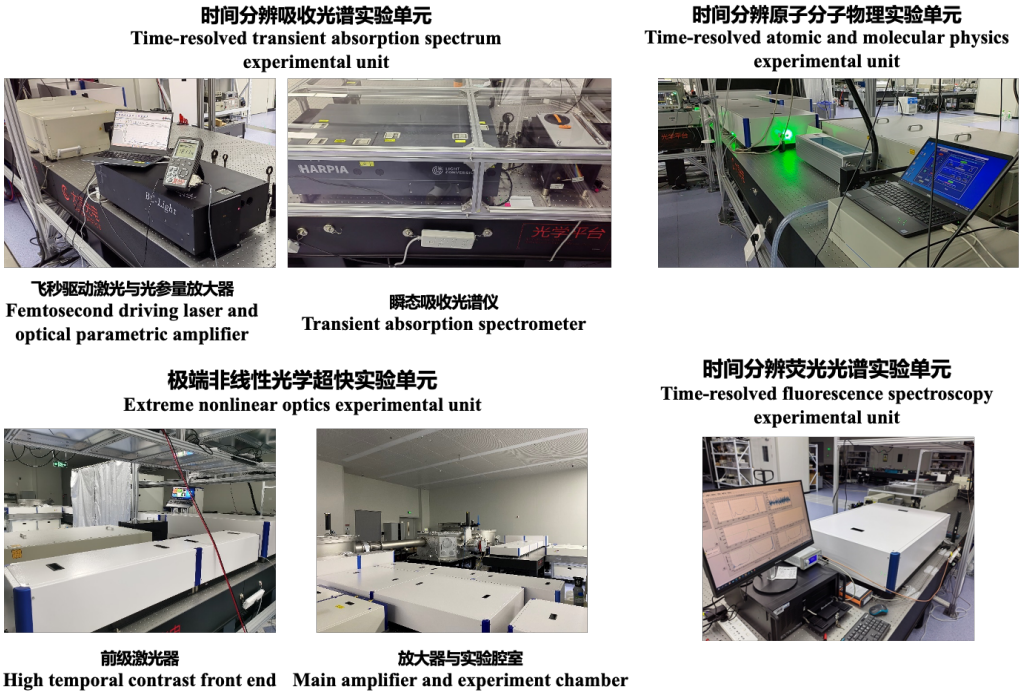
Femtosecond dynamics experimental station

In the research of material science, the time scale of atomic and molecular motion is mostly in the order of femtosecond, so femtosecond laser has become the most important tool to study atomic and molecular dynamics. Femtosecond dynamics experimental station is a comprehensive experimental platform for ultrafast scientific research based on different femtosecond laser light sources. It will provide users with a wide spectral range and multi-purpose ultrafast scientific research device to study the dynamics of atoms, molecules, liquids and the lattice in solids on the femtosecond time scale. The experimental station consists of a time-resolved absorption spectroscopy experimental unit, a time-resolved atomic and molecular physics experimental unit, an extremely nonlinear optics experimental unit and a femtosecond time-resolved fluorescence spectroscopy experimental unit.



Photos of the experimental station

The time-resolved transient absorption spectroscopy experimental unit is equipped with a Ti:sapphire femtosecond laser amplifier, optical parametric amplifier and transient absorption spectrometer, which will be used to carry out transient absorption

spectrum measurement in visible, near infrared and terahertz range. A femtosecond laser with a repetition rate of 1 kHz, a central wavelength of 800 nm, a pulse width of less than 40 fs and a pulse energy of 7 mJ is used as the driving laser. Combined with an optical parametric amplifier as pump and probe, transient absorption spectrometers with pump wavelength covering 400-1500 nm and probe wavelength covering 350-2600 nm is achieved. Besides, terahertz pulses of 0.1-10 THz through 800 nm laser air filamentation could also be used as the probe. The delay accuracy of the measurement system is better than 5 fs, and the delay range is 2 ns. Energy transfer, charge transfer, formation and breaking of chemical bonds, configuration relaxation and isomerization processes can be studied on this unit.

