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Ultra low-energy hybrid spintronics and straintronics: multiferroic nanomagnets for memory, logic and ultrafast image processing[1]

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We have theoretically shown that multiferroic nanomagnets (consisting of a piezoelectric and a magnetostrictive layer) could be used to perform computing while dissipating $\sim$ few 100 kT/bit (Appl. Phys. Lett. 97,173105, 2010) at clock rates of $\sim$1GHz. They can act as memory elements (Appl. Phys. Lett. **99**, 063108, 2011), logic gates (Nanotechnology, 22, 155201, 2011, http://arxiv.org/abs/1108.5758v1) and associative memory for higher order computing such as ultrafast image reconstruction and pattern recognition (J. Phys. D: Appl. Phys. 44, 265001 (2011), http://arxiv.org/abs/1109.6932v1). This talk will provide an overview of our research in:

1. Theoretical study of stress induced magnetization dynamics in isolated multiferroic nanomagnets (memory) and dipole coupled nanomagnetic arrays laid out in specific geometric patterns to implement a universal logic gate.

2. Monte Carlo simulations of the magnetization trajectories in such systems described by the stochastic Landau-Lifshitz-Gilbert (LLG) equation, that show error-free (>99.99%) *fast* ($\sim$1 GHz) switching with very low dissipation (few 100kT/bit/magnet).

3. Demonstrating that multiferroic nanomagnets possessing biaxial anisotropy could be used for four-state logic and perform image processing applications such as image reconstruction and pattern recognition.

4. Experimental fabrication of such devices using e-beam lithography and deposition to create $\sim$ 100 nm diameter elliptical nanostructures and study them with magnetic force microscopy.

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