Recent Results on the "Paramagnetic Meissner Effect"

Michael W. McElfresh, Victor Souw, Shi Li

Department of Physics. Purdue University, West Lafayette, Indiana 47907

Ladislav Pust, and Lowell E. Wenger

Department of Physics and Astronomy, Wayne State University, Detroit, Michigan 48202

Abstract

The "Paramagnetic Meissner Effect" (PME) was studied in a Nb disk of 6.4 mm diameter and 0.127 mm thickness. In SQUID magnetometer measurements, the magnetic field was applied perpendicular to the disk surface and the sample position rigidly fixed in order to eliminate any possible complications due to field nonuniformities.

The zero-field-cooled SQUID data, collected while warming the sample in an applied field, shows two diamagnetic m(T) transitions near T = 9 K, separated by less than 0.2 K. In contrast, subsequent field-cooling of the sample produces a positive step in the SQUID feedback loop voltage. This indicates a positive, or paramagnetic, step in the magnetization, at T = 9 K. The magnitude of this paramagnetic step increases with increasing field until it reaches 10^{-4} emu at H = 50 Oe. This corresponds to less than 0.1% of the zero-field-cooled, diamagnetic change in m(T). At still higher fields, the field-cooled magnetization step also becomes diamagnetic, although an initial positive step at Tc remains.

In order to provide an independent measurement of this effect, localized magnetization measurements were conducted with millimeter-scale Hall sensors. Hall sensors were placed at the top and the bottom of the disk and also

near the center and near the edge of the disk. In all cases, the field-cooled Hall sensor measurements show no magnetization step to an accuracy of 0.5 G. In contrast, simultaneous SQUID measurements clearly show the paramagnetic magnetization step.