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Strain-induced metal-insulator phase coexistence in perovskite manganites[1]

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The observed coexistence of distinct metallic and insulating electronic phases within the same sample of a perovskite manganite, such as $La_{1-x-y}Pr_yCa_xMnO_3$, has been a puzzle to both theorists and experimentalists. In particular, colossal magnetoresistance in these materials is considered to be closely related to the texture owing to nanometer- and micrometer-scale heterogeneities. In this talk, we show that such texturing can be due to the intrinsic complexity of a system with strong coupling between the electronic and elastic degrees of freedom. More specifically, we demonstrate, using an atomic scale description of lattice distortions, that the presence of multiple local energy minimum states with different lattice distortions and different electronic properties, and the long-range interaction between strain fields provide a natural mechanism for such self-organized multiphase coexistence within the same material. This framework provides a basis for engineering nanoscale patterns of metallic and insulating phases, and for understanding other novel features observed in manganites, such as: precursor short range ordering and quasielastic scattering near the phase transition temperature; hysteretic and glassy dynamics; metastability; and photoinduced insulator-metal transition.

[1]This work was done at Los Alamos National Laboratory in collaboration with T. Lookman and A. R. Bishop, and was published in Nature, V.428, p.401 (2004).