Tata Institute of Fundamental Research
Survey No. 36/P, Gopanpally Village, Serilingampally Mandal, Ranga Reddy Dist., Hyderabad – 500 046

Seminar

Multiferroics: Lattice assisted magneto-electric coupling

Daniel Carlos Cabra

UNLP, Argentina

We present a microscopic framework for magnetoelectric coupling in type-II multiferroics, where the interaction between magnetic moments and electric polarisation is mediated by lattice distortions. The magnetic sector is described by a Heisenberg spin model coupled to the lattice through a spin-Peierls mechanism, while electric dipoles, modelled for simplicity as Ising variables, are indirectly coupled to the spins via distortion-induced modifications of their local electronic environment.

This magneto-electro-elastic "pantograph" mechanism generates an effective and highly efficient magnetoelectric coupling in low-dimensional systems. Focusing first on one-dimensional chains, we show, using bosonisation and extensive DMRG simulations, that increasing an external magnetic field beyond the spin-Peierls gap leads to a sharp switch-off of the electric polarisation. Microscopically, this effect originates from the proliferation of soliton pairs that destroy the long-range distortion pattern responsible for ferroelectricity.

By including further-neighbour magnetic interactions and easy-axis anisotropy, the model stabilizes the collinear "uudd" (antiphase) magnetic order characteristic of many type-II multiferroic materials, while preserving the field-controlled polarisation switching. Finally, we briefly discuss recent progress toward two-dimensional generalisations, showing that the same lattice-mediated mechanism can stabilize complex magnetoelectric phases beyond one dimension.

Thursday, Feb 26th 2026

16:00 Hrs (Tea / Coffee 15:45 Hrs)

Auditorium, TIFRH