NMR Investigation on Vortex Structures and Dynamics in Superconductors

Moohee Lee
Department of Physics, Kon-Kuk University

In the mixed state of type II superconductors, namely, for $H_{c1}<H_{ext}<H_{c2}$, external magnetic field penetrates incompletely generating huge variation in space. Therefore, local magnetic field exhibits a large degree of inhomogeneity. Depending on position, the local magnetic field shows maximum, minimum and saddle point. Around the maximum field position, superconductivity is suppressed and this region becomes normal. Within this region, no cooper pairs exist and this area is called a normal core. Outside the core, cooper pairs are circulating like a vortex of stream in the sea, to cancel out the external magnetic field. Consequently, this region is called the vortex core. Away from the vortex core, the local magnetic field decreases due to the counter field generated by the circulating cooper pairs. Depending on interaction energy between vortices, one of several vortex phases is stabilized.

It is widely known that cuprate superconductors show distinct superconducting properties unlike other conventional superconductors. Those characteristic properties are high transition temperature T_c, short coherence ξ, long penetration depth λ, and low dimensional nature. Due to these characteristics, cuprate superconductors highlight an unprecedented wealth of exotic phenomena regarding vortex structures and dynamics.

Since NMR frequency is exactly proportional to local magnetic field, vortex structures and dynamics can be sensitively detected in the atomic scale by NMR. Static data of NMR such as spectrum, shift, linewidth are related to the vortex structures whereas dynamical responses of nuclei, such as relaxation times reflect vortex dynamics. I will talk about how NMR data are related to vortex structures and dynamics. Then, some NMR results for cuprate superconductors regarding vortex dynamics will be reviewed. Lastly, our recent results of ^{11}B NMR for nickel borocarbide superconductors will be also presented

and discussed in connection with time and length scale of structural distortion and thermal fluctuation of vortices.