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Quantum Metal States in high Tc superconducting films and MBE-grown type II Ising superconducting films

After decades of explorations, suffering from the subtle nature and sample quality, whether a metallic ground state exists in a two-dimensional system (2D) beyond Anderson localization is still a mystery. Our work reveals how quantum phase coherence evolves across bosonic superconductor-metal-insulator transitions via magneto-conductance quantum oscillations in high-Tc superconducting films with patterned nanopores. A robust intervening anomalous metallic state characterized by both resistance and oscillation amplitude saturations in the low temperature regime is detected, which suggests that the saturation of phase coherence plays a prominent role in the formation of the anomalous metallic state.[1] Furthermore, Recent emergence of 2D crystalline superconductors has provided a promising platform to investigate novel quantum physics and potential applications. To reveal essential quantum phenomena therein, ultralow temperature transport investigation on high quality ultrathin 2D superconducting films is critically required. Here we report a systematic transport study on the macro-size ambient-stable ultrathin $PdTe_2$ films grown by molecular beam epitaxy [2]. Interestingly, a new type of Ising superconductivity in 2D centrosymmetric materials is revealed by the detection of large in-plane critical field more than 6 times Pauli limit. Remarkably, in perpendicular magnetic field, the film undergoes the quantum phase transition from quantum metal to weakly localized metal with the presence of intermediate quantum Griffiths singularity. Our findings lead to a global phase diagram of 2D superconducting system with strong spin-orbit coupling.

References

[1] arXiv:1901.07706
[2] arXiv:1904.12719