EXPLORING HIGHLY ANISOTROPIC VORTEX LATTICES OF UNCONVENTIONAL SUPERCONDUCTORS USING SMALL ANGLE NEUTRON SCATTERING

Abstract
by
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Superconductivity is described by its electronic and magnetic properties. One way to explore unconventional superconductors is to examine how these properties of superconductors behave differently along different crystalline directions in various materials. The magnetic behavior for many of these materials is highly anisotropic, meaning the basal plane superconducting length scales are quite different than that of the $c$ axis.

In this work, the superconducting length scales were explored by novel small angle neutron scattering (SANS) techniques of the vortex lattice. Unconventional superconductors were placed in a magnetic field, which induced a vortex lattice whose properties reflect the overall superconducting state. The description of the vortex lattice reveals direct insights into the nature of superconductivity in the studied materials. In the iron based superconductor KFe$_2$As$_2$, SANS was used to show, for the first time, simultaneous evidence for multiband superconductivity and Pauli paramagnetism. In the unconventional superconductor Sr$_2$RuO$_4$ a polarized SANS method was developed. This was used to find evidence for multiband superconductivity as well as evidence for nodes or deep minima in the order parameter.
“...And, departing, leave behind us
Footprints on the SANS of time”

-paraphrased from Henry Wadsworth Longfellow (1838)