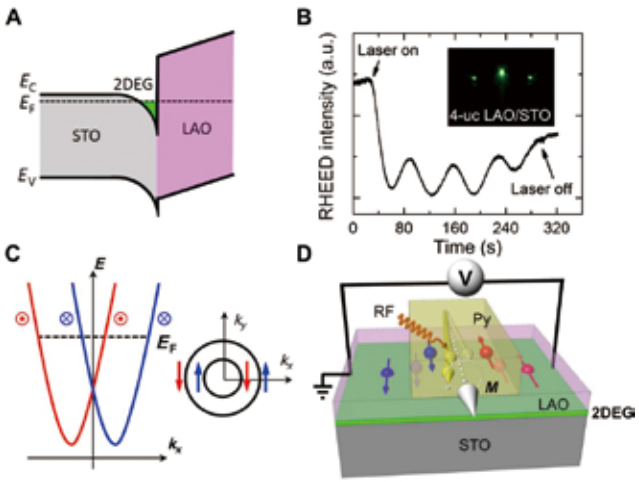
Inverse Edelstein Effect Observed in Rashba-split 2DEG at Complex Oxide Interfaces at Room Temperature

To get efficient approaches to the spin-to-charge conversion is crucially important for spintronics which, as is widely believed, might lead to a new generation of information technology. Fortunately, V. M. Edelstein has proposed a new effect for two-dimensional systems with Rashba spin-orbit coupling which relates spin current to charge current. According to his theory, charge current will generate a pure spin current in perpendicular direction, *i.e.* the Edelstein effect; conversely, when injecting spin current into the system, one will get a charge current, *i.e.*, the inverse Edelstein effect.

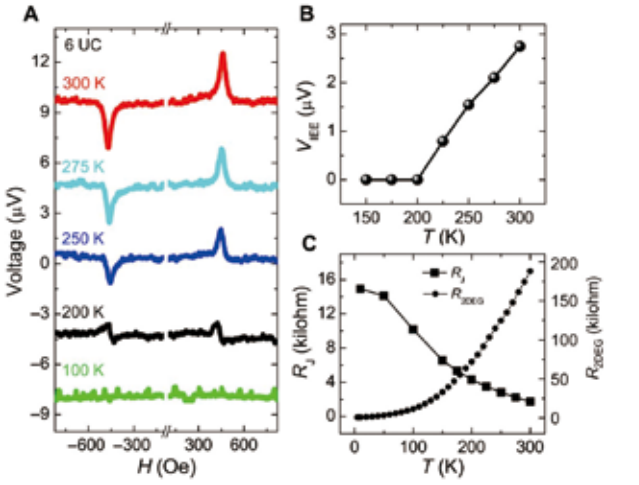
The Edelstein effect has received extensive attention since its first prediction in 1990's, and has been experimentally detected on several metallic interfaces and topological surfaces/interfaces over the past few years. However, it remains unexplored for the interface between two insulator oxides with strong electron correlation and d-electron character, which is completely different from the systems studied before.

The two-dimensional electron gas (2DEG) at the interface displays distinctive properties characterized by 2-dimensional magnetism and superconductivity, though both LAO and STO are non-magnetic, and electrically tunable Rashba-like spin-orbit coupling. It thus provides an idealized platform for this kind of investigations.

