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Topological phase transitions and a two-dimensional Weyl superconductor in a superconductor/half-metal heterostructure

We find a series of topological phase transitions in s-wave superconductor/half-metal thin-film heterostructure, by tuning the direction of the magnetization of the half-metal film. The heterostructure is grown on top of a semiconductor. The function of the semiconductor surface is to provide a Rashba spin-orbit coupling to charge carriers in the half-metal film where the superconductivity could be induced via the proximity effect from the superconducting film. Employing numerical and analytic methods, we explore the novel physics in the half-metal film and its edge states, these include transitions from a topological superconducting phase with a bulk gap to another phase without a bulk gap, but has a ubiquitous local gap which implies only parts of the Fermi surface being gaped. At the same time, the edge states change from counter-propagating Majorana edge modes to unidirectional Majorana edge modes. In addition, we find transitions between the second phase and a nodal phase which turns out to be a two-dimensional Weyl superconductor with Fermi line edge states. We identify the topological invariants relevant to each phase and the symmetry that protects the Weyl superconductivity. Experiments to detect these phases are going to be proposed. The physics with a d-wave superconducting film in the heterostructure will also be discussed.

Biography

C S Ting is a Professor of Physics at the University of Houston, USA. His major research area has been on theoretical condensed matter physics including transport theories in various solid state systems, superconductivity in copper oxide materials and iron pnictides, magnetism, metal-insulator transition, electronic property of graphene, solids with the spin-orbit couplings and strongly correlated electron systems. He is the Principal Investigator of Theory at the Texas Center for Superconductivity at the University of Houston, and a Fellow of APS in the Division of Condensed Matter Physics.

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