Centre de Nanosciences & de Nanotechnologies

C2N General Seminar

Friday June 4 - 10h00

"Addressing plasmonic hot-spots: from DNA-based self-assembly to far-field wavefront shaping"

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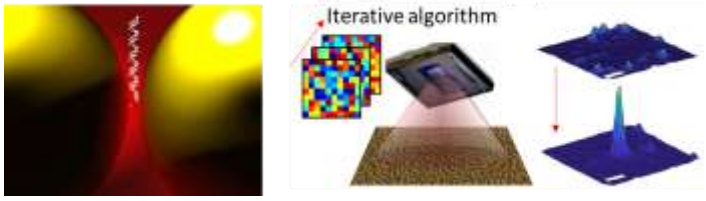
Link: https://us02web.zoom.us/j/86277738532

Light-matter interactions in condensed media at room-temperature are fundamentally limited by electron-phonon coupling. For instance, while the excitation cross-section of an isolated atom, or of a single quantum emitter at cryogenic temperatures, can reach one half of the wavelength of light squared (meaning that ~50% of incoming photons will interact for a diffraction-limited excitation); this value is reduced by 6-7 orders of magnitude for a fluorescent molecule or for a colloidal quantum dot at room temperature because of homogeneous phonon broadening. In order to render the exceptional optical properties of single quantum systems (such as single-photon emission and nonlinearities) efficiently accessible at room temperature and in condensed media, it is essential to enhance and optimize these interaction cross-sections.



Addressing plasmonic hots-pots: deterministic introduction of a controlled number of emitters using DNA-based self-assembly or far-field wavefront-based optimization in a disordered gold surface.

Over the last two decades, plasmonic resonators have shown amazing promise towards this goal thanks to their ability to enhance optical fields by several orders of magnitude in deeply sub-wavelength volumes. However, the nanoscale dimensions of these field enhancements or "hot-spots" mean that it is extremely difficult to exploit them in a controlled and reproducible way. At Institut Langevin, we develop two approaches in order to achieve this:

-We introduce, in a deterministic way, a controlled number of quantum emitters in the nanoscale hot-spot between two gold nanoparticles using a DNA-based self-assembly strategy. Using this approach, we were able to enhance single-photon emission from fluorescent molecules by more than two orders of magnitude in a weak-coupling regime. I will discuss recent experiments where we reach a strong-coupling regime between a plasmonic resonator and five organic molecules.

-We actively control the seemingly random plasmonic hot-spots featured by disordered gold surfaces using far-field wavefront shaping. In practice, by tuning the phase of a pulsed excitation, we ensure the constructive interference of plasmonic modes that are delocalized over several microns on the surface; leading to a local enhancement of the nonlinear luminescence of gold by more than two orders of magnitude.

Sébastien Bidault is a CNRS Researcher at Institut Langevin in Paris since 2008. He defended a PhD thesis in nonlinear optics in 2004 under the supervision of Sophie Brasselet and Joseph Zyss at ENS Cachan, before joining the group of Albert Polman at the AMOLF Institute in Amsterdam for a post-doctoral project in Plasmonics. His group develops novel nanofabrication techniques based on colloidal chemistry and DNA nanotechnology with applications in optical biosensing; studies Purcell effects in plasmonic and dielectric nanoantennas; and exploits far-field wavefront shaping in disordered nanophotonic media.