Light-Matter Interaction

in Quantum Nanostructures

Resp. UE: Christophe Voisin (PR Paris University, LPENS)

Teachers: Carlo Sirtori (PR ENS, LPENS), Jérôme Tignon (PR Sorbonne University, LPENS), Angela Vasanelli (PR Paris University, LPENS), Christophe Voisin (PR Paris University, LPENS), Emmanuel Baudin (MCF ENS, LPENS)

ECTS credits: 6

Language of instruction: English

Examination: written exam (60%) and/report on the practicals (40%)

Description:

The main goal of this course is to cover the physics of light-matter interaction in the context of quantum devices, and materials at the nanoscale. This UE features both theoretical aspects in lectures and tutorials - possibly based on the analysis and discussion of recent research papers - and experimental projects (12h) on research grade experiments at the end of the semester. Typical experimental projects comprise (i) a nanofabrication stage in one of the clean rooms of the Paris center cluster (including a general introduction to nanofabrication techniques) and (ii) optical measurements guided by a researcher in one of the associated labs.

The lectures will cover a general introduction on the basics of light-matter interaction in the semi-classical and quantum approach. The body of the lectures will consist of three main parts:

I Properties arising from free electrons in both the bulk and quantum confined regimes, including plasmonics and its applications for photo-detection and optical information processing, photonic quantum devices, cooperative enhancement of the light-matter interaction.

II Properties arising from interband transitions in natural and artificial nanostructures of semi-conductors: excitons, correlations effects, light absorption, light emission, introduction to spectroscopic techniques; strategies to enhance light-matter interaction at the single quantum particle level. Applications.

III Ultrafast phenomena in nanostructures: introduction to nonlinear optics and ultrafast spectroscopy (femto/picosecond): pump-probe, four-wave-mixing, photon-echo experiments.