Electromagnons in multiferroics probed by Raman light scattering comparison to neutron scattering investigations

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In multiferroic materials the two antagonistic effects, magnetic and ferroelectric orders, exist simultaneously. The switching of these orders is known as magnetoelectric coupling. Thereby, magnetoelectric materials can potentially be used to control spins or electric polarization with the application of an external electric or magnetic field, respectively. This makes them promising candidates for applications in spintronics or magnonics that use magnetic excitations for information processing.

$BiFeO_3$ is the rare case where both orders coexist at room temperature. Using Raman scattering, we show that in $BiFeO_3$ the spin-wave energy can be tuned electrically by over 30%, in a non-volatile way with virtually no power dissipation. [1]

In $TbMnO_3$ (and RMn_2O_5) the coupling of the orders gives rise to a hybrid excitation: the electromagnon. Electromagnons are spin wave excitations which possess an electric dipole. We have identified the magnetic excitation underneath the electromagnon by comparison with neutron measurement [2] and further the phonon mode at the origin of the dipole activity. [3,4] We have extended our investigations to Raman scattering and inelastic neutron scattering on $DyMnO_3$. The combination of both techniques offers the opportunity to obtain more information on the electromagnetic interaction in this type of multiferroic material.

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[1] P. Rovillain, et al. , Nature Mat. 9, 975 (2010)
[2] D. Senff, et al., Phys. Rev. Lett. 98, 137206 (2007)
[3] P. Rovillain, et al. , Phys. Rev. B 81, 054428 (2010)
[4] P. Rovillain, et al. , Phys. Rev. Lett. 107, 027202 (2011)