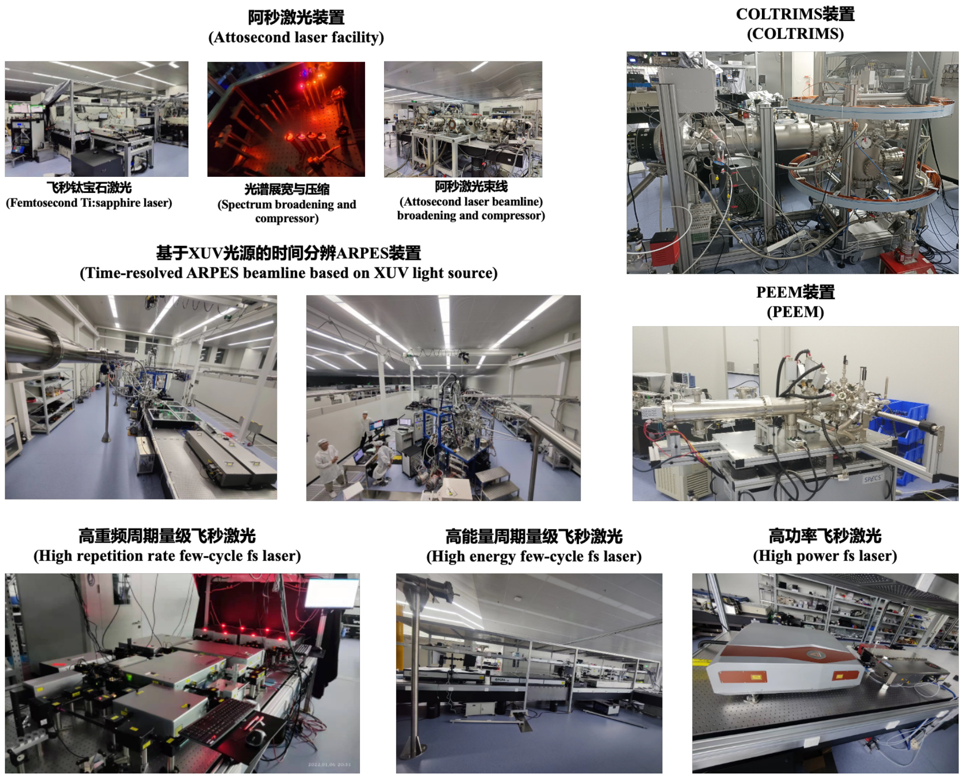
Attosecond dynamics experimental station

Attosecond dynamics experimental station is based on attosecond pulses and high harmonic generation (HHG) light source in the extreme ultraviolet (XUV) range in combination with photoelectron spectroscopy such as angle-resolved photoemission spectroscopy (ARPES), cold target recoil ion momentum spectroscopy (COLTRIMS), photoemission electron microscopy (PEEM) and time of flight spectrometer (TOF), as well as the extreme cryogenic condition. The station is capable of investigating electron ultrafast dynamics in atoms, molecules, surfaces and solids with high temporal resolution, momentum resolution, energy resolution and spatial resolution in order to understand and manipulate the microscopic and corresponding macroscopic phenomenon in physics, chemistry, biology and medicine. The station includes attosecond laser facility, time-resolved ARPES, time-resolved PEEM, time-resolved COLTRIMS, and four femtosecond lasers with different specifications.



Photos of the experimental station

The attosecond laser beamline consists of few-cycle driving laser, high harmonic generation, attosecond streak camera, attosecond time-resolved application and XUV spectrometer. The driving laser delivers 10 W, 23 fs, 10 kHz pulses. After hollow-core fiber and chirped mirror compressor, the laser pulses are compressed to sub-6-fs and the CEP stability of pulse is better than 400 mrad. The generated attosecond pulse duration is measured to be 86 as. It can also conduct time-resolved XUV attosecond pulse and IR femtosecond pulse pump-probe experimental studies using attosecond streaking camera.

The driving laser for attosecond laser system can be switched to COLTRIMS. The time-resolved COLTRIMS beamline is used to study the photoionization and dissociation in atoms and molecules. The supersonic cold target technique can provide high density, monochromatic, low dispersion gas target and increase the momentum resolution of the recoil ion. When the supersonic cold target is produced, femtosecond IR pulses and attosecond XUV pulses are coupled into the reaction chamber to interact with the target. The ionized electrons and ions are measured by the COLTRIMS. The momentum resolution of the setup is 0.03 a.u. for electrons and 0.04 a.u. for ions.

The time-resolved ARPES beamline uses high-repetition-rate HHG as the light source. The driving laser is seed with Yb fiber laser, the output parameters of the amplified laser are 280 W average power, less than 70 fs pulse and 100 kHz to 1 MHz tunable repetition rate. HHG at 16~30 eV is produced by interaction of the driving laser with Ar. The narrowband HHG as the probe are selected by a monochromator. The HHG and IR laser are focused on the sample to perform pump-probe experiment. The emitted photoelectron is collected by the energy analyzer. By tuning the delay between the XUV and IR pulse, time-resolved information can be achieved. The resolution of the setup is less than 150 fs in temporal domain and less than 50 meV in energy domain at 3.8 K temperature. It is suitable for the investigation of dynamic electron structure in Brillion zone of the quantum materials in condensed matter physics.

The time-resolved PEEM beamline utilizes HHG driven by 100 kHz, 10 W average power, 300 mrad CEP stability and 10 fs OPCA laser. The spatial resolution of the TOF-PEEM is 20 nm. The temporal resolution realized by the photoemission from XUV and IR two-photon pump-probe measurements, and makes it a prominent tool in the study of ultrafast process in surface physics.

Specification of Attosecond dynamics experimental station

Parameters	Specification	
Attosecond laser	Pulse duration	86 as
	Photon energy	70~100 eV
Time-resolved ARPES	Temporal resolution	< 150 fs
	Energy resolution	< 50 meV
	Lowest Temperature	3.8 K
	Photon energy	16~30 eV
	Repetition rate	400~500 kHz
PEEM	Spatial resolution	20 nm
COLTRIMS	momentum resolution(electron)	0.03 a.u.
	momentum resolution(ion)	0.04 a.u.
Few-cycle fs Ti:sapphire laser	Pulse energy	> 0.5 mJ
	Pulse duration	< 6 fs
	Repetition rate	10 kHz
	Central wavelength	800 nm
	CEP stability	< 400 mrad
High repetition rate fs laser	Pulse energy	~ 0.1 mJ
	Pulse duration	< 10 fs
	Repetition rate	100 kHz
	Central wavelength	800 nm
	CEP stability	< 300 mrad
High energy few-cycle fs laser	Pulse energy	7 mJ@800 nm, 10 mJ@2 μm
	Pulse duration	< 7 fs@800 nm, < 20 fs@2 μm
	Repetition rate	1 kHz
	Central wavelength	800 nm, 2 μm (Work independently or simultaneously)
	CEP stability	< 300 mrad
High power fs laser	Power	280 W
	Pulse duration	< 70 fs
	Central wavelength	1030 nm
	Repetition rate	500 kHz~1 MHz

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