# Superconducting transistor effect via gate-controlled inversion symmetry breaking in twisted $NbSe_2$

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Abstract :
Moiré pattern formed by marginal rotational misalignment or lattice mismatch of two atomically thin layers offers a powerful platform for engineering local crystallographic symmetries through the atomic reconstruction. A number of exciting physical phenomena, such as correlated and topological electronic states, have been revealed in twisted graphene and twisted semiconductors systems. Still, very little attention has been paid to the twisted superconductors systems, where control over electronic properties is much more challenging due to high carrier concentration. Here, we demonstrate a new mechanism of engineering the electronic properties in such structures, through the control of the level of the local inversion symmetry breaking.
In twisted trilayer NbSe2 such symmetry breaking leads to the formation of local electric polarization, altering the spin-orbit coupling. The resulting local variations in the order parameter breaks the inversion symmetry for the pinning of superconducting vortices, thus causing the diode effect. Owed to the atomic thinness, such an electric dipole can be tuned by external electric field, allowing for the superconducting transistor behaviour through the control of the level of the inversion symmetry breaking, rather than the direct influence on the carrier concentration. Our results constitute a step forward for constructing novel quantum states and tuning many-body effects in twisted superconductors with potential application for superconducting nonreciprocal circuits