Experimental signatures of finite-momentum Cooper pairing and superconducting diode effect in $LaAlO_3/SrTiO_3$ heterostructures

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The research area of non-reciprocal superconductivity has attracted significant attention in recent years due to its fundamental novelty and strong potential for applications in low-power dissipationless electronics and quantum technologies [1–5]. The superconducting two-dimensional electron gas (2DEG) formed at the $LaAlO_3/SrTiO_3$ (LAO/STO) interface provides a unique environment for studying unconventional superconductivity owing to its strong Rashba spin-orbit coupling, low carrier density, and electrostatic tunability [6]. Building on our previous theoretical prediction of finite-momentum Cooper pairing in the LAO/STO interface [7], we present its experimental verification through low-temperature magnetotransport measurements.

The LAO/STO heterostructures were fabricated by pulsed laser deposition and patterned into Hall-bar devices. Low-temperature transport measurements were performed in a dilution refrigerator down to 50 mK under in-plane magnetic fields up to 2 T. The fabricated devices exhibit a superconducting transition at approximately 240 mK. The temperature dependence of the resistance, $R(T)$, is consistent with the Berezinskii-Kosterlitz-Thouless model, confirming the two-dimensional nature of superconductivity.

By comparing the critical currents measured for opposite current directions and opposite orientations of the in-plane magnetic field, we observe non-reciprocal superconducting transport. The sign reversal of the diode response upon magnetic-field reversal is in agreement with our theoretical prediction [7] of finite-momentum Cooper pairing. Our results experimentally verify this prediction and demonstrate the superconducting diode effect at the LAO/STO interface.

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References

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