Multiferroic Focus Session 2

Spin-orbit interaction and Multiferroicity in Transition Metal Oxides

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The coupling among the charge, spin and orbital degree of freedom is one of the central issues in strongly correlated electron systems.

Recent intensive experimental studies have confirmed a linear coupling between the magnetism and electric polarization. Particularly, in helical magnets, the polarization appears in proportion to the vector spin chirality and to the spin-orbit interaction. In this talk, a systematic microscopic theory of magnetically induced ferroelectricity and lattice modulation is presented for all electron configurations of Mott-insulating transition-metal oxides. Various mechanisms of polarization are identified in terms of a strong-coupling perturbation theory. The origin of polarization is classified as the spin-orbit interaction effective (i) within the magnetic $t_\{2g\}$ orbitals, (ii) between the $t_\{2g\}$ and e_g orbitals, and (iii) within the ligand ion's p orbitals. Predictions for X-ray and neutron scattering experiments are proposed to clarify the microscopic mechanism of the spin-polarization coupling in different materials.

Semiquantitative agreements with the multiferroic TbMnO$_3$ are obtained.