PHYSICAL SEMINAR

Hsing-Ta (Theta) Chen

Assistant Professor | Department of Chemistry and Biochemistry | University of Notre Dame

"Navigating Various Disorders and Dynamics in Strongly Coupled Light-Matter Systems"

Strong light-matter interactions hold great promise for modulating molecular and material properties, including chemical reactivity, energy transfer, and charge conductivity, via polaritonic states. In realistic chemical and material systems, disorder arising from thermal fluctuations and structural defects is inevitable and has a significant impact on the polaritonic state. However, disorder is often considered a perturbative effect and is usually omitted from models of light-matter dynamics and spectroscopy. In this talk, I aim to explore dynamical simulations of strongly coupled systems under various forms of disorder, including random dipole orientations, electromagnetic field fluctuations, and electron-phonon coupling. Contrary to the intuition that disorder inherently hinders exciton transport and suppresses strong coupling phenomena, our findings suggest that disorder can actually facilitate access to hidden degrees of freedom, specifically optical dark states. We demonstrate how these states can be leveraged to modulate exciton transport properties and introduce unique spectroscopic signatures.

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Hsing-Ta (Theta) Chen's Biography

Hsing-Ta (Theta) Chen received his B.S. in Mathematics and double major in Physics from National Taiwan University in 2006, then earned his M.S. in Physics also from the same institute in 2010. He received his Ph.D. in Chemical Physics from Columbia University in 2016. He was a Sackler Postdoctoral Fellow at Tel Aviv University in 2016. From 2017 to 2022, he was a postdoctoral researcher at the University of Pennsylvania. In 2022, he joined the faculty in the Department of Chemistry and Biochemistry at the University of Notre Dame. He received an NSF CAREER award in 2026.

Professor Chen's research lies in the area of theoretical chemical physics, emphasizing the development and application of new methods that accurately and efficiently capture light-matter interactions at the molecular and nanomaterial level. He pioneered the investigation of disorder effects, especially on dynamics and spectra, under collective light-matter interactions. He developed advanced computational techniques to simulate quantum dynamics in complex dielectric environments. He recently leveraged these tools to elucidate charge transport and energy conversion at the interface of semiconductors and metallic nanostructures.