Two-Dimensional Imaging of Electronic Wavefunctions in Carbon Nanotubes

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We have obtained two-dimensional maps of the electronic wavefunctions in single-walled carbon nanotubes. The measurements were performed by shortening individual metallic nanotubes so as to form discrete “particle-in-a-box” states, and imaging the spatial structure of the corresponding wavefunctions using scanning tunnelling spectroscopy. The measured spatial patterns, which differ markedly from the underlying atomic lattice, can be directly understood by considering the pi-orbital network of a single graphite sheet. The wavefunction images furthermore exhibit delicate quantum mechanical interference effects such as “beating” between electron waves with slightly different wavevectors. We exploit these to directly measure the linear electronic dispersion relation of a metallic nanotube and deduce a value for the Fermi velocity.

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