Probing Magnetic Field Induced States in Unconventional Superconductors

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Applying a magnetic field to a superconductor is a powerful way of revealing the complexity of this macroscopic quantum state of matter. Even though the effects of the field in conventional type-II superconductors are well established, in a wide range of systems (such as the high-T_c, heavy fermions, and organic superconductors) the consequences are far from being understood. One possibility is that the magnetic field may affect the competition between superconductivity and antiferromagnetism (or other competing orders). Furthermore, an applied magnetic field may induce a novel superconducting state in which the momentum of the Cooper pairs is not equal to zero, but becomes finite and proportional to field, as predicted by Fulde, Ferrell, Larkin, and Ovchinnikov (FFLO). In this state the superconducting order parameter oscillates in real space. Heavy fermion superconductor $CeCoIn_5$ is a unique example of complex coexistence of a field induced magnetic order and the FFLO phases; and, thus, provides a strikingly rich ground to study the complex interplay between exotic superconductivity and magnetic degrees of freedom. In this talk, I will discuss how nuclear magnetic resonance (NMR), a microscopic probe sensitive to both magnetic and SC degrees of freedom, is used to probe microscopic nature of these exotic states.