Abstract Submitted
for the MAR17 Meeting of
The American Physical Society

Electrostatic *vs.* Electrochemical Doping and Control of Ferromagnetism in Ion-Gel-Gated $La_{0.5}Sr_{0.5}CoO_{3-\delta}$.[1] J. WALTER, B. YU, G. YU, H. WANG, B. LUO, Univ of MN, Z. ZHANG, H. ZHOU, J. FREELAND, Argonne National Laboratory, A. GRUTTER, J. BORCHERS, B. KIRBY, NIST Center for Neutron Research, C. D. FRISBIE, M. GREVEN, C. LEIGHTON, Univ of MN — Recently developed ionic liquid/gel gating techniques have proven remarkably expedient in the study of charge density effects in a variety of conductors. Much remains to be learned, however, about the exact gating mechanisms (*i.e.*,electrostatic *vs.* electrochemical), particularly in oxides, where oxygen vacancy formation and diffusion is facile. In this work we demonstrate that in ion-gel-gated $La_{0.5}Sr_{0.5}CoO_{3-\delta}$ (LSCO) films, transport, AFM, and XPS measurements indicate that negative gate biases induce reversible electrostatic hole accumulation, whereas positive biases irreversibly induce oxygen vacancies [1]. This is rationalized in terms of the known redox stability of LSCO, with broad implications for electrolyte gating of hole- *vs.* electron-doped oxides. Clear voltage-control of magnetic and transport properties is then demonstrated under hole accumulation, including a 12 K shift in $T_C$probed *via* anomalous Hall effect [1]. Further to this, *in operando* probes have also been applied, including synchrotron X-ray diffraction directly revealing expansion in unit cell volume due to oxygen vacancy formation under positive bias, and polarized neutron reflectometry to probe the gate-voltage-dependent depth-profile of chemistry and magnetization. [1] Walter *et al.* ACS Nano. (2016).

[1]Work supported by the NSF MRSEC under DMR-1420013.

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Date submitted: 11 Nov 2016 Electronic form version 1.4