Muon Spin Rotation and the Vortex Lattice in Superconductors

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Muon Spin Rotation (μSR) experiments with superconductors containing a vortex lattice provide unique information about the superconducting properties of the sample. The correct interpretation of the μSR signal requires a detailed theory of the magnetic field distribution $B(\mathbf{r})$ inside the superconductor. μSR allows to measure the probability $P(B)$ that at a random position $\mathbf{r}$ the magnetic field has the value B. The field density $P(B)$ for a perfectly periodic 2-dimensional vortex lattice exhibits van Hove singularities at the maxima, minima, and saddle point values of B. When the vortex lattice is sheared away from the simple triangular or square lattice symmetry, the van Hove peak at the saddle point may split into two or three peaks [1]. Random distortion of the vortex lattice, e.g. by vortex pinning, typically broadens the van Hove singularities and increases the variance of B. However, when a 3-dimensional lattice of point-like pancake vortices in layered superconductors is perturbed randomly, this may reduce the field variance (line narrowing) [2].

Recently, an elegant method was developed that computes the exact solution of the Ginzburg-Landau (GL) theory for the ideally periodic vortex lattice in the entire ranges of the average induction $\bar{B}$ and GL parameter κ. This method was first applied to the 2D vortex lattice in bulk superconductors [3], but later was extended to the 3D vortex lattice in superconducting films of arbitrary thickness in perpendicular field [4]. The field densities $P(B)$ for some of these cases are presented.

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