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James C. McGroddy Prize for New Materials Talk: What is new in multiferroicity?: Mott ferroelectrics!

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Multiferroicity is an old topic. For example, linear magnetoelectric effect in materials such as Cr_2O_3 with broken time reversal and space inversion symmetry has been known since 1960's. However, giant cross-coupling effects such as flipping polarization or enormous change of dielectric constant by applied magnetic fields have been recently observed in systems such as Tb(Dy)MnO_3 and Tb(Dy)Mn_2O_5 [1-3]. The important ingredient for these giant magnetoelectric effects turns out to be associated with the presence of non-zero d electrons and their mutual interactions, leading to the Mott-insulator-type charge gap, magnetism, and collective phase transitions. Particularly, the collective nature of simultaneous magnetic-ferroelectric phase transitions results in the giant magnetoelectric effects. In addition, fascinating charge transport properties such as a switchable photovoltaic effect and characteristic conduction properties at domain walls stem from the (carrier-doped) Mott insulating nature of compounds such as $BiFeO_3$ and hexagonal $YMnO_3$ [4,5].

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