2025-2026

Master thesis proposal

Institut des NanoSciences de Paris (INSP)
Sorbonne Université
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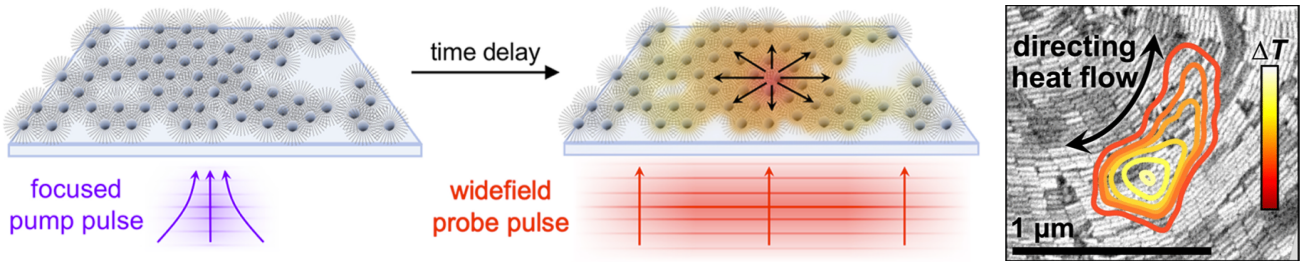
Spatiotemporal Phonon and Thermal Transport in Nanocrystal Optoelectronics

Keywords: ultrafast spectroscopy, colloidal nanocrystal, phonon transport, thermal transport

Scientific project: The aim of this experimental project is to use a pump-probe optical microcopy method[1] to spatiotemporally study microscopic coherent phonon and incoherent thermal transport in nanocrystal-based optoelectronics systems. Controlling nanoscale energy carrier transport is fundamental to energy conversion applications from solar cells to LEDs. While the optical and electronic properties of colloidal nanocrystal solids have been extensively studied, phonon and heat management remain largely unexplored. To address this area, one needs a probe of local phonon transport with ultrafast to nanosecond time resolution and sub-micron spatial resolution. One also needs a way to probe microscopic temperature gradients in a material under realistic device conditions. Our approach is to combine ultrafast microscopy, nanocrystal self-assembly, optoelectronic device fabrication, and custom data processing. These studies will reveal microscopic structure–property relationships that govern energy transport.



During the timeframe of the master's internship, the student will take on one of several possible projects regarding spatiotemporal imaging of sound wave propagation or thermal transport in nanocrystal assemblies. The goal is that the student continues on to do a PhD, during which the student lead a new direction of investigating microscopic phonon and thermal transport in active devices.

The team: The student would be advised by Dr. James Utterback, CNRS Chargé de Recherche at the Institut des NanoSciences de Paris (INSP, Sorbonne Université). The group has expertise in pump-probe optical spectroscopy and microscopy of nanomaterials.[1,2] The student would also benefit from the environment of the Optoelectonics of Confined Nanocrystals group, whose expertise spans across nanocrystal synthesis, characterization, spectroscopy, and nanocrystal device integration.

Student Background and Learning: The student will gain expertise in spectroscopy, solid state physics, optics, nanoscience, data acquisition, and data analysis. Students with background in the above areas are preferred. Programming skills (Python) will be highly valued. The group is international so the student must speak English.

[1] Feldman *et al.* *ACS Nano* 2024, 18, 50, 34341. [2] Utterback *et al.* *Nano Letters* 2021, 21(8), 3540.

Possibility to go on with a PhD ? Yes, preferred. Funding is part of ERC Starting Grant.

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If you are interested, please email James Utterback directly.