The time-resolved atomic and molecular physics experimental unit is equipped with a Ti:sapphire femtosecond amplifier, a nonlinear pulse compressor and a composite velocity imaging spectrometer to conduct femtosecond time-resolved atomic and molecular physics studies. A Ti:sapphire laser amplifier with a repetition rate of 1 kHz, wavelength of 800 nm, pulse width of less than 50 fs and an energy of more than 20 mJ is used as the driving laser. A part of the energy can also be used for nonlinear compression to achieve a pulse energy of 5 mJ and few cycle pulse width of less than 10 fs as the driving laser. The composite velocity imaging spectrometer uses ultrasonic molecular beam. In the electron ion composite measurement mode, the electron energy range is 10-100 eV, and the resolution is 1 %@40-80 eV. The ionic energy range is 1-13 eV, the resolution is 4 %@13 eV, and the mass spectrometry resolution $m/\Delta m \geq 100$. In the ion high resolution measurement mode, the ion energy range is 1-13 eV, the resolution is 1.5 %, and the mass spectrometry resolution is $m/\Delta m \geq 1000$. The unit can be used to study the ultrafast dynamics of ionization/dissociation of atoms and molecules. At the same time, it is equipped with a confocal Raman microscopy, which can be excited at three wavelengths of 325 nm, 532 nm and 785 nm for sample

characterization.

The extreme nonlinear optics experimental unit is equipped with a 200 TW Ti:sapphire femtosecond laser amplifier and vacuum experimental chambers. A femtosecond laser with a repetition rate of 1 kHz, center wavelength of 800 nm and pulse energy of 7 mJ is used as the first stage CPA. After temporal contrast improvement by XPW technology, the cleaned pulse was further stretched amplified and compressed, generating 6 J laser pulses with repetition rate of 1 Hz and pulse width of 30 fs. There is another synchronized 30 fs femtosecond beamline with repetition rate of 1 kHz could be used as probe. The experimental area is equipped with a vacuum chamber with an inner diameter of 1.5 m and a high back pressure pulsed gas jet, which can be used for the study of laser acceleration and laser-plasma interaction under relativistic intensity. At the same time, a portion of the first CPA is delivered to a two-dimensional processing platform, which can realize the precision machining with resolution of 10 μm for sample preparation.

The time-resolved fluorescence spectroscopy experimental unit is equipped with a Ti:sapphire laser amplifier, optical parametric amplifier and transient fluorescence spectrometer, which can be used for the study of femtosecond time-resolved transient fluorescence spectroscopy. A Ti:sapphire laser amplifier with repetition frequency of 2 kHz, central wavelength of 800 nm and pulse width of less than 100 fs was used as the driving laser, and an optical parametric amplifier with tunable output wavelength is used as the pump of fluorescence. The measurement was carried out with a transient fluorescence spectrometer. This devise could be used to measure transient fluorescence signals in the range of 500-900 nm with time-resolution better than 100 fs and time-range of fs-1 ns. This unit could be used to study photochemical processes such as excited state relaxation, energy transfer and charge transfer.

Specification of femtosecond dynamics experimental station

Experimental unit	Specification	
Time-resolved transient absorption spectrum experimental unit	Repetition rate	1 kHz
	Probe wavelength	1.1-2.6 μm
	Pulse energy	>1 mJ@1.3 μm
	Pulse width of the pump	<40 fs
	Delay resolution	5 fs
	Delay range	2 ns
Time-resolved atomic and molecular physics experimental unit	Repetition rate	1 kHz
	Driving wavelength	800 nm
	Pulse duration	<50 fs@20 mJ，<10 fs@5 mJ
	Electron energy range	10-100 eV
	Electron energy resolution	1 %@40-80 eV
	Ion energy range	1-13 eV
	Ion energy resolution	4 %@13 eV
	Mass spectrometry resolution	$m/\Delta m \geq 100$
Extreme nonlinear optics experimental unit	Repetition rate	1 Hz
	Driving wavelength	800 nm
	Pulse energy	6 J
	Pulse duration	30 fs
Time-resolved fluorescence spectroscopy experimental unit	Repetition rate	2 kHz
	Fluorescence signal range	500-900 nm（excited by 400 nm）
	Temporal resolution	<100 fs
	Delay range	fs-1 ns

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