INSTITUT DE PHYSIQUE ET CHIMIE DES MATERIAUX DE STRASBOURG
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SEMINAIRE DON
Vendredi 26 avril 2019
à 10h00 à l'auditorium

"Laser-induced magnetization reversal in Fe/MnAs/GaAs(001) and time-resolved study of MnAs phase transitions"

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MnAs is a semi-metal with potential for applications in the fields of magnetocalorics, spintronics and laser-driven magnetization reversal. The interest for MnAs stems from a peculiar sequence of phase transitions. The low temperature structure is hexagonal and ferromagnetic (FM). At 313 K, ferromagnetic order is lost and the structure becomes orthorhombic in a first order phase transition. The orthorhombic distortion parameter decreases progressively through a second-order phase transition and vanishes at 400 K, where hexagonal symmetry is recovered. In this talk, I will present results showing that phase transitions in MnAs can be exploited for laser-driven magnetization reversal and a study of coherent phonons in MnAs by time-resolved diffraction.

In MnAs/GaAs(001), minimization of the elastic energy leads to a phase-coexistence in the form of a stripes-pattern, alternating FM and not FM regions. This peculiar self-organization can be exploited to act on the magnetization of a Fe layer in Fe/MnAs/GaAs heterostructures: a single laser shot can trigger the Fe magnetization reversal, as demonstrated by time-resolved measurements performed at FERMI [1].

Recent DFT calculations suggest that the second order transition of MnAs is a displacive phase transition driven by the softening of a THz mode with normal coordinate along the orthorhombic distortion path [2]. We investigated the structural dynamics of laser excited MnAs/GaAs(001) films using time-resolved x-ray diffraction at the LCLS FEL source [3]. The temperature dependent intensity oscillations of several Bragg reflections allow us to identify the optical phonon associated with the orthorhombic distortion and to follow its softening as the distortion vanishes on the path towards the hexagonal symmetry. The frequency of this mode falls in the THz range, in agreement with DFT calculations.

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[1] C. Spezzani et al., Phys. Rev. Lett. 113, 247202 (2014).
[2] J. Lazewski et al., Phys. Rev. Lett. 104, 147205 (2010); Phys. Rev. B 83, 054108 (2011).
[3] F. Vidal et al., Phys. Rev. Lett., accepted

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