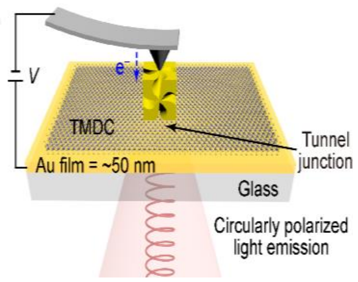
M2/Ph.D. position available (funding already acquired)

Electrical excitation of a 2D semiconductor in a plasmonic nanocavity

In this project we will locally and electrically excite chiral plasmonic nanocavities in order to enhance the chiral properties of a new class of two-dimensional (2D) semiconductors called *transition metal dichalcogenides* (TMDCs). These materials are key for a new branch of physics and technology called *valleytronics*.

Chiral structures, whose initial and mirror structural images cannot be superimposed, interact differently with left-handed and right-handed circularly polarized light. This "chiroptical response" is in general very weak, but is enhanced in gold plasmonic nanoparticles. The goal of this project is thus to electrically excite a 2D semiconductor in a chiral plasmonic nanocavity at the nanoscale in order to enhance this effect and thus control the polarization of the luminescence from a 2D semiconductor.

The chiroptical response of materials and structures is most often studied by optical means, yet in a future optoelectronic nanodevice, a local electronic excitation is necessary. Working with this long-term goal in mind, we will apply a potential difference to the nanocavity using the conducting tip of an *atomic force microscope*. It is the resulting *tunneling current* in the cavity that will excite the luminescence.



A chiral plasmonic nanocavity is formed between a chiral gold nanoparticle and a thin gold film. When a voltage bias is applied between the particle and film via the tip of an AFM, the resulting inelastic tunneling electrons excite the plasmonic modes of the system, which subsequently decay as circularly polarized photons. 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.

During this internship/thesis, the student will acquire experience in (i) scanning tunneling microscopy and atomic force microscopy (imaging of the chiral structures and excitation), (ii) optical microscopy (detection and analysis of the emitted light) and (iii) the theory of plasmonics and two-dimensional semiconductors ("valleytronics"). The successful applicant will have a physics background 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 also 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)