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Electric field control of magnetism in multiferroic heterostructures[1]

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Much interest is being devoted to designing systems where magnetic and ferroelectric orders coexist (multiferroics), and where the presence of magnetoelectric coupling could enable the electrostatic control of magnetism in the solid state. In particular, proximity effects can be tailored to design novel electronic structures with enhanced magnetoelectric couplings in composite heterostructures [1]. A striking example of this approach is our recent demonstration of a large, charge-mediated, magnetoelectric coupling in epitaxial PZT/LSMO heterostructures [2], which explores the sensitivity of the magnetic properties of the doped manganites to charge. Through magnetic, electric, structural and spectroscopic characterization, we demonstrate that the magnetoelectric coupling in PZT/LSMO heterostructures is electronic in origin, and results from the modulation in the valency of the Mn upon switching the PZT ferroelectric polarization [3]. In particular, we conclude that the interfacial spin ordering is modified upon charge doping, which explains the large magnetoelectric response found in this system [4]. This ability to control spin via electric fields opens a new pathway for the development of novel spin-based technologies.

[1] Vaz et al. Adv. Mater. 22:2900, 2010.
[2] Molegraaf et al. Adv. Mater. 21:3470, 2009.
[3] Vaz et al. Phys. Rev. Lett., 104:127202, 2010.
[4] Vaz et al. Appl. Phys. Lett., 97:042506, 2010.

[1]Work carried out at the Deparment of Applied Physics, Yale University, New Haven, CT 06520.