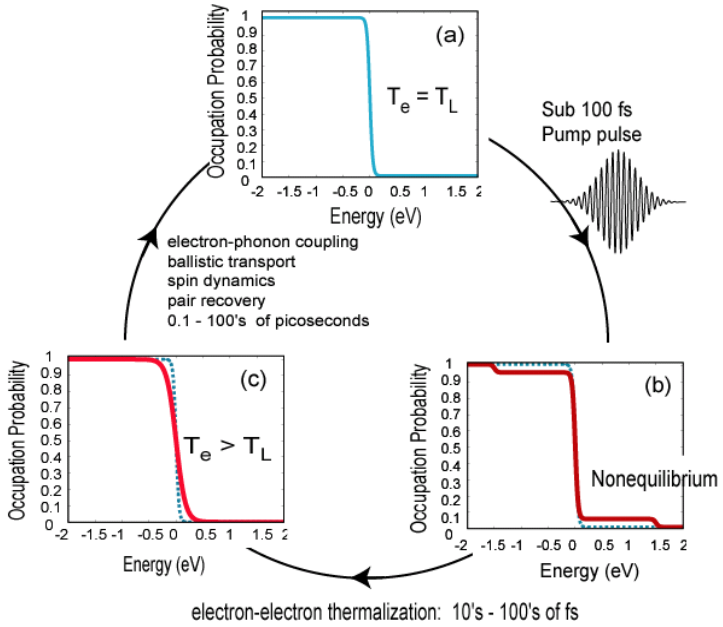
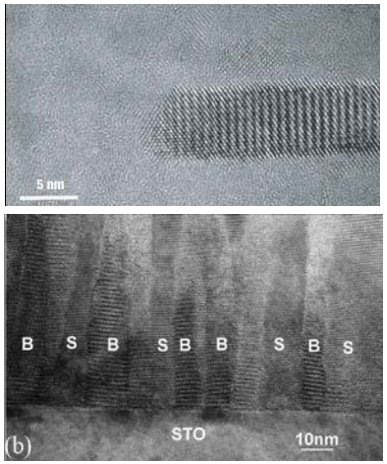
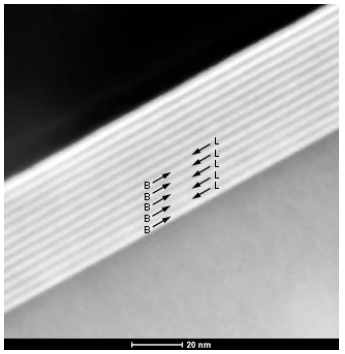
# Emergent states in oxide interfaces

## Time resolved probes for interfaces

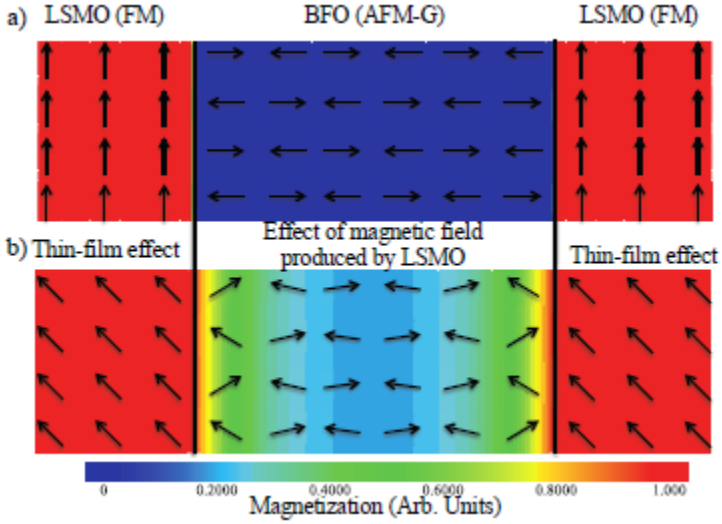



## 3D and 2D interface effects

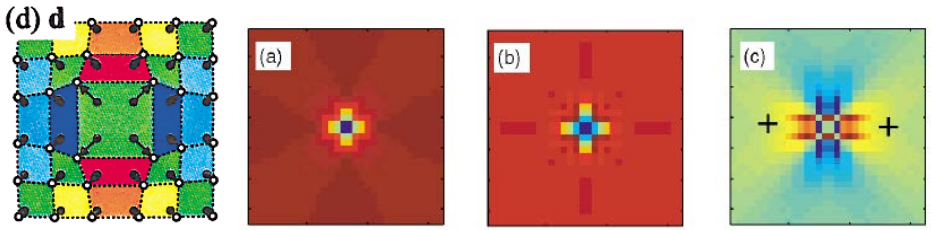



## Magnetic Field Proximity effect in LSMO/BFO multilayers




## Strain effect on electronics




Electronic states change near strain defect
Zhu *et al.*, PRL **91**, 057004 (2003)

Mesoscale Priority Research Direction

# Emergent states in oxide interfaces

## Opportunity

New advances in controlled deposition make possible design of interfaces of materials with competing interactions that develop new states not available in the regular bulk growth. Coupled to tremendous advances in modeling and characterization methods, it opens up an opportunity for "rational" design of composite oxide materials with novel or enhanced functionalities unattainable in the bulk form.

## Approach

To succeed in this challenge we need: i) to manipulate mesoscale structure of the nanocomposites; ii) characterize the collective phenomena using conventional nanoscale and ultrafast probes, and apply/develop new penetrating probes of spin, charge and lattice dynamics across nano-to-macroscales, e.g. time-resolved X-Ray facilities; iii) theory and modeling at the hybrid level that bridges ab initio atomistic description to the mesoscale simulations.

## Meso Challenge

Nanostructured interfaces create responses that span larger length scales up to tens of microns. The challenge is to develop basic principles relating nano-to-mesoscale structure of composite oxide materials to ensuing material functionality.

## Impact

Harnessing collective phenomena in composite oxide materials will constitute a transformational leap in the development of "materials-by-design" approaches, and will pave the way to introduction of the materials with unprecedented functionalities.

References: A. Balatsky, J. X. Zhu and I. Vekhter, Impurity Effects in Superconductors, Rev. Mod. Phys. **78**, 373 (2006).
MacManus-Driscoll et al., "Spontaneous ordering, strain control and manipulation in vertical nancomposite heteroepitaxial films", *Nature Materials,* **7**, 314 (2008)
Liu, Y. H., et al,. "Charge transfer at the interface between ferromagnetic La0.7Sr0.3MnO3} and superconducting EuBa2Cu3O7." Submitted to *Nat. Physics*



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