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Origin of electromagnons in multiferroic manganites[1]

ROLANDO VALDES AGUILAR, Department of Physics, University of Maryland

The interest in multiferroic materials has increased in the last few years due to the fundamental physics of strong interaction between ferroelectric and magnetic orders, as well as for the promise of novel applications in future electronics. From powerful symmetry arguments and with modeling of the microscopic coupling mechanism, these efforts have led to the discovery of a vast set of multiferroic compounds. An important recent step in this regard was the discovery of a new kind of magnetic excitation that couples strongly to light by acquiring electric dipole activity from the infrared active phonons, called electromagnon, which is a hybrid excitation of magnon and phonon character [2,3]. These discoveries have highlighted the importance of the dynamical aspects of the magnetoelectric coupling. Even though a wide consensus has been reached regarding the origin of the static ferroelectric polarization, the mechanism of the magnetoelectric dynamic effect of electromagnons was not clear. In this talk a combination of theory and experiment is presented that clarifies the origin of the electromagnon excitations in $RMnO_3$. This model is based on symmetric exchange striction and takes into account the lattice and magnetic symmetry of this family of perovskite manganites. It reproduces the fact that the observed selection rule for electromagnons in $RMnO_3$ is independent of the spin plane[4,5]. This result is due to the effective modulation of the exchange interaction between Mn spins induced by the electric field of light. The proposed mechanism is also related to the origin of static polarization in the E-phase of this $RMnO_3$ multiferroic family. The model and experiments carried out so far demonstrate that the symmetric exchange interaction is responsible for all the observed dynamical magnetoelectric effects, and opens a new avenue for study of these multiferroic compounds.

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[2]A. Pimenov, et al. Nature Physics 2, 97 (2006)
[3]A.B. Sushkov, et al. PRL 98, 027202 (2007)
[4]R. Valdés Aguilar, et al. PRB 76, 060404 (2007)
[5]R. Valdés Aguilar, et al. arxiv:0811.2966