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Static and dynamic magnetoelectric coupling in frustrated magnets[1]

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The recently discovered multiferroic materials, where ferroelectricity is induced by spin orders breaking inversion symmetry, show strong sensitivity of electric polarization and dielectric constant to applied magnetic fields. Most of these multiferroics are frustrated magnets with incommensurate spiral spin structures, in which case a polar lattice distortion is driven by the Dzyaloshinskii-Moriya interaction between non-collinear spins. Since this interaction originates from the relatively weak spin-orbit coupling, the induced electric polarization in spiral multiferroics is small compared with that of proper ferroelectrics. Much larger polarizations were predicted for multiferroics where electric dipoles are induced by superexchange interactions between spins. This mechanism of magnetoelectric coupling works for spin structures commensurate with the crystal lattice and does not require non-collinear spins. In many frustrated magnets incommensurate spiral and commensurate collinear spin states compete. Furthermore, in materials such as orthorhombic rare earth manganites $RMnO_3$ and RMn_2O_5, both types of magnetic states are ferroelectric. This competition has important implications for the dynamic magnetoelectric coupling between spin waves and polar phonons resulting in mixed electromagnon excitations. I will discuss microscopic mechanisms of the single-magnon and bi-magnon excitation by an electric field of light in multiferroic and magnetoelectric materials, focusing in particular on the recently observed electromagnon peaks in orthorhombic manganites and Kagome magnets carrying monopole and toroidal magnetic moments. I will show that optical studies can provide useful information about competing multiferroic states in frustrated magnets.

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