Coexistence of antiferromagnetism and d-wave superconductivity induced by paramagnetic pair-breaking

R. Ikeda, Y. Hatakeyama, K. Hosoya, and K. Aoyama

Department of Physics, Kyoto University, Kyoto 606-8502, Japan

The discovery of antiferromagnetic (AFM) order [1] in the high field corner of the d-wave superconducting phase of $CeCoIn_5$ has led to a tremendous interest in the genuine picture on the high field and low temperature (HFLT) superconducting phase of this compound in fields parallel to the basal plane which has been identified earlier with the long-sought Fulde-Ferrell-Larkin-Ovchinnikov (FFLO) phase. The detected field-induced AFM order is peculiar in the sense that it is absent outside the HFLT phase and has its *incommensurate* **Q**-vector parallel to (π, π).
We develop a theory [2] identifying the HFLT phase of $CeCoIn_5$ as the coexistent phase of AFM and FFLO orders in a d-wave superconductor with strong paramagnetic pair-breaking (PPB). At this time, details of the resulting AFM order and its stability against a field-tilt are also examined. It is shown that the incommensurate **Q**-vector parallel to (π, π) is a reflection of the fact that the principal Fermi surface of $CeCoIn_5$ has the largest densty of states along (π, π) and that the disappearance of the AFM order due to the field tilt is naturally understood if the AFM staggered moment of the PPB-induced AFM order or fluctuation is locked primarily along the c-axis irrespective of the orientation of the applied field.
[1] M. Kenzelmann et al., Science **321**, 1652 (2008).
[2] R. Ikeda, Y. Hatakeyama, and K. Aoyama, Phys. Rev. B **82**, 060510(R) (2010).