Creating and exploring new phases and properties in highly ‘functional’ transition metal oxides

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Among the most promising candidates for the next generation of functional materials are various transition metal oxides (TMO), whose strong coupling between charge, spin, and lattice degrees of freedom spawns numerous scientifically interesting and technologically useful properties, such as magneto-conductive, magneto-electric, and magneto-thermal phenomena. In this talk, I’ll describe our efforts, first, to use high-pressures and high-magnetic fields to create new, highly responsive phases of matter in TMO, and second, to carefully explore the structure-function relationships associated with these novel phases using optical spectroscopic and other methods.

I’ll discuss, as time permits, studies of several different materials systems, including: (i) magnetically frustrated spinels, which exhibit magneto-dielectric and magnetically driven “shape memory” behavior that is found to be associated with field-dependent structural changes caused by strong spin-orbital coupling; (ii) charge-ordered manganites, whose magnetically driven insulator-metal transitions are identified with field-induced melting of the “frozen” lattice of electronic charges; and (iii) layered ruthenate materials, whose novel magnetoconductive phenomena is shown to result from the field- and pressure-dependent manipulation of electron orbital populations.