Highly Efficient and Tuneable Spin-to-Charge Conversion at $LaAlO_3/SrTiO_3$ Interfaces Through the Inverse Rashba-Edlestein Effect

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The spin-orbit interaction couples the electrons' motion to their spin. Accordingly, passing a current in a material with strong spin-orbit coupling generates a transverse spin current (spin Hall effect, SHE) and vice-versa (inverse spin Hall effect, ISHE). The emergence of SHE and ISHE as charge-to-spin interconversion mechanisms offers a variety of novel spintronics functionalities and devices, some of which do not require any ferromagnetic material. However, the interconversion efficiency of SHE and ISHE (spin Hall angle) is a bulk property that rarely exceeds ten percent, and does not take advantage of interfacial and low-dimensional effects otherwise ubiquitous in spintronics hetero- and mesostructures. In this talk, we will show how to make use of an interface-driven spin-orbit coupling mechanism – the Rashba effect – in the oxide two-dimensional electron system (2DES) $LaAlO_3/SrTiO_3$ to achieve spin-to-charge conversion with unprecedented efficiency. Through spin-pumping, we inject a spin current from a NiFe film into the oxide 2DES and detect the resulting charge current, which can be strongly modulated by a gate voltage. We discuss the amplitude of the effect and its gate dependence on the basis of the electronic structure of the 2DES.