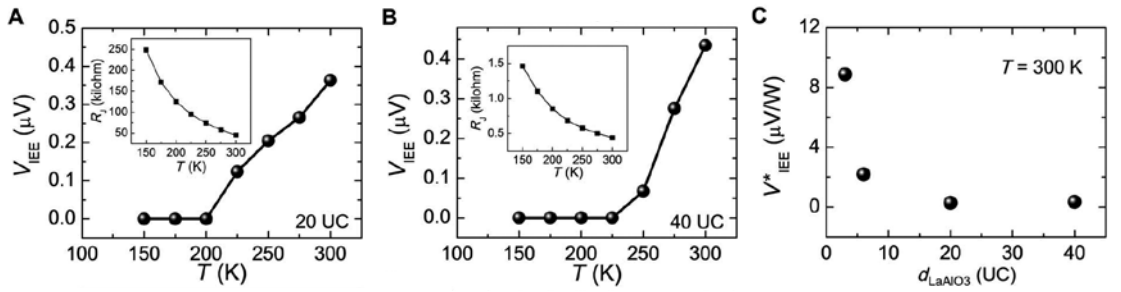
Collaborating with Prof. HAN Wei and Prof. SHI Jing's group from the International Center for Quantum Materials, School of Physics of the Peking University, recently ZHANG Hongrui at Prof. SUN Jirong's group from the Institute of Physics, Chinese Academy of Sciences successfully achieved an efficient spin-to-charge conversion in a wide temperature range around



The Rashba-split 2DEG between $SrTiO_3$ and $LaAlO_3$. (Image by Institute of Physics and Peking University)

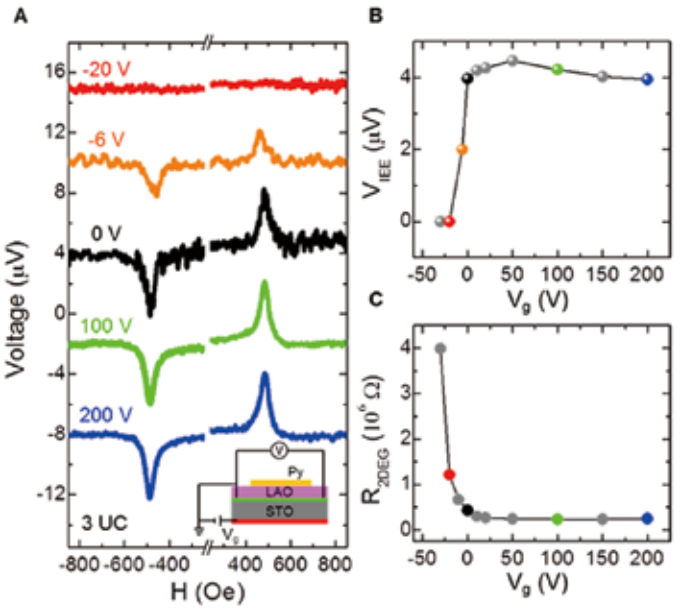


The temperature dependence of inverse Edelstein effect of the Rashba-split 2DEG between $SrTiO_3$ and 6-unit-cell $LaAlO_3$. (Image by Peking University and Institute of Physics)



The temperature and $LaAlO_3$ thickness dependences of the inverse Edelstein effect for the Rashba-split 2DEGs for $SrTiO_3/LaAlO_3$ with thickness up to 40 unit cells. (Image by Institute of Physics and Peking University)

room temperature, through pumping spin current via ferromagnetic resonance into the LAO/STO interface. The spin-to-charge conversion is sensitive to gate field, *i.e.*, it is electrically tunable. More interestingly, spin current is found to be able to transmit through a thick insulating LAO layer before reaching the LAO/STO interface, and considerable conversion effect is obtained even when the thickness of the LAO layer increases up to 16 nm. This is completely different from the previously studied metallic devices, and suggests an unusual transport mechanism for spin current in oxides. The present work shows that the oxide interfaces own nontrivial characters that favor highly efficient spin-to-charge conversion at room temperature, which is a kernel issue of spintronics, a discipline based on spin current generation, detection and manipulation.



The gate voltage dependence of the inverse Edelstein effect of the Rashba-split 2DEG between $SrTiO_3$ and 3-unit-cell $LaAlO_3$. (Image by Peking University and Institute of Physics)

This study, entitled "Observation of inverse Edelstein effect in Rashba-split 2DEG between $SrTiO_3$ and $LaAlO_3$ at room temperature", was published in *Science Advances*.

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