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Flexoelectricity vs Piezoelectricity at the Nanoscale

Piezoelectricity (polarization induced by strain) has been studied and utilized for many decades in useful technologies such as ultrasound scanners or pressure sensors. By contrast, a close relative of piezoelectricity, flexoelectricity (polarization induced by strain *gradient*) has been relatively neglected until very recently. In the last decade, however, this situation has changed due to the realization that strain gradients can be very big at the nanoscale. In this seminar, I will give an overview of flexoelectricity, putting emphasis on new phenomena and functionalities enabled by flexoelectricity that are not possible with just piezoelectricity. These include control of polarization in ferroelectrics¹, generation of voltage in non-piezoelectrics^{2,3}, and even the generation of asymmetric response in nominally non-polar properties such as elasticity⁴.

¹Catalan *et al*, *Flexoelectric rotation of polarization in ferroelectric thin films*, *Nature Materials* 10, 963 (2011).

²H. Lu *et al*, *Mechanical Writing of Ferroelectric Polarization*, *Science* 336, 59-61 (2012).

³P. Zubko, G. Catalan, A. K. Tagantsev, *Flexoelectric Effect in Solids*, *Annual Review of Materials Research* 43, 387 (2013)

⁴Abdollahi *et al*, *Fracture Toughening and Toughness Asymmetry Induced by Flexoelectricity*, *Phys. Rev. Lett.* (submitted).



Gustau Catalan graduated in Physics at the Universitat de Barcelona and gained his PhD, also in Physics, at Queen's University of Belfast (2001). This was followed by research positions at the Mediterranean Institute for Advanced Studies, at the University of Groningen and at the University of Cambridge. Since 2009, he is an ICREA Research Professor and heads the Oxide Nanoelectronics group at the Institut Catala de Nanociencia i Nanotecnologia (ICN2) in Barcelona.

Prof. Catalan's research explores the functional properties of oxide electroceramics at the nanoscale, and currently the two main themes of his research are the effects of strain gradients on electrical properties (flexoelectricity) and the physics and applications of domain walls (domain wall nanoelectronics).

Host:
Prof. Alexei Gruverman
Department of
Physics & Astronomy

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Wednesday, January 28, 4:00 pm
136 Jorgensen Hall