**Séminaire GEMaC**

**Jeudi 31 août 2017**

Salle F4109 à 11h00

**Multiferroic coupling and ferroic ordering**

**revealed by linear and nonlinear optical studies**

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Recent investigations of multiferroic materials —in which more than one ferroic order exists— mainly focus on their potential to exhibit large coupling between the magnetic and ferroelectric phase. This coupling is particularly suited for technological applications since it allows to control the magnetization by means of electric voltage instead of magnetic fields or spin-polarized currents. The study of these complex materials requires sophisticated experimental techniques, which should provide the possibility to access each ferroic order at the microscopic scale (domains and domain walls) and, moreover, allow to study the multiferroic coupling at different time scales without perturbing the system. Optical methods, based on polarimetry analysis of the emitted or reflected/transmitted electromagnetic wave, are particularly adapted to the study of the ferroic order and the magnetoelectric coupling through linear or nonlinear optical processes.

In the first part of this talk I will discuss our recent investigation of magnetoelectric coupling in Co/PbZr0.2Ti0.8O3 bilayers. [[1](http://pubs.acs.org/doi/abs/10.1021/acsami.5b12777)] The static and dynamic properties of the interface-related coupling in this system are investigated by means of linear optical measurements in which the changes in the optical properties in electrical and magnetic fields are revealed through the magneto-optical Kerr effect and the linear and quadratic electro-optical effects. We find a remarkably stable coupling over a wide frequency range of the applied electric field. This property could be very promising for the development of magnetoelectric memory devices.

In the second part I will present an experimental study evidencing unusual structures at ferroelectric domain wall regions. [[2](http://rdcu.be/vayR)] We use nonlinear optical microscopy to probe the internal structure of 180° domain walls in lead zirconate titanate thin films and lithium tantalate bulk crystals. In both systems we detect a pronounced nonlinear optical signal at the walls that we attribute to a planar polarization within the walls. Our results demonstrate a clear deviation from the ideal Ising-type domain wall configuration (zero polarization at the center of the walls) that is traditionally expected in such uniaxial ferroelectrics. This corroborates recent theoretical predictions of a more complex, often chiral domain wall structure.

[[1](http://pubs.acs.org/doi/abs/10.1021/acsami.5b12777)] Vlasin *et al.,* *ACS Appl. Mater. Interfaces* ***8****, 7553 (2016)*.

[[2](http://rdcu.be/vayR)] Cherifi-Hertel et al. *Nat. Commun. 8, 15768 (2017)*.