Quantum modality of Cu-Nb clusters

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Abstract

A new class of materials was identified as Cu20Nb monolayer clusters, which hosts strong correlation electrons. Direct observation show maps of electron wave function patterns, where the symmetry, brightness and size of features was directly related to the position of a Nb atom in Cu lattice, around which the electron was bound. Using the Fourier transform (FT) of the fractal dimension of the AFM images, these clusters present quasi-particle interference (QPI), which reveals a unique picture of electron waves and the trapping of further electrons in the lattice. Furthermore, density functional theory (DFT) calculations validated electronic features of the clusters with remarkable accuracy. DFT calculations also revealed differences between the lowest unoccupied energy (LUMO) and the highest occupied energy (HOMO), and these phase gaps evolved in the ground state. These phenomena provide evidence that electron correlation stimulates electronic bands to pseudo-gap states. Indeed, our experiments pave the way for realizing unconventional superconductivity in zero-dimension materials.

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