIBK Austria
16:15-16:30		Tea break	
16:30-17:15	**Hanns-Christoph Nägerl**	TBA	UIBK Austria
June 13, AM			
9:00-9:45	**Augusto Smerzi**	Quantum Phase Estimation and Interferometry	SZTU China
9:45-10:00		Tea break	
10:00-10:45	**Augusto Smerzi**	Fisher Information and Quantum Limits	SZTU China
10:45-11:00		Tea break	
11:00-11:45	**Augusto Smerzi**	Entanglement as a Useful Resource	SZTU China
June 13, PM			
14:30-15:15	**Denis Vasilyev**	Variational Quantum Metrology Beyond Spin Squeezing: From Programmable Sensors to Quantum Tests of Gravity (1)	UIBK Austria
15:15-15:30		Tea break	
15:30-16:15	**Denis Vasilyev**	Variational Quantum Metrology Beyond Spin Squeezing: From Programmable Sensors to Quantum Tests of Gravity (2)	UIBK Austria
16:15-16:30		Tea break	
16:30-17:15	**Denis Vasilyev**	Variational Quantum Metrology Beyond Spin Squeezing: From Programmable Sensors to Quantum Tests of Gravity (3)	UIBK Austria

Antoine Browaeys (CNRS, France)

Antoine Browaeys is a Senior Staff Scientist at CNRS. He works in the Charles Fabry laboratory at the Institut d'Optique. He is working on experiments manipulating Individual Cold Atoms and Small, Dense Atomic Clouds. Part of his research led to the creation of the Pasqal company, that he is a co-founder and scientific adviser of. He was awarded the Aimé Cotton Prize of the French Physical Society in 2007 and the Silver medal of CNRS in 2021. He was elected member of the French Academy of Sciences in December 2023.

Tile: Arrays of Atoms for Q Simulation & Computing

Abstract:

Lecture 1: Arrays of atoms in optical tweezers, Rydberg atoms and Interactions between atoms.

Lecture 2: Rydberg blockade, Quantum computing with Rydberg atoms and Quantum simulation (1): from Rydberg interactions to spin models and more.

Lecture 3: Quantum simulation (2): spin models in and out-of-equilibrium… and beyond.

Holger Müller (University of California, Berkeley, USA)

Holger Müller is a Professor of physics at the University of California, Berkeley. His research focuses on advancing atomic, molecular, and optical (AMO) physics to probe nature with the highest sensitivity. His group conducts pioneering work in areas such as atom interferometry—using atomic waves for precision measurements of gravity, fundamental constants, and tests of quantum physics, including ongoing contributions to NASA's space-based atomic physics initiatives. He also explores novel laser applications in cryo-electron microscopy to image biological structures at high resolution. As a dedicated researcher and educator, he is committed to training the next generation of scientists through rigorous, curiosity-driven inquiry.

Hanns-Christoph Nägerl (University of Innsbruck, Austria)

Hanns-Christoph Nägerl is the Director of the Institute for Experimental Physics of the University of Innsbruck. His research focuses on the fundamentals of quantum science and its applications to quantum technologies, including quantum state engineering, quantum gases and fluids, many-body quantum physics, non-equilibrium quantum phenomena, quantum simulation, quantum computation, quantum transport, ultracold molecules, dipolar quantum gases, low-dimensional quantum systems, and quantum state control. He has been awarded numerous prizes, including the Rudolf Kaiser Prize (2010), an ERC Consolidator Grant (2011), the prestigious Wittgenstein Award (2017), and an ERC Advanced Grant (2018).

Augusto Smerzi (Shenzhen Technology University, China)

Professor Augusto Smerzi is a chair professor at the College of Engineering Physics, Shenzhen Technology University, China. He has long been engaged in fundamental research on quantum metrology, entanglement theory and quantum parameter estimation. He has made pioneering contributions to the theory of quantum phase estimation, as well as to the characterization of many-body entanglement and ultimate measurement precision using Fisher information. His research covers cutting-edge directions such as nonlinear and distributed interferometers, quantum sensing networks, and the dynamics of coherent matter waves, which has played an important role in advancing the development of the quantum precision measurement field.

