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Four-state straintronics: Ultra low-power collective nanomagnetic computing using multiferroics with biaxial anisotropy[1] NOEL D'SOUZA, JAYASIMHA ATULASIMHA, SUPRIYO BANDYOPADHYAY, Virginia Commonwealth University
— Two-phase multiferroic nanomagnets, consisting of elastically coupled magnetostrictive/piezoelectric layers, can be endowed with four stable magnetization states by introducing biaxial magnetocrystalline anisotropy in the magnetostrictive layer. These states can encode four logic bits. We show through extensive modeling that dipole coupling between such 4-state magnets, combined with stress sequences that appropriately modulate the energy barriers between the stable states through magnetoelastic coupling, can be used to realize 4-state NOR logic (J. Phys. D: Appl. Phys. 44, 265001 (2011)) as well as unidirectional propagation of logic bits along a "wire" of nanomagnets (arXiv:1105.1818). As very little energy is consumed to "compute" in such a system, this could emerge as an ultra-efficient computing paradigm with high logic density. We show, by solving the Landau-Lifshitz-Gilbert (LLG) equation, that such nanomagnet arrays can be used for ultrafast image reconstruction and pattern recognition that go beyond simple Boolean logic. The image processing attribute is derived from the thermodynamic evolution in time, without involving any software. This work is supported by the NSF under grant ECCS-1124714 and VCU under PRIP.

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