PS-D-3

Effects of magnetic fields in Mott insulator/band insulator heterostructures

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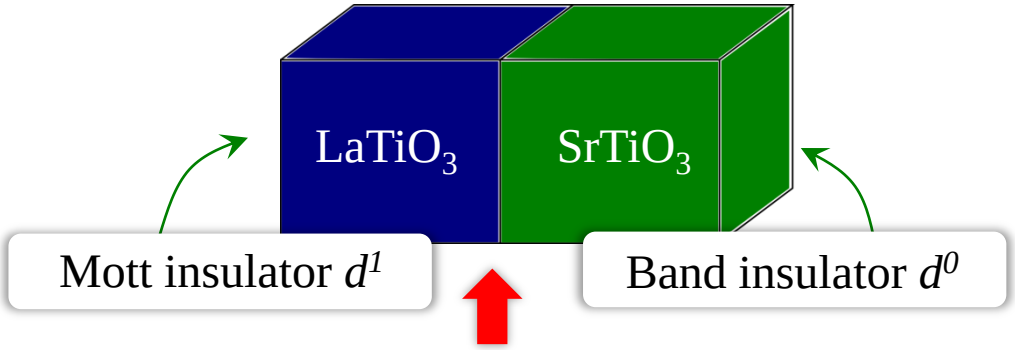
Introduction

Hetero-structure of transition metal oxides

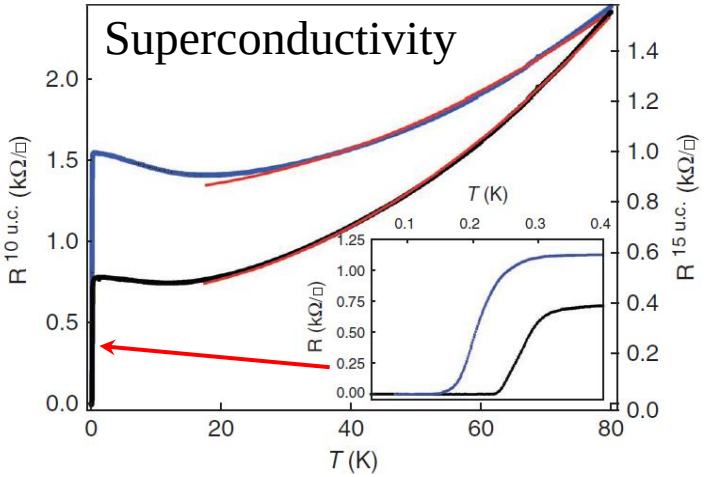
Interplay of Correlation effect & Spatial inhomogeneity…

Unexpected and novel behavior at the interface!

e.g.) Experiment on $LaTiO_3/SrTiO_3$



Interface of insulating materials…

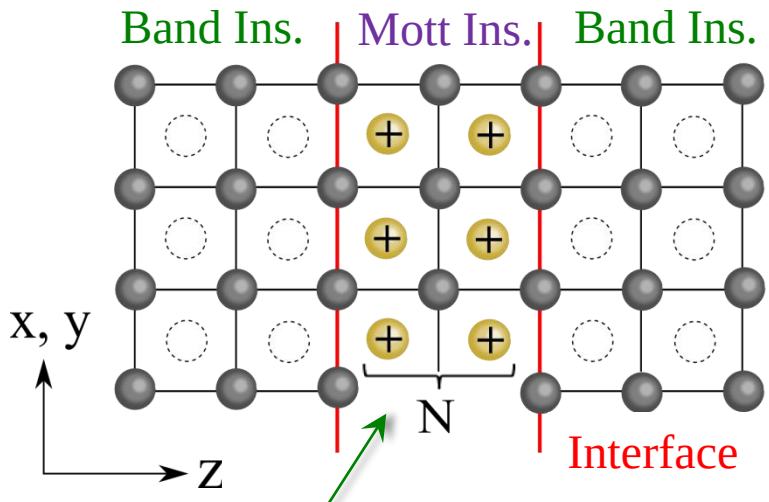


- Metallic conductivity A.Ohtomo et al, Nature **419**, 378(2002)
- Superconductivity J. Biscaras et al. nature comm 1084 (2010)

Interface phases looks different from the bulk !

Model

"$LaTiO_3$/$SrTiO_3$"-structure under magnetic fields



La^{3+} vs. Sr^{2+} :
Extra "+1 charge"

Charge neutrality :
# of electron= # of cation

Hamiltonian

$$H = H_{Hub} + H_{Coul} + H_Z$$

◆ Single band Hubbard model

$$H_{Hub} = -t \sum_{<i,j>,\sigma} (c^{\dagger}_{i\sigma} c_{j\sigma} + h.c.) + U \sum_i \hat{n}_{i\uparrow}\hat{n}_{i\downarrow}$$

