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Soft X-ray Observation of electronic contribution to ferroelectric polarization

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Multiferroic materials open up new interesting possibilities for devices by enabling the switching of an electric state by magnetic field or *vice-versa*. In addition to this functionality, multiferroics are intriguing from a fundamental physics perspective, raising interesting questions concerning coupling of the electric and magnetic order parameters. To date, most coupling mechanisms are understood to occur due to distortions in the crystal lattice. Here we present experimental evidence that in the multiferroics RMn_2O_5 (where R is a rare earth) there exists a new, purely *electronic* contribution to the ferroelectric polarization, which can exist in the absence of any lattice distortions. This contribution arises due to spin-dependent hybridization of O $2p$ and Mn $3d$ states and was observed through soft x-ray resonant scattering, which has proved to be a very useful tool in the study of the magnetic structure of multiferroics[1]. Through resonant x-ray scattering at the oxygen K-edge, we find that such spin dependent hybridization occurs in both $TbMn_2O_5$[2] and YMn_2O_5[3]. Remarkably, in YMn_2O_5 we find that the temperature dependence of the integrated intensity of the signal at the oxygen K-edge closely follows the macroscopic electric polarization [3], and hence is proportional to the ferroelectric order parameter. This is in contrast with the temperature dependence observed at the Mn L_3 edge, which reflects the Mn magnetic order parameter.
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