Junde Liu

Date of Birth: October 1996

Major: Condensed matter physics

Email: liujunde@iphy.ac.cn

Graduation Date: June 2024

Address: Beijing, China

Tel: +86 15116318190

Research interests: ultrafast angle-resolved photoelectron spectroscopy, photo-induced phase transitions, application of machine learning method to data processing

EXPERIENCE

2014.08 - 2018.06	**University of Chinese Academy of Sciences**	Physics	Bachelor	(GPA : 3.81/4.00)
2017.08 - 2017.12	**National University of Singapore**	Physics	Exchange	(GPA : 4.83/5.00)
2018.08 - 2024.06	**Institute of Physics, CAS**	Physics	PhD	(GPA : 3.96/4.00)
2024.08 - present	**University of Göttingen**	Physics	Postdoc	

MAJOR COURSES

- Mathematics: Linear Algebra, Mathematical Analysis, Differential Equations, Group Theory, Probability Theory and Mathematical Statistics
- Physics: Advanced Quantum Mechanics, Solid State Theory, Experimental Methods in Solid State Physics, Introduction to Condensed Matter Physics, Nonlinear Optics, Density Functional Theory and Applications, Principles and Applications of Photoelectron Spectroscopy, Superconductivity Physics, Mesoscopic Physics

PERSONAL SKILLS

- **Frontier research in condensed matter physics:** Photo-induced hidden states in strongly correlated materials, laser-induced ultrafast non-equilibrium process
- **Ultrafast laser generation and applications:** Design and construction of deep- and extreme-ultraviolet coherent femtosecond light sources based on the high harmonic generation and nonlinear processes
- **Construction of ultra-high vacuum systems:** Ability to design, build and maintain complex ultra-high vacuum systems independently
- **Measurement of film and surface:** familiar with the vacuum transfer of two-dimensional materials and ARPES/AFM/RHEED characterization
- **Construction of laboratories:** Proven experience in the construction, maintenance, and upgrading of large scientific installations and laboratories
- **Use of scientific software:** Proficiency in Igor Pro, Solidworks, LabView, and Python
- **Language:** Proficiency in English literature reading, writing, academic reporting, and communication

MAJOR PROJECTS

2019.07 - 2021.11 Design and construction of HHG-based time-resolved ARPES

- **Main work:** Designed and built an ARPES system, including an ultra-high vacuum analysis and sample processing system, a fast sample loading and sample transferring system, a helium lamp ultraviolet light source, and a six-axis low-temperature manipulator; Designed and built an extreme ultraviolet light source based on HHG in rare gases, including the generation, monochrome, analysis and focus process; The combination of the coherent pump-probe light source and the ultra-high vacuum ARPES system was designed and achieved, including vacuum differential, the temporal and spatial overlap of the pump-probe laser at the analyzer focal position; The control program of the system and the linkage between the analyzer SES and program of delay stage were written based on LabView and C++; The program for data processing and analysis was written based on Igor Pro, including data loading, data visualization, data transformation, and data model fitting and analysis.
- **Results:** The photon energy of the HHG source covers 12eV to 40.8eV and the HHG-based time-resolved ARPES

setup generates a flux of 10^{11} photons/s with tunable photon energy selectively among 12, 16.8, and 21.6eV at high repetition rates (up to 400kHz). The energy and temporal resolution of the 18^{th} order (21.6eV) are determined as 157meV and 154fs, respectively. The ultimate vacuum of the analysis chamber reaches 10^{-11} torr and the measurement temperature of the sample can be as low as 5K.

2022.01 - 2023.03 Design and construction of 6eV/7.2eV time-resolved ARPES based on nonlinear crystal

- **Main work:** Designed and constructed time-resolved ARPES based on femtosecond deep-ultraviolet coherent light source by using nonlinear optical crystal (LBO/BBO/KBBF), including the generation of a deep-ultraviolet coherent laser, pulse width compression based on the concave multi-pass focal cavity, dual-pump coherent light source and Pockels cell-based pulse picking module; Designed and implemented the connection between the atmospheric pressure optical path and ultra-high vacuum ARPES system.
- **Results:** Successfully built time-resolved ARPES system based on multi-band UV light source with three photon energy (1.2eV/2.4eV/3.6eV) of pump laser depending on experimental needs. The energy and temporal resolution are determined as 15meV and 100fs, respectively. The repetition rate can be continuously adjusted from 1kHz to 10MHz. The ultimate vacuum of the analysis chamber reaches 10^{-11} torr and the measurement temperature of the sample can be as low as 5K.

2022.01 - 2022.10 Removal of noise and grid structure from ARPES spectra via deep learning method

- **Overview:** Developed a novel method to improve spectral data quality using deep learning techniques. By applying this method to the spectra processing, the scientists will be able to overcome instrument limitations and obtain higher-quality data more efficiently, which can contribute to discovering detailed physical features.
- **Results:** Based on the low-dimensional structure in the high-dimensional data, a novel spectra-processing algorithm is designed to achieve the effect of removing the extrinsic structure such as noise, grid, and spurious signal by using the correlation information of the data itself without the need for the training set, thus has better robustness and universality, which has wide application in the field of spectra processing.

2022.10 - 2024.05 Electronic structure study of the hidden state in the strongly correlated system 1T-TaS_2

- **Overview:** 1T-TaS_2, a strongly correlated material with rich physical properties such as charge density wave, Mott phase, interlayer order, and superconductivity, has received close attention from researchers recently. In particular, 1T-TaS_2 can be induced and modulated by ultrashort pulsed laser and electric pulses to the hidden state that cannot be reached in equilibrium. We use the ultrafast laser and time-resolved ARPES to characterize the electronic structure before and after excitation to further understand the mechanism of the transition. At the same time, we increase the efficiency of the writing or erasing process through modulation by pressure, doping, and thinning, thus providing the possibility of ultrafast optical devices.

SELECTED PUBLICATIONS

1. **Junde Liu***, et al. Nonvolatile optical control of interlayer stacking order in 1*T*-TaS_2. *arXiv:2405.02831* (2024).
2. **Junde Liu***, et al. Removing grid structure in angle-resolved photoemission spectra via deep learning method. *Physical Review B* **107**, 165106 (2023).
3. Dongchen Huang*, **Junde Liu***, et al. Training-set-free two-stage deep learning for Spectroscopic data de-noising. *arXiv:2402.18830* (2024).
4. Mojun Pan*, **Junde Liu***, et al. Time-resolved ARPES with probe energy of 6.0/7.2 eV and switchable resolution configuration. *Review of Scientific Instruments* **95**, 013001 (2024).
5. Dongchen Huang*, **Junde Liu***, et al. Spectroscopic data de-noising via training-set-free deep learning method. *Science China Physics, Mechanics & Astronomy* **66**, 267011 (2023).
6. Famin Chen*, Ji Wang*, Mojun Pan*, **Junde Liu***, et al. Time-resolved ARPES with tunable 12-21.6eV XUV at 400 kHz repetition rate. *Review of Scientific Instruments* **94**, 043905 (2023).