Curriculum Vitae

Chia-Lung Hsieh

Research Fellow
Institute of Atomic and Molecular Sciences (IAMS)
Academia Sinica, Taiwan

Email address: clh@gate.sinica.edu.tw

Education & Professional Experiences

2006 – 2011	PhD, Electrical Engineering, California Institute of Technology, USA
2011 – 2012	Postdoc, Max Planck Institute for the Science of Light, Germany
2012 – 2019	Assistant Research Fellow, IAMS, Academia Sinica, Taiwan
2019 – 2024	Associate Research Fellow, IAMS, Academia Sinica, Taiwan
2024 – present	Research Fellow, IAMS, Academia Sinica, Taiwan

Research Interests

Dr. Chia-Lung Hsieh seeks to uncover how the physical state and dynamics of living matter govern biological regulation. His early work pioneered high-speed, three-dimensional single-particle tracking of viruses and nanoparticles in complex cellular environments, establishing new standards for temporal resolution and quantitative trajectory analysis in live-cell biophysics. Building on this foundation, his laboratory now develops ultrasensitive interferometric scattering microscopy platforms that transform intrinsic nanoscale density fluctuations into quantitative, label-free readouts of molecular organization and chromatin dynamics. By pushing transmission microscopy to the single-protein sensitivity limit and achieving sub-millisecond temporal resolution in living cells, his team bridges single-particle motion, collective density fluctuations, and genome-scale organization within a unified physical framework. Through this integration of high-speed tracking and fluctuation-based interferometry, his research reframes cellular imaging as a means to directly interrogate how structure, motion, and gene regulation are physically coupled in living systems.

Selected Publications

1. Huang YF, Zhuo GY, Chou CY, Lin CH, Chang W, Hsieh CL, “Coherent brightfield microscopy provides the spatiotemporal resolution to study early stage viral infection in live cells,” ***ACS Nano***, 11(3), pp. 2575-2585 (2017).
2. Liao YH, Lin CH, Cheng CY, Wong WC, Juo JY, Hsieh CL, “Monovalent and oriented labeling of gold nanoprobes for the high-resolution tracking of a single membrane molecule,” ***ACS Nano***, 13(10), 10918-10928 (2019).
3. Hsiao YT, Tsai CN, Chen TH, Hsieh CL, “Label-free dynamic imaging of chromatin in live cell nuclei by high-speed scattering-based interference microscopy,” ***ACS Nano***, 16(2), 2774 (2022).
4. Hsiao YT, Wu TY, Wu BK, Chu SW, Hsieh CL, “Spinning disk interferometric scattering confocal microscopy captures millisecond timescale dynamics of living cells,” ***Optics Express*** 30(25), pp. 45233-45245 (2022).
5. Tsai SF, Hsieh CL, “Ultrasensitive bright-field microscope enables label-free single-protein detection,” ***Optics Letters***, 50(24), pp.7520-7523 (2025).

Lecture Title:

Label-Free Interferometric Scattering Microscopy for Quantitative Nanoscale Dynamics in Living Cells

Abstract

Fluorescence microscopy has transformed our understanding of cellular organization, yet its reliance on molecular labels imposes constraints on photophysics, photon budgets, and long-term observation of rapid nanoscale dynamics. In this talk, I will present interferometric scattering (iSCAT) microscopy as a complementary, label-free optical platform for probing intracellular structure and dynamics with high spatiotemporal sensitivity.

iSCAT detects weak scattering from subwavelength objects via interference with a coherent reference field, enabling quantitative measurements of nanoscale mass density fluctuations in living cells. I will discuss the physical basis of signal formation, sensitivity limits, and strategies for extracting dynamical information from high-speed recordings. We apply this framework to visualize and quantify intracellular organelle dynamics, including mitochondria, endoplasmic reticulum, and vesicular transport, without exogenous contrast agents.

Building on this foundation, I will introduce an iSCAT-based correlation spectroscopy approach that characterizes chromatin density-fluctuation dynamics in live nuclei. By analyzing scattering amplitude and temporal correlations, we infer nanoscopic chromatin condensation states and relaxation behavior, linking optical fluctuations to underlying biophysical organization.

Finally, I will discuss the integration of iSCAT with fluorescence modalities, enabling multimodal measurements that combine molecular specificity with quantitative label-free structural readouts. Together, these developments position interferometric scattering microscopy as a powerful tool for interrogating mesoscale cellular organization and fast dynamical processes in their native physiological context.