Strain induced modulation of the superconducting gap in Fe(Se,Te)

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Fe-based high-temperature superconductors often combine superconductivity, structural distortions, and electronic nematicity, yet their interplay is not always clear. In $FeTe_{1-x}Se_x$, electronic nematicity develops near the critical composition ($x \approx 0.45$), coinciding with the maximum superconducting transition temperature. Spectroscopic-imaging STM measurements revealed that superconducting coherence peaks are locally reduced in regions of strong static nematic order, while nanoscale strain can pin nematic fluctuations and promote localization [1]. These findings suggest a competition between superconductivity and nematicity, with strain acting as a key tuning parameter. While previous work showed reduced coherence peaks, the gap size itself did not seem affected, though this is difficult to confirm at 4.5 K due to thermal broadening. In our 300 mK experiments, we observe that the superconducting gap can be entirely suppressed along strain lines, whereas unstrained regions show a well-defined gap. Using the Lawler–Fujita method [2], we determine the strength and orientation of surface strain to establish its relation to superconductivity. Superconductivity progressively recovers away from the strain lines, and by quantifying both the recovery of the gap and the decay of the strain we can give a characteristic length that is not strictly the coherence length of the superconductor. We show that strain acts as the tuning knob for the superconducting gap, while nematicity play a secondary role: as evidenced by fully gapped spectra on nematic regions, it develops in parallel and is not necessary for suppressing superconductivity.

References

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