



AUDITORIUM – Institut d'Optique
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Sciences of Light

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Colloquium ISL

Nano-optics with fast electrons

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Hunting optical phenomena at the nanometer scale, namely performing nanooptics, is paradoxical. On the one hand, the typical length-scale relevant for optics is of the order of a visible radiation wavelength: few hundred of nanometers. On the other hand, optical properties of nano-objects become to depart from bulk properties when the nano-objects become smaller than a few hundred of nanometers. This is for example the case of plasmons in metallic nanoparticles. In this case, the optical properties depend on minute variations of the size and shape of the nano-objects. Even more, the morphology or structure of nano-objects may have to be known with atomic resolution, such as in the case of quantum dots or quantum wells. Therefore, techniques that are not limited by the optical diffraction limit have been developed in the last 15 years to make possible to study novel optical nanomaterials and the novel physics they brought.

In this talk, I will introduce a family of such techniques. They use free electron beams – such as delivered in a transmission electron microscope – to perform optical spectroscopy at the nanometer scale. I will show how they can be used to map plasmons, excitons, photonic modes and even phonons with unbeatable spatial resolution. Beyond their impressive success in generating nice images, I will show how it is now possible to quantitatively understand such experiments in pure optical terms, such as extinction and scattering cross-sections or electromagnetic local density of states. Then, I will present the use of free electron beams to perform quantum optical measurements, and introduce very recent techniques that ally the spatial resolution offered by free electrons and the spectral resolution given by lasers.