

Massachusetts Institute of Technology
Department of Physics

Condensed Matter Theory Seminar

" Topological superconducting states revealed by NMR
-- $\text{Cu}_x\text{Bi}_2\text{Se}_3$ and $(\text{K,Rb})_2\text{Cr}_3\text{As}_3$ --"

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Abstract: Topological Insulators (TIs) are materials in which the bulk is insulating but the surface hosts gapless metallic states due to non-zero topological invariants of the bulk band structure. A topological superconductor is analogous to a TI in that the superconducting gap function has a nontrivial topological invariant. The gapless quasiparticle states on the surface (called Majorana fermions) of a topological superconductor have potential applications in topological quantum computing.

Although a great success has been achieved in the study of topological insulators, progress in establishing bulk topological superconductivity has been slow until recently [1]. In this seminar, I will present some of our results in the quest of topological superconductivity in doped topological insulators $\text{Cu}_x\text{Bi}_2\text{Se}_3$ [1] and $\text{Sn}_{1-x}\text{In}_x\text{Te}$ [2,3], as well as in strongly-correlated superconductors $(\text{K,Rb})_2\text{Cr}_3\text{As}_3$ [4]. In $\text{Cu}_{0.3}\text{Bi}_2\text{Se}_3$, our ^{77}Se nuclear magnetic resonance (NMR) measurements indicate that spin rotation symmetry is spontaneously broken in the hexagonal plane below the superconducting transition temperature $T_c=3.4$ K [1]. This is the first evidence for such symmetry breaking found in any superconductors. Our results not only establish spin-triplet (odd parity) superconductivity in this compound, but also show that it is a topological superconductor belonging to DIII class. I will also discuss our most recent effort to obtain single crystals of $\text{Cu}_x\text{Bi}_2\text{Se}_3$ with various doping contents.

In $\text{Rb}_2\text{Cr}_3\text{As}_3$ ($T_c=4.8$ K), we found strong ferromagnetic spin fluctuations in the normal state and point nodes in the superconducting gap [4], which suggest that this compound may be a solid-state analogue of superfluid ^3He .

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