PC3-2-INV

Fulde-Ferrell-Larkin-Ovchinnikov Phases in Layered Organic Superconductors

*S. Uji[1], S. Sugiura[1], T. Isono[1], N. Kikugawa[1], T. Terashima[1], H. Akutsu[2], Y. Nakazawa[2], D. Graf[3], P. Day[4]

National Institute for Materials Science, Tsukuba 305-0003, Japan[1]
Osaka University, Toyonaka, Osaka 560-0043, Japan[2]
National High Magnetic