Stony Brook University
The Graduate School

Doctoral Defense Announcement

Abstract

Investigations in the crystal growth and neutron scattering of

superconductors and a relaxor ferroelectric

By

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In this dissertation, I present research on four materials with properties that are not well understood. First, we investigated materials synthesis and annealing conditions of the proposed topological superconductor $Cu_xBi_2Se_3$, finding that quenching above a minimum temperature was essential for superconductivity. Due to the inhomogeneity of $Cu_xBi_2Se_3$, we suggest that a metastable secondary phase may be responsible for the superconductivity. Second, we performed neutron scattering measurements on samples in the $Fe_{1+y}Te_{1-x}Se_x$ family of iron-based superconductors, focusing on the anomalous phonon mode recently discovered near Bragg peaks forbidden by symmetry and at high-symmetry wavevectors where the mode's neutron scattering intensity is expected to be zero. We characterize this mode and propose that disorder may explain its existence. Third, a superconducting crystal of the bilayer cuprate $La_{1.9}Ca_{1.1}Cu_2O_{6+d}$ was synthesized and measured by neutron scattering. Though the magnetic excitations near (0.5,0.5) in reciprocal space resemble those of undoped or lightly hole-doped non-superconducting cuprates, changes in spectral weight with temperature suggest the presence of a superconducting resonance. Fourth, the relaxor ferroelectric $Pb(Mg_{1/3}Nb_{2/3})_{0.68}Ti_{0.32}O_3$ was measured with neutron scattering while subjected to an electric field. From differences in neutron scattering intensity with and without electric field, we find a possible coupling between short-range polar correlations and transversely-polarized phonons near certain Brillouin zone centers.

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