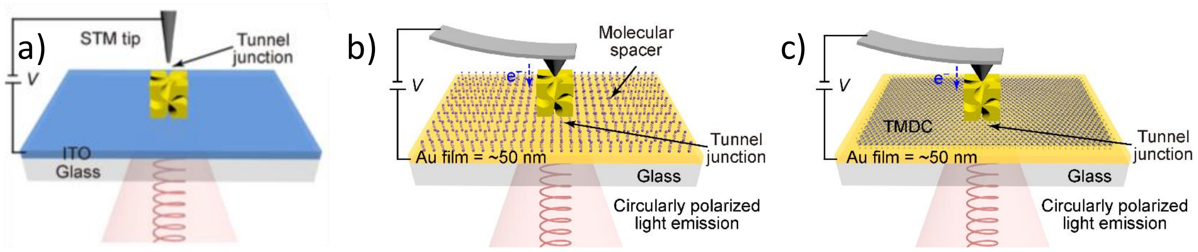
**M2 internship / Ph.D position available (already funded)**

# Controlling the polarization of light with chiral nanoparticles

Chiral structures, whose initial and mirror structural images cannot be superimposed, interact differently with left-handed and right-handed circularly polarized light. This is called the "chiroptical response". Chirality is a crucial property for many essential molecules in biology. Most often, however, the corresponding chiroptical response is very weak. Gold plasmonic nanoparticles, on the other hand, have a relatively strong chiroptical response. The main idea of this project is to enhance the chiroptical response and thus control the polarization of light using chiral plasmonic nanoparticles.

In this project we will locally and electrically excite chiral plasmonic nanoparticles, with the goal of using them to enhance the chiral properties of **a new class of two-dimensional semiconductors called TMDCs (transition metal dichalcogenides)**. In particular, the idea is to control the polarization of the semiconductor luminescence with the "handedness" of the nanoparticle. The long-term goal of the project is a new computational framework called "valleytronics". What makes the studied nanoparticles "plasmonic" is that they may support *localized surface plasmons*, i.e., collective surface electron oscillations coupled to an electromagnetic wave.




Local electrical excitation of a chiral plasmonic nanoparticle. a) Schematic of the experiment: the tunneling current between the scanning tunneling microscope (STM) tip and the plasmonic chiral nanoparticle excites the plasmonic modes of the system. These modes then decay radiatively, leading to the emission of circularly polarized light. The "handedness" of the circularly polarized light depends on the "handedness" of the nanoparticle. b) A chiral plasmonic nanocavity is formed between a chiral gold nanoparticle and a thin gold film. When a voltage difference is applied between the particle and film via the tip of an atomic force microscope, the resulting inelastic tunneling electrons excite the existing plasmonic modes of the system (which subsequently decay as circularly polarized photons). c) This sample geometry and excitation method will be used to preferentially excite the luminescence of a particular circular polarization from a monolayer of a two-dimensional semiconductor of the TMDC family, a first step towards "valleytronics".

During this thesis, the student will learn about and acquire experience in (i) scanning tunneling microscopy (imaging of the chiral structures and excitation) (ii) atomic force microscopy (imaging of the chiral structures and excitation) (iii) optical microscopy (detection and analysis of the emitted light) and (iv) the theory of plasmonics and two-dimensional semiconductors ("valleytronics"). The successful applicant will have a background in **physics** or equivalent, and will have an affinity for **optics** and **nanoscience** and a desire to do **experiments**. Good communication skills in English OR French are required. Note that for a motivated candidate, the project may include numerical modeling.

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For more information about our work:
https://www.youtube.com/watch?v=nqqpkWicR2k (in French)
https://www.youtube.com/watch?v=bZAs1W25_dQ (in French)
http://www.ismo.u-psud.fr/spip.php?rubrique199 (available in French and English)
http://www.ismo.universite-paris-saclay.fr/spip.php?rubrique443 (available in French and English)