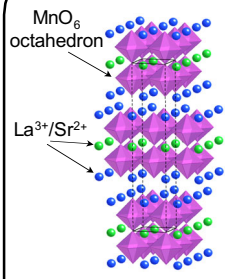
Charting the Roadmap for Layered Manganite Physics

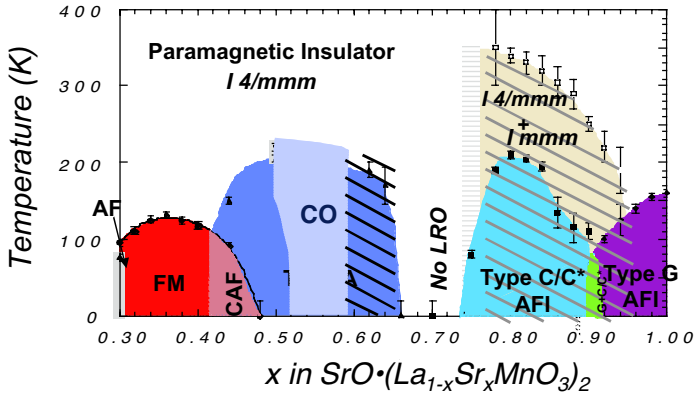
J.F. Mitchell (MSD), C.D. Ling (MSD), Simine Short (MSD), D.N. Argyriou (HMI)

Motivation: To understand ordered states arising from interplay among charges, spins, and orbitals in 2-D manganites.
Approach: Synthesize a broad range of compositions and survey the structural and magnetic phase diagram.
Accomplishment: A basis for strategically chosen future detailed studies in important phase regions.

Structural/Magnetic Phase Diagram of $La_{2-2x}Sr_{1+2x}Mn_2O_7$

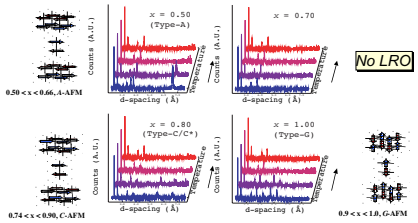


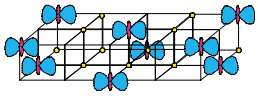
3-2-7 Layered Manganite



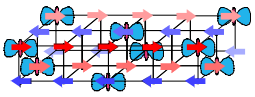
Evolution of Magnetic Structures

Temperature-dependent neutron diffraction experiments reveal the evolution of magnetic phases as well as an unexpected region 0.66 < x < 0.74 where no long-range order (LRO) is found.





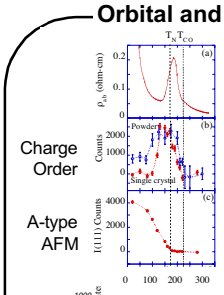
T_O ~ 340 K orbital ordering a < b, ortho phase



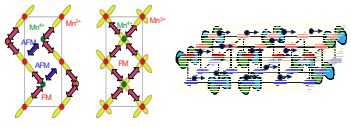
T_N ~ 210 K magnetic ordering *C*-type phase: FM rods coupled AF

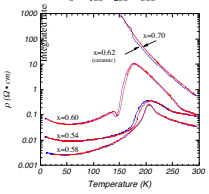
Goodenough rules rationalize magnetic structure assuming localized Mn^{3+}/Mn^{4+} sites

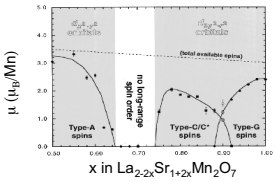
Orbital and Charge Ordering



CO and A-type antiferromagnetism (AFM) compete at x~0.50. Orbital ordering (OO) drives the first order phase transition.

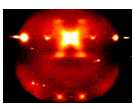




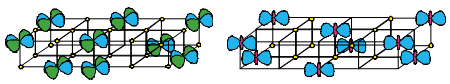


Transport consistent with double-exchange (DE) of charge in the sheets, despite overall AFM structure. MIT at x~0.62 results from rapid loss of A-type fraction.

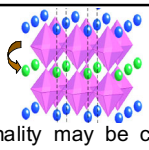
Future Directions



Short-range order (SRO) can be static and/or dynamic. Phase diagram will illuminate the various types of SRO and their relationships

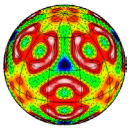


Orbital frustration may result in short-range magnetic structure at x~0.7. Pair distribution function analysis, single xtals can test this idea.



Dimensionality may be controlled by introducing oxygen vacancies between layers. What is the impact on charge ordering and magnetism?

J.F. Mitchell, D.N.Argyriou, A. Berger, K.E. Gray, R. Osborn and U. Welp J. Phys. Chem. B 105, 10731-10745 (2001)



BES - DOE

This work was supported by the U. S. Department of Energy, Basic Energy Sciences, under contract W-31-109-ENG-38.

MSD - ANL

ARGONNE NATIONAL LABORATORY · UNIVERSITY OF CHICAGO