◆ Long-range Coulomb interaction

$$H_{Coul} = E_c \left(\frac{1}{2} \sum_{i \neq j,\sigma,\sigma'} \frac{\hat{n}_{i\sigma}\hat{n}_{j\sigma'}}{|\vec{R}_i - \vec{R}_j|} - \sum_{ij,\sigma} \frac{\hat{n}_{i\sigma}}{|\vec{R}_i - \vec{R}^{ion}_j|} \right)$$

electron-electron

electron-cation

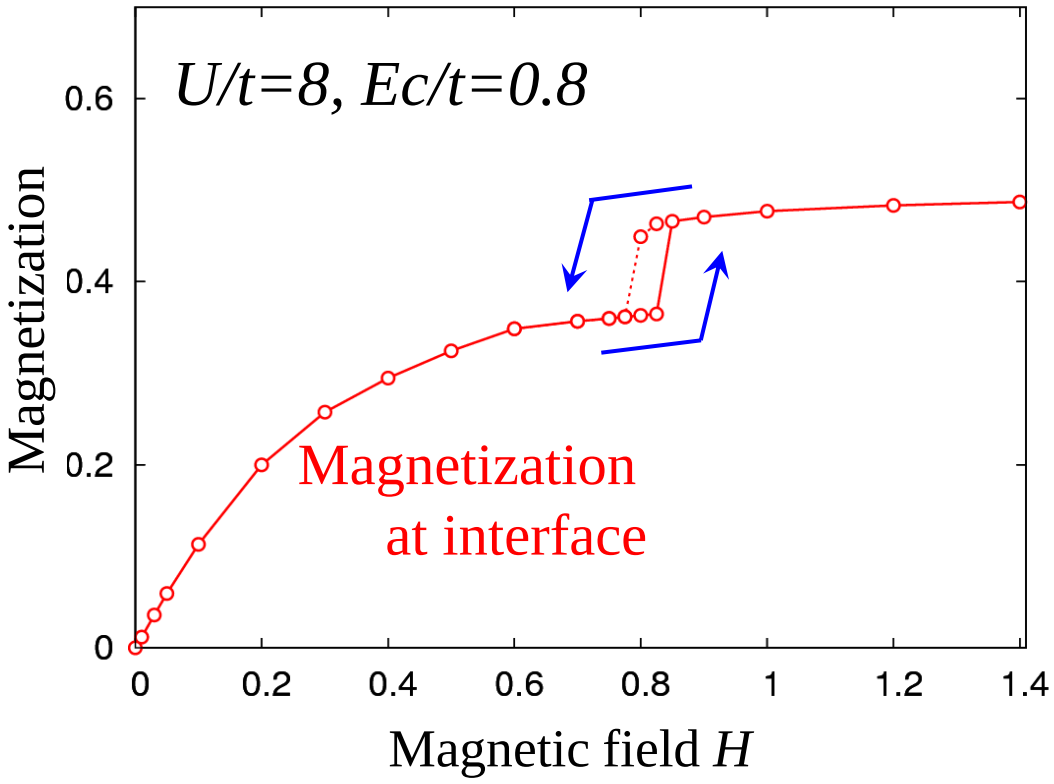
◆ Zeeman coupling term

$$H_Z = -H \sum_i (\hat{n}_{i\uparrow} - \hat{n}_{i\downarrow})$$

Study: magnetic properties with Hartree-Fock approximation

Result 1, Meta-magnetic transition

The direction of magnetic fields: $H \perp$ AF-moment.



Hysteresis, Abrupt jump
$\Rightarrow$ 1st order transition

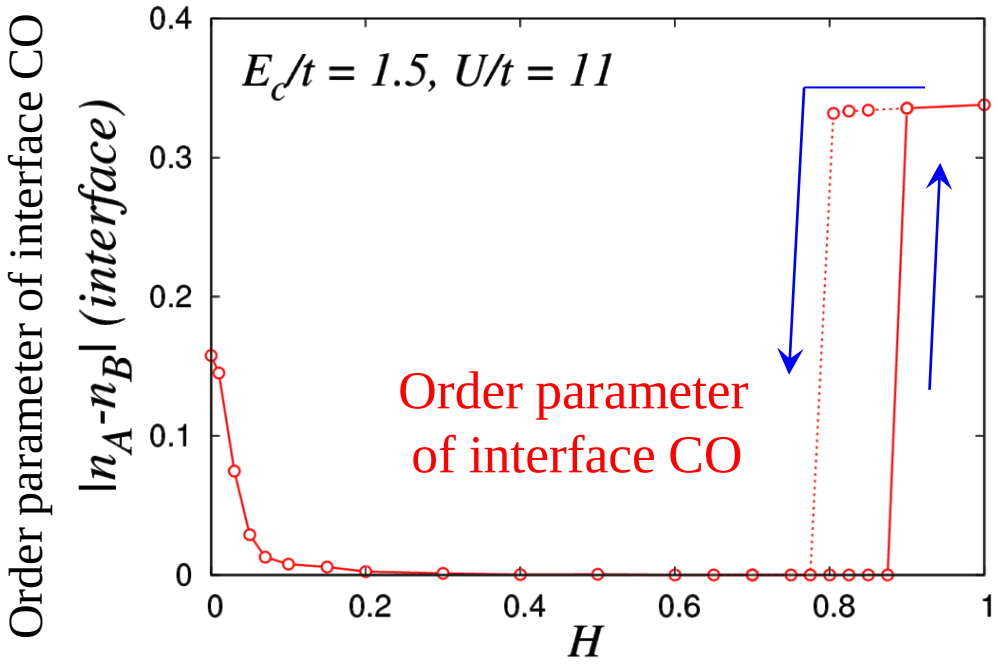
Meta-magnetic transition:
only around the interface

The Meta-magnetism is intrinsic to the heterointerface.

Result2; Field induced Charge Order

In certain parameter regime,

Magnetic field⇒chessboard charge ordered (CO) state



The physical aspects of these transition would be common:

Spin & Charge coupling

Details are discussed in our poster.

Summary

We analyzed “band Ins./Mott Ins./band Ins.” heterostructure under external magnetic fields.

We newly found the interplay of magnetism and charge redistribution induces,

- Metamagnetic transition
- Field induced charge ordered state

Details are presented in our poster.
I’m looking forward to fruitful discussions