Evidence for charge-vortex duality at the LaAlO$_3$-SrTiO$_3$ interface

MANAN MEHTA, DIMITRY DIKIN, Department of Physics and Astronomy, Northwestern University, Evanston, IL, CHUNG WUNG BARK, CHAD FOLKMAN, CHANG-BEOM EOM, Department of Materials Science and Engineering, University of Wisconsin-Madison, Madison, WI, VENKAT CHANDRASEKHAR, Department of Physics and Astronomy, Northwestern University, Evanston, IL — The conducting gas formed at the interface between LaAlO$_3$ and SrTiO$_3$ undergoes a superconductor to insulator transition (SIT) on the application of a back gate voltage, $V_g$. The system also shows evidence of ferromagnetic order coexisting with superconductivity. The juxtaposition of the ferromagnet with the conducting gas allows for the observation of a novel manifestation of charge-vortex duality. The field due to the magnetization dynamics in the ferromagnet causes a sharp increase in resistance on the superconducting side of the transition, in the magnetoresistance measurements, and a sharp decrease in resistance on the insulating side. The system can be modeled as an array of Josephson junctions, with two characteristic energy scales: a Josephson coupling energy $E_J$, and a Coulomb charging energy $E_c$. $V_g$ then tunes the ratio, $E_J/E_c$, to cause the transition. We will present external field sweep-rate dependent magnetoresistance data on both sides of the transition to elucidate the nature of the superconducting and insulating states.

$^1$Funded by the DOE through grant number DE-FG02-06ER46346.
$^2$Dikin et al, PRL 107, 056802 (2011)