Magnetoelectric effects in multiferroics

Loidl, Alois[1]

[1] *Center for Electronic Correlations and Magnetism, University of Augsburg, 86135 Augsburg, Germany*

Magneto-electric phenomena were investigated for two different classes of multiferroics: The coupling of dielectric and magnetic properties and the simultaneous occurrence of long-range magnetic and polar order are discussed for rare-earth manganese perovskites and for chromium spinels. In addition to the pure rare-earth manganites, we investigated Eu:$YMnO_3$ where the multiferroic phases do not interfere with the rare-earth magnetism. In this perovskites, special attention is being paid to the occurrence of fundamentally new excitations, i.e. electromagnons, which can be characterized as spin waves excited by an ac electric field. We provide experimental evidence for a strong coupling of electromagnons to phonons and further, that as a function of magnetic field optical weight can be transferred from these new excitations to a low-lying phonon branch. At the same time this transfer of optical weight results in considerable changes of the index of refraction allowing the tuning of the refractive index by moderate magnetic fields. For the second class, multiferroic chromium spinels, we discuss the simultaneous occurrence of colossal magneto resistance and colossal magneto capacitance in ferromagnetic $CdCr_2S_4$ and antiferromagnetic $HgCr_2S_4$ which revals a complex helical spin structure at low temperatures. Both compounds exhibit short range polar order only, which can be characterized as relaxor-like ferroelectricity. A detailed investigation of the phonon properties demonstrates that these multiferroics are not characterized by soft phonon modes as observed in classical ferroelectrics, but rather by significant changes of the effective plasma frequencies of the IR-active modes as function of temperature.