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Andreev mapping studies of NbSe2 using Scanning Tunneling Microscopy

We use non-contact Andreev reflection (NCAR) spectroscopy with scanning tunneling microscopy to map superconducting correlations in $NbSe_2$ with atomic resolution. Unlike point-contact Andreev reflection (PCAR), which lacks spatial control and can disturb the surface, NCAR operates in the tunneling regime, enabling systematic, non-invasive imaging of Andreev processes across individual atomic sites. By analyzing the decay of tunneling conductance with tip-sample separation, we detect spatial variations in Andreev reflection arising from orbital-dependent tunneling at Nb and Se atomic sites.

This variation is not explained by local density of states alone, and instead reflects how orbital symmetry and tip coupling modulate Andreev processes. Enhanced reflection near charge density wave (CDW) regions further reveals interplay between superconductivity and competing electronic order.

NCAR distinguishes superconducting gaps from other spectral features based on decay rate behavior, providing a complementary probe to conventional spectroscopic methods. It also allows access to higher-order Andreev processes as the junction approaches near-contact conditions.

This technique offers a sensitive, non-invasive method for probing microscopic aspects of superconductivity, with potential relevance for studying gap symmetry, orbital effects, and local electronic inhomogeneities in complex superconductors.

Topical Area

Hard matter: quantum, electronic, semiconducting materials

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