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Spatially and temporally resolved exciton dynamics and transport in single nanostructures and assemblies LIBAI HUANG, Purdue University — The frontier in solar energy conversion now lies in learning how to integrate functional entities across multiple length scales to create optimal devices. To address this new frontier, I will discuss our recent efforts on elucidating multi-scale energy transfer, migration, and dissipation processes with simultaneous femtosecond temporal resolution and nanometer spatial resolution. We have developed ultrafast microscopy that combines ultrafast spectroscopy with optical microscopy to map exciton dynamics and transport with simultaneous ultrafast time resolution and diffraction-limited spatial resolution. We have employed pump-probe transient absorption microscopy to elucidate morphology and structure dependent exciton dynamics and transport in single nanostructures and molecular assemblies. More specifically, (1) We have applied transient absorption microscopy (TAM) to probe environmental and structure dependent exciton relaxation pathways in sing-walled carbon nanotubes (SWNTs) by mapping dynamics in individual pristine SWNTs with known structures. (2) We have systematically measured and modeled the optical properties of the Frenkel excitons in self-assembled porphyrin tubular aggregates that represent an analog to natural photosynthetic antennae. Using a combination of ultrafast optical microscopy and stochastic exciton modeling, we address exciton transport and relaxation pathways, especially those related to disorder.

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