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Expansion of a superconducting vortex core into a diffusive metal

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Vortices in quantum condensates exist owing to a macroscopic phase coherence. Here we show, both experimentally and theoretically, that a quantum vortex with a well-defined core can exist in a rather thick normal metal, proximized with a superconductor. Using scanning tunneling spectroscopy we reveal a proximity vortex lattice at the surface of 50 nm—thick Cu-layer deposited on Nb. We demonstrate that these vortices have regular round cores in the centers of which the proximity minigap vanishes. The cores are found to be significantly larger than the Abrikosov vortex cores in Nb, which is related to the effective coherence length in the proximity region. We develop a theoretical approach that provides a fully self-consistent picture of the evolution of the vortex with the distance from Cu/Nb interface, the interface impedance, applied magnetic field, and temperature. Our work opens a way for the accurate tuning of the superconducting properties of quantum hybrids.

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