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Spin-dependent transport across $SrTiO_3$-based heterostructures

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Identification of candidate spin-preserving materials is of crucial importance for the realization of functional spin logic devices. An oxide spin channel is particularly attractive because of the ease of epitaxial integration with other functional complex oxides, which could manipulate spins in transit. Electron-doped $SrTiO_3$ is one emerging material where high mobility conduction has been realized at the interface between $LaAlO_3$ and $SrTiO_3$, as well as in more traditional semiconducting Nb-doped $SrTiO_3$ thin films. We have investigated spin injection in both systems using a three-terminal (3T) geometry with ferromagnetic electrodes and have observed magnetoresistance commonly attributed to dephasing of an ensemble spin population (Hanle effect), with associated spin lifetimes in the range of 40-130 ps, large enough for the realization of lateral spin transport devices. However, such a picture fails to explain all the experimentally observed behavior. Further experiments indicate contributions from magnetic-field modulation of spin-dependent transport through defect states in the barrier region, suggesting that the 3T approach does not uniquely probe spin accumulation in the $SrTiO_3$ channel.