

Master 2: *International Centre for Fundamental Physics*

Nanooptics with phase-shaped relativistic electrons

Laboratory name: Laboratoire de Physique des Solides

CNRS identification code: UMR8502

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Internship location: universit  Paris-Saclay (Orsay)

Thesis possibility after internship: YES

Funding already obtained for a PhD: YES (ANR QUENOT)

Nanooptics with phase-shaped relativistic electrons

Nanooptics is the science of optical phenomena arising much below the diffraction limit of light. To overcome the latter, new techniques and concepts have been introduced in the last twenty years. In particular, using fast (~half the speed of light) electrons to interrogate the optical properties of nanomaterials has proven very useful. Indeed, the related electron energy loss spectroscopy (EELS) provides unchallenged spatial resolution and is a direct map of a fundamental observable in nanooptics, namely the Electromagnetic local density of states (EMLDOS). The EMLDOS is the direct signature of the spatial and spectral variations of many of the nanooptical excitations – from surface plasmons to surface phonons.

Despite their strength, the electron spectroscopies lack information on the polarization of nanoscale excitations, despite them being encoded in the EMLDOS. Beyond that, the EMLDOS itself is not sufficient to unveil yet unexplored large parts of nanooptics, such as spatial coherence of optical excitations.

The basic idea behind this internship proposal is that the long-ignored phase of the relativistic electrons involved in EELS can be engineered to unveil both the local density of optical spin (a local measure of the polarization) and new observables such as the cross-density of electromagnetic states (a measure of the spatial coherence). This project builds on several years of theoretical and instrumental developments on state-of-the-art equipment, and is strongly supported by a French ANR and European FET-OPEN projects. The applicant would be in an ideal situation to tackle an emerging field in physics.

The intern will be backed up with a skilled team in Orsay. If COVID restrictions are left, experiments in a collaboration team in Toulouse have to be expected.

During the internship, the intern will be trained on electron microscopes, EELS data analysis, and potentially electron beam lithography. This internship targets an applicant with curiosity, a taste for hands-on experiments and interested in exploring new concepts in physics. A good theoretical background will be a plus.

Do not hesitate to contact and/or visit us to learn more on the subject and the lab.

Please, indicate which speciality(ies) seem(s) to be more adapted to the subject:

Condensed Matter Physics: YES Soft Matter and Biological Physics: NO

Quantum Physics: YES

Theoretical Physics:

NO