Possible Topological Superconductivity in $Cu_xBi_2Se_3$ and $Sn_{1-x}In_xTe$

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Topological insulators (TI) are a new state of matter attracting a lot of interest (for a recent review see, e.g., [1] and references therein). TIs are fully gapped in the bulk while the surface (or edge in 2D) exhibits metallic conduction due to gapless surface states protected by time-reversal symmetry and with a Dirac-like energy dispersion. Examples are $Bi_{1-x}Sb_x$, Bi_2Se_3, or Bi_2Te_3. Among them, Bi_2Se_3 attracted special interest since Cu intercalation into Bi_2Se_3 introduces superconductivity [2]. Therefore this system is discussed as a possible topological superconductor (TSC), characterized by a topologically protected gapless surface state, i.e., an Andreev bound state consisting of Majorana fermions.

In this talk, the superconducting phase in $Cu_xBi_2Se_3$ will be characterized by discussing the results of thermodynamic and transport measurements [3-5]. An analysis of the specific-heat data suggests strongly-coupled superconductivity in this system [4]. Field-dependent magnetization data reveal a very small lower critical field strength B_{c1} of less than 0.5 mT and hence a rather small superfluid density $\rho_s \sim B_{c1}$ [5]. From a point-contact spectroscopy study it was found, that this system exhibits a surface Andreev bound state and hence the superconductivity in $Cu_xBi_2Se_3$ is unconventional. An analysis of all possible superconducting gap functions allows the conclusion, that $Cu_xBi_2Se_3$ is a strong candidate for a topological superconductor [6] as also supported by recent theoretical works [7, 8].

Another candidate material is the superconductor In-doped SnTe [9,10]. The parent material SnTe was found to be a topological crystalline insulator, a material where the nontrivial topology is protected by the point-group symmetry of its crystal lattice rather than time-reversal symmetry. This material ($x \sim 0.04$) also exhibits a surface Andreev bound state and with support from theory there is strong evidence that this system is a topological superconductor [10].

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