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Spatial mapping of screened electrostatic potential and superconductivity by scanning tunneling microscopy/spectroscopy

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By using scanning tunneling microscopy/spectroscopy (STM/S), we can make images of various physical properties in nanometer-scale spatial resolutions. Here, I demonstrate imaging of two electron-correlated subjects; screening and superconductivity by STM/S.

The electrostatic potential around a charge is described with the Coulomb potential. When the charge is located in a metal, the potential is modified because of the free electrons in the host. The potential modification, called screening, is one of the fundamental phenomena in the condensed matter physics. Using low-temperature STM we have developed a method to measure electrostatic potential in high spatial and energy resolutions, and observed the potential around external charges screened by two-dimensional surface electronic states. Characteristic potential decay and the Friedel oscillation were clearly observed around the charges [1].

Superconductivity of nano-size materials, whose dimensions are comparable with the coherence length, is quite different from their bulk. We investigated superconductivity of ultra-thin Pb islands by directly measuring the superconducting gaps using STM. The obtained tunneling spectra exhibit a variation of zero bias conductance (ZBC) with a magnetic field, and spatial mappings of ZBC revealed the vortex formation [2]. Size dependence of the vortex formation will be discussed at the presentation.

References

[1] M. Ono et al., Phys. Rev. Lett., 96, 016801 (2006)

[2] T. Nishio et al., Phys. Rev. Lett. 101, 167001 (2008).