Title: Entanglement Enhanced Sensing and Metrology

Abstract:

These lectures introduce the theory of quantum-enhanced sensing and metrology. Within a quantum information perspective and language, we first discuss how a physical signal is encoded as a phase in a Mach-Zehnder interferometer and how this phase is estimated from measurement data. We then introduce Fisher information and the quantum limits to sensitivity. Finally, we explain why entanglement can improve precision and how to characterize useful metrological entanglement.

Lecture 1: Quantum Phase Estimation and Interferometry

Abstract:

This lecture introduces the basic problem of quantum phase estimation. A physical signal, such as a field or a force, is encoded as a phase shift in an interferometer. The aim is to estimate this phase with the smallest possible uncertainty. I will discuss the Mach-Zehnder interferometer and the basic ideas of measurement probabilities, estimators, and sensitivity.

Lecture 2: Fisher Information and Quantum Limits

Abstract:

This lecture introduces Fisher information as the quantity that tells us how much information measurement data contain about an unknown parameter. I will derive the Cramer-Rao bound and its generalizations.

Lecture 3: Entanglement as a Useful Resource

Abstract:

This lecture explains why entanglement can improve precision measurements. Entangled states can become more distinguishable than separable states under the same phase shift, leading to sensitivities beyond the standard quantum limit. I will discuss spin squeezing, Heisenberg scaling, and quantum Fisher information as a witness of multipartite entanglement.

Denis Vasilyev (University of Innsbruck, Austria)

Dr. Vasilyev's research explores how quantum mechanics can be harnessed to measure the physical world with unprecedented precision. Working at the intersection of quantum optics, quantum metrology, and quantum networks, He develops theoretical methods that use entanglement optimal measurements, and programmable quantum devices to push sensing beyond classical limits. A central theme of his work is the use of variational and information-theoretic approaches to design optimal quantum sensors—systems that adaptively learn how to prepare probe states and perform measurements to extract maximal information. These ideas are being explored in collaboration with experimental groups on platforms such as trapped ions and atomic ensembles.

Tile: Variational Quantum Metrology Beyond Spin Squeezing: From Programmable Sensors to Quantum Tests of Gravity

Abstract:

Quantum-enhanced sensing is often associated with spin squeezing, but the optimal sensor for a given task generally requires a tailored entangled state, a tailored measurement, and a cost function matched to the physical question. This lecture series presents variational quantum metrology as a systematic route to such task-specific sensors. We discuss how experimentally feasible quantum circuits can optimize Ramsey interferometry, atomic clocks, and programmable trapped-ion sensors close to fundamental limits. The course then moves beyond single-parameter sensing to multiparameter estimation, quantum compass protocols, and entangled measurements. The final part highlights quantum sensing networks based on entangled atomic ensembles and optical clock qubits as a platform for probing the interface of quantum mechanics and general relativity, including gravitational redshift, non-local mass superpositions, clock interferometry, and possible tests of gravitationally induced decoherence.

Hui Zhai (Tsinghua University, China)

Hui Zhai is a Professor at the Institute for Advanced Study, Tsinghua University, fellow of the American Physical Society (APS). His research focuses on quantum matter in cold atom and condensed matter systems. This mainly includes nonequilibrium dynamics of quantum matter, atom-array-based quantum computation, and quantum many-body physics in cold atom systems. He has predicted new quantum phases and phenomena, which have been experimentally verified, including the stripe phase. He was selected as an APS Fellow in 2022 for contributions to cold atom physics including spin-orbit coupled BEC, orbital Feshbach resonance, and scale invariant hydrodynamics.

Tile: Quantum Thermalization, Chaos and Information Scrambling

Abstract:

In this talk, I will introduce the connection between quantum chaos and information scrambling during quantum thermalization, and discuss recent developments in experimental measurements of the Lyapunov exponent in quantum many-body systems.