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Congratulations to New ICFO PhD Graduate

Dr. Ying-Hao Chien graduated with a thesis entitled "Revealing Ultrafast Dynamics in Hexagonal Boron Nitride with Attosecond X-ray Absorption Fine-structure Spectroscopy"

January 27, 2026

We congratulate Dr. Ying-Hao Chien who defended his thesis this morning in ICFO's Auditorium.
Dr. Chien obtained his MSc in Physics from the University of Wyoming, before joining the Attoscience and Ultrafast Optics research group led by ICREA professor Dr. Jens Biegert. Hi thesis titled "Revealing Ultrafast Dynamics in Hexagonal Boron Nitride with Attosecond X-ra Absorption Fine-structure Spectroscopy" was supervised by Prof. Dr. Jens Biegert

ABSTRACT:

Since the invention of the integrated circuit (IC) in the 1950s, modern civilization has been built upon its foundation. As ICs continue to scale down and operate at higher speeds, managing heat dissipation and energy transfer process is critical to overcoming performance limitations and enabling the development of next-generation ICs. In classical models, electrons and phonons are treated as independent systems to simplify calculations. This approximation successfully describes electronic band structures, charge transport, and optical responses in many materials under equilibrium conditions. However, it neglects the critical role of electron-phonon coupling, a fundamental many-body interaction that governs non-equilibrium energy exchange between electronic and lattice degrees of freedom. Recent advances in attosecond X-ray absorption fine structure (atto-XAFS) spectroscopy offer an unprecedented opportunity to observe electron-phonon coupling dynamics with both attosecond temporal and element-specific resolution. Hexagonal boron nitride (hBN), a widely studied prototypical material with diverse applications, still presents unresolved questions regarding its ultrafast dynamics. In this work, we investigate the coupled electron and phonon dynamics in bulk hBN using atto-XAFS. By employing different excitation conditions and exploiting different temporal resolutions, we disentangle the respective contributions of electrons and phonons to the transient response, demonstrating the unique capability of atto-XAFS to probe many-body dynamics in real-time. To enable further studies of novel materials, we upgraded our titanium-doped sapphire (Ti:sapphire) chirped pulse

amplification (CPA) laser system, integrated a new commercial TOPAS optical parametric amplifier, designed a novel microfluidics gas target combined with a piezo pulse valve system aimed at reducing helium consumption for high harmonic generation (HHG), implemented a cryogenic sample mount for temperature-dependent measurements, and replaced the diffraction grating in the soft X-ray spectrograph with high diffraction efficiency and high resolving power reflection zone plates. We demonstrate the enhanced performance of the upgraded system for future advanced atto-XAFS experiments.

Thesis Committee:

Prof. Dr. Heinrich Schwoerer, Max Planck Institute for the Structure and Dynamics of Matter
Prof. Dr. David Artigas Garcia, ICFO
Prof. Dr. Themistoklis Sidiropoulos, Friedrich-Schiller-Universitat Jena

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Thesis Committee