Ultrafast exciton transport studied with 2D White-Light Spectroscopy at 100 kHz

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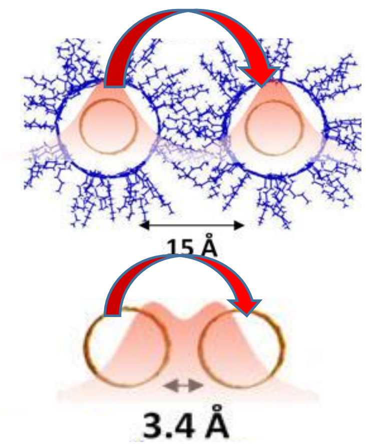
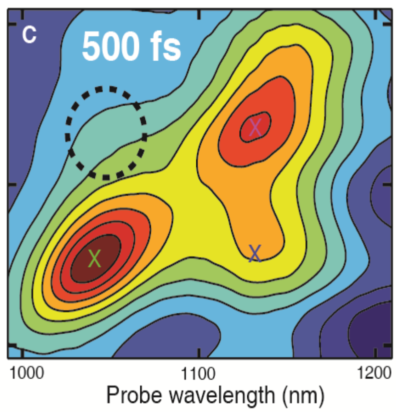
Exciton transport in thin films made from semiconducting carbon nanotubes was studied with a new 2D WL spectrometer operating at a repetition rate of 100 kHz. Exciton lifetimes are found to scale with the rate of energy transfer, which has implications for working devices.

This talk will present recent results on exciton transport in strongly coupled semiconducting carbon nanotubes as studied with a newly built 100 kHz 2D White-Light spectrometer. Carbon nanotubes are well known to have excellent energy transport properties, but could not be made into semiconducting materials because metallic tubes ruined the bulk properties. But it is now possible to purify purify semiconducting carbon nanotubes from their metallic counterparts, and incorporate these films into devices like photovoltaics. We are studying the photophysics of these films to understand their exciton transport properties. One experimental challenge is that these films absorb across the entire visible and near-IR. To interrogate this broad frequency range, we have built a 2D spectrometer that uses white-light continuum, the same continuum used for decades as a probe pulse in transient absorption spectrometers. Our 2D spectrometer utilizes a 100 kHz laser system with a newly designed pulse shaper, also optimized to operate at 100 kHz. Performance of our spectrometer will be demonstrated on a number of systems commonly studied in the ultrafast community. For the nanotube films, we will that we can manipulate energy flow by the film preparation. We will show results from a film preparation in which the excitons predominantly transfer at the intersections and another in which the transfer occurs between parallel tubes. Studying and learning to manipulate energy flow in these semiconducting carbon nanotube films could create a new class of designer materials.





(Left) We are studying energy transfer in films with carbon nanotubes at two average distances. (Right) 2D WL spectrum showing ultrafast energy transfer in one of these films.