Nanomechanics of atomically-thin magnetic membranes

DIRECTEURS DE THESE: STEPHANE BERCIAUD (HDR), ARNAUD GLOPPE
INSTITUT DE PHYSIQUE ET CHIMIE DES MATERIAUX DE STRASBOURG (IPCMS, UMR 7504), 23 RUE DU LOESS BP43, 67034 STRASBOURG
TEL: 03 88 10 72 56
E-MAIL: BERCIAUD@ UNISTRA.FR, ARNAUD.GLOPPE@IPCMS.UNISTRA.FR

The recent demonstration of an intrinsic magnetic order in atomically-thin van der Waals materials opens a vast new playground to understand and control magnetism at the nanoscale. These materials propose a rich portfolio of magnetic order with intralayer ferromagnetism, antiferromagnetism (zigzag or Néel-type), interlayer ferro- and antiferromagnetism, and configuration that can be described along Ising, Heisenberg or XY models according to the anisotropy and exchange interactions within the system, from textbook phenomenology to more exotic spin states. This nascent class of magnetic van der Waals materials embeds magnetic degrees of freedom in van der Waals heterostructures that could be controlled by proximity effects, doping or strain.

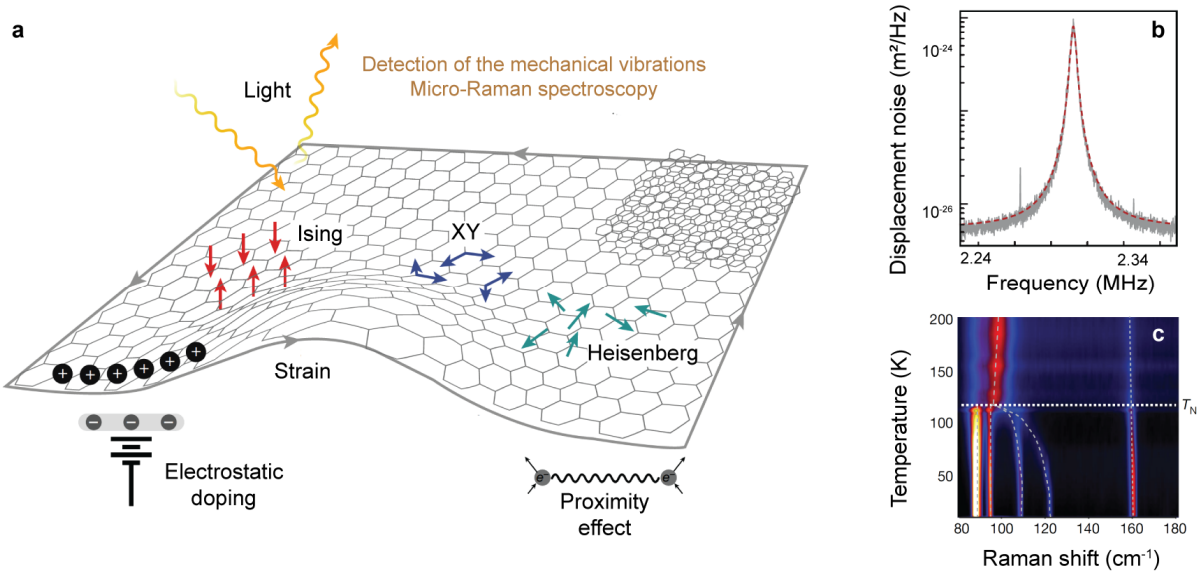

Figure 1: (a) Overview of the degrees of freedom available in magnetic 2D materials physics [1]. (b) Optical detection of the mechanical vibrations of a suspended graphene monolayer [2]. (c) Temperature-dependent Raman spectroscopy of a $FePS_3$ monolayer revealing a magnetic phase transition at 118 K [3].

This PhD project aims at creating an optomechanical platform in which the drum-like vibrations of a suspended magnetic membrane can be optically monitored to observe and control its magnetic order. The student will build suspended magnetic van der Waals heterostructures and develop an optical interferometric setup to detect the mechanical vibrations of the membranes – coupled with Raman spectroscopy to attest to changes in the magnetic order.

The understanding and control over these delicate atomically-thin magnetic materials will enable in-depth investigations of magnetism in 2D, the design of new magnetic nanodevices and new paradigms in hybrid optomechanics.

[1] K. Burch, D. Mandrus, and J. Park, Nature **563**, 47–52 (2018).
[2] C. Schwarz et al., Phys. Rev. Applied **6**, 064 021 (2016).
[3] J. Lee et al, Nano Lett. **16**, 7433–7438 (2016).