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Multiferroics: lattice assisted magneto-electric coupling

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A microscopic magneto-electric model is studied in which the coupling between spins and electric dipoles is mediated by lattice distortions. The magnetic sector is described by a Heisenberg model coupled directly to the lattice via a standard spin-Peierls term and indirectly to the electric dipole variables via the distortion of the surrounding electronic clouds.
Electric dipoles are described by Ising variables for simplicity. We show that the effective magneto-electric coupling which arises due to the interconnecting lattice deformations is quite efficient in one- and two-dimensional arrays. In the 1D case, using bosonization and extensive DMRG numerical simulations we show that for a magnetic field above the spin Peierls gap, a massive polarization switch-off occurs due to the proliferation of soliton pairs.
Introducing further neighbors couplings and single ion anisotropy, the system shows the "uudd" (or so-called antiphase) magnetic ordering observed in several type II multiferroic materials. In a bidimensional Ising like case we use extensive Monte Carlo simulations to show a qualitatively similar behaviour.

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