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Vortex-antivortex symmetry in finite-sized superconducting networks

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It is well known that the Abrikosov vortex lattice is a typical vortex configuration in clean bulk superconductors. Downsizing in superconductors may bring in symmetric vortex configurations, giant vortices, and spontaneous antivortices [1]. Another interesting modification to superconductors is their topology. We propose that vortices (antivortices) in finite-sized superconducting networks are able to act like electrons (holes) accommodated in an atomic orbital.

In this talk, we report the effect of vortex doping into superconducting finite-sized Pb square networks fabricated by e-beam lithography. In our system, the application of magnetic field corresponds to the particle (vortex) doping into networks. The vortex configuration was examined with the aid of a SQUID microscope. Vortex images thus observed were compared with the theoretical predictions of the full Ginzburg-Landau equation. For example, we confirmed the exactly reversed pattern between the vortex-doping x and the antivortex doping x into the fully occupied network (x=1/4). This is the consequence of particle-antiparticle symmetry of vortices and antivortices. We also found that a checker-board crystal is the most stable state in a half-filling state. We also discuss the effect of disorder in the superconducting networks.

We also report the vortex configuration in an infinite triangular microhole lattice of Pb investigated by using the SQUID microscope. For example, a half filling (x = 1/2) to the triangular microhole lattice causes a labyrinth vortex pattern, which is in good agreement with a prediction by molecular dynamics calculations [2].

[1] L. F. Chibotaru et al., Nature 408 (2000) 833.

[2] C. Reichhardt and N. G. Jensen, Phys. Rev. B 63 (2001) 054510.