Quantum and classical vortex ratchets in a trigonal 2D superconductor MoS$_2$

One of the unique features of recently emerging 2D superconductors is the quantum metallic state, which is a temperature-independent finite resistive state that appears once finite magnetic field is switched on [1, 2]. This quantum metallic state exhibits a sharp contrast with the conventional superconductor-insulator transition in 2D systems, where the metallic state appears only at a single critical point. To investigate the vortex dynamics which governs the resistance in the quantum metallic state, we have investigated the nonreciprocal transport in gated MoS$_2$, an archetypal noncentrosymmetric 2D superconductor with trigonal symmetry. We found that the second harmonic resistance $R_{xx}^{2\omega}$ appears when the vortex motion is controlled by the classical vortex flow, while $R_{xx}^{\omega}$ is substantially suppressed when the vortex motion is in quantum creep region. The present result indicates that the trigonal 2D superconductor is a new model system for investigation of quantum and classical ratchets.

References


Figures

Figure 1: Trigonal crystal structure of MoS$_2$ and measurement setup.