Effects of the Experimental Geometry on the Vortex Dynamics in High−Temperature Superconductors

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Superconductors of type−II are penetrated by vortices of supercurrent, each carrying one quantum of magnetic flux. These Abrikosov flux lines arrange to a more or less perfect triangular vortex lattice, which exhibits interesting non−local elasticity and may be plastically deformed, amorphous, entangled, and even melted. In layered superconductors the vortex lines are composed of vortex disks (''pancakes'') positioned in the superconducting layers and connected by vortex segments, which have their core between the layers (''Josephson strings''). Under the action of an applied electric current the vortices can move and dissipate energy. This undesired vortex drift is suppressed by introducing material inhomogeneities, which pin the vortices. In the new High−Temperature Superconductors the vortices may depin by thermal activation, which causes a non−zero and in general highly nonlinear resistivity even at low current densities. In typical measurements of the magnetic response, the superconductor is a thin platelet or film exposed to a *perpendicular* magnetic field. Up to quite recently, appropriate theories for the evaluation of such experiments were not available but one resorted to theories which were derived for long slabs or cylinders in *parallel* field. For other specimen shapes one used corrections by a demagnetization factor, but this works only for homogeneous specimens with elliptical shape and linear response. Recent exact analytical results extend the *static* Bean model to thin disks and strips of constant thickness in a perpendicular magnetic field. Analytical and numerical methods yield the *dynamics* of the magnetic flux in thin strips, disks, rings, rectangles, and also in thick strips and short cylinders treated as conductors with non−linear or complex linear resistivity. Our powerful numerical methods are based on an equation of motion for the current density inside the superconductor and can be used for a wide class of problems with different geometries.