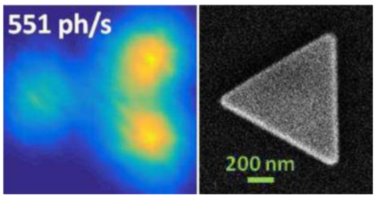
NÉEL INSTITUTE Grenoble

Topic for Master 2 internship – Academic year 2019-2020

Origin of the nonlinear response in gold nanoprism antennas

General Scope:
Plasmonics has opened fascinating applications owing to the ability of noble metals (and more generally any material holding free electrons) to locate light below the diffraction limit and conjointly to enhance the light-matter interaction through optical resonances in the visible range. Magnifying the electric field is also a key path for reveling nonlinear responses when the electron cloud is tightly driven. In this context, nonlinear plasmonics is a rather new topic where many fundamental properties are still to be understood, including its very origin. This is precisely the aim of this Master 2 project.

Research topic and facilities available:



We have recently made decisive progresses from three viewpoints: nanofabrication (with hybrid nonlinear/plasmonic nanostructures), optical characterization (with the building of a nanoscopy setup) and numerical simulation (with the first simulations of photon pair generation in hybrid systems). This work has put forward long-lasting opened questions by investigating the wave-mixing (interaction between two photons known as Second Harmonic Generation) in chemically-produced nanoprisms. To give the final proof to our finding we plan here:

1- to fabricate Au nanoprism antennas by e-beam lithography at the NanoFab platform
2- to map the SHG of single nanoprism (600nm) under a tightly focused femtosecond laser beam
3- to quantitatively compare with chemically-synthetized nanoprisms and numerical simulations.

This is foreseen to show that the usually invoked mechanism for SHG is not the dominant one and to reveal a largely disregarded contribution as the main SHG source in crystalline nanostructures.
There are many potential extensions to this subject such as exploring the symmetry breaking effects by playing with the nanoprism shape or even to enter in the strong coupling regime by reducing the gap size between two nanoprisms.

Possible collaboration and networking:
This project benefit from established collaborations with E. Dujardin from Toulouse and A. Bouhelier and B. Cluzel from Dijon.

Possible extension as a PhD:
An ANR project will be deposited in collaboration with the CEA for the 2020 call for investigating a new type of hybrid structures built on DNA boundings between plasmonic antennas and active nanoparticles.

Required skills:
An experimental profile is clearly targeted to manage advanced lithography and nonlinear microscopy experiments. Good skills in Optics and Electromagnetism are therefore expected with a strong interest in developing knowledges in nanofabrication.

Starting date: February - April

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