Abstract Submitted
for the MAR11 Meeting of
The American Physical Society

**Electrically Controlled Spin Valve at a Complex Oxide Interface**

EVGENY TSYMBAL, J.D. BURTON, University of Nebraska - Lincoln — Since the discovery of giant magnetoresistance exploration of spin-dependent electronic transport has proved promising for applications. To avoid the costly generation of magnetic fields in these devices there have been recent efforts toward manipulating magnetization by *electric* fields. Such magnetoelectric effects can be induced at the surfaces and interfaces of many ferromagnetic metals. Ferroelectric materials are especially helpful in this because their spontaneous electrical polarization can induce a large response at the interface with a magnetic metal. One example is the ferroelectric control of magnetic order at the interface between $La_{1-x}A_xMnO_3$ (where $A$ is a divalent cation), and the ferroelectric $BaTiO_3$ [1]. Importantly, ferroelectric films can now be made thin enough (less than a few nm) to allow measurable electron tunneling while still maintaining a stable and switchable polarization [2]. Here we show that those few atomic layers near the interface sensitive to the ferroelectric polarization can act as an atomic scale spin-valve in series with the ferroelectric tunnel barrier. Switching the ferroelectric barrier induces more than an order of magnitude change in the conductance due to the interfacial spin-valve, constituting a substantial spin-dependent transport phenomenon controlled by an electric field alone.

[1] J. D. Burton and E. Y. Tsymbal, Phys. Rev. B **80**, 174406 (2009).
[2] A. Gruverman *et al.*, Nano Lett. **9**, 3539 (2009).

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Date submitted: 12 Nov 2010 Electronic form version 1.4