MAR12-2011-002663

Abstract for an Invited Paper
for the MAR12 Meeting of
the American Physical Society

Dynamic magnetoelectric interaction in multi-orbital Mott insulators[1]

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The control of spin textures in magnetic insulators with an applied voltage can be of great importance for dissipationless spintronics. The coupling between spin and charge degrees of freedom in Mott insulators originates from the fluctuations of electron occupancy of strongly correlated orbitals of transition metal ions. Several microscopic mechanisms resulting from the virtual hopping of electrons from a magnetic site to its neighbor, e.g. the "inverse Dzyaloshinskii-Moriya" and the Heisenberg exchange striction mechanisms, are responsible for the electric polarization induced by non-centrosymmetric magnetic orders, the excitation of spin waves with the oscillating electric field of a light wave, and other effects recently observed in multiferroic materials. I will discuss a new dynamic magnetoelectric interaction, which describes the electric polarization induced by time-dependent spin textures [1]. Simple symmetry arguments as well as the explicit derivation from an extended Hubbard model of multi-orbital Mott insulators are used to obtain the form of this interaction, which is the electric analogon of the coupling between the scalar spin chirality and magnetic field. It is closely related to the so-called spinmotive force exerted by spins on electrons in magnetic conductors. This interaction makes possible to displace spin textures in ferromagnetic insulators by applying a voltage. It couples the external electric field to the center-of-mass coordinates of topological spin textures in ferromagnetic thin films, such as Skyrmions and magnetic vortices. The effect of this coupling is dramatically amplified in the resonant absorption of circularly polarized light by spin vortices in nanodiscs.

[1] M. Mostovoy, K. Nomura and N. Nagaosa, Phys. Rev. Lett. 106, 047204 (2011).

[1]This work supported by FOM grant 08PR2586.