

Optical probing of in-plane dipolar textures in trigonal oxide heterointerfaces

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The crystalline symmetry of quantum materials plays a critical role in governing their physical properties—including electronic structure and magnetism—according to Neumann’s principle. In oxide heterostructures, epitaxial growth techniques have enabled precise control of crystal symmetry for material design. Recently, (111)-oriented oxide heterostructures have drawn significant attention due to their unique symmetry, electronic behavior, and interfacial characteristics. Notably, the trigonal symmetry along the (111) direction exhibits broken mirror symmetry in both out-of-plane and in-plane directions, giving rise to exotic phenomena such as polar metallicity[1], Berry curvature[2,3], and quantum metric effects[4] at the oxide heterointerfaces.

In this work, we investigate the emergence of two-dimensional dipolar textures at the (111)-oriented LaAlO₃/SrTiO₃ (LAO/STO) heterointerface through nonlinear optics. By probing and analyzing the symmetry evolution under varying external conditions, such as temperature, position, and gate voltage, we characterize the electric polarization states at the conducting interfaces. Particularly, our experimental findings highlight the role of structural symmetry in governing interfacial electronic properties, such as the orbital Rashba effects.

References

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