Flexoelectricity in Two-Dimensional Crystalline and Biological Membranes

Research Themes

The ability of a material to convert electrical stimuli into mechanical deformation, i.e. piezoelectricity, is a remarkable property of a rather small subset of insulating materials. The phenomenon of flexoelectricity, on the other hand, is universal. All dielectrics exhibit the flexoelectric effect whereby non-uniform strain (or strain gradients) can polarize the material and conversely non-uniform electric fields may cause mechanical deformation. The flexoelectric effect is strongly enhanced at the nanoscale and accordingly, all two-dimensional membranes of atomistic scale thickness exhibit a strong two-way coupling between the curvature and electric field. In this research, we focus on the recent advances made in our understanding of flexoelectricity in two-dimensional (2D) membranes—whether the crystalline ones such as dielectric graphene nanoribbons or the soft lipid bilayer membranes that are ubiquitous in biology. Aside from the fundamental mechanisms, phenomenology, and recent findings, we highlight the rapidly emerging directions in this field and discuss applications such as energy harvesting, understanding of the mammalian hearing mechanism and ion transport among others.

Recent Accomplishments

On this topic, so far we have published two peer reviewed journal papers:

Ahmadpoor, Fatemeh, and Pradeep Sharma. "Flexoelectricity in two-dimensional crystalline and biological membranes." Nanoscale 7.40 (2015): 16555-16570.

Ahmadpoor, F., et al. "Apparent flexoelectricity in lipid bilayer membranes due to external charge and dipolar distributions." Physical Review E 88.5 (2013): 050701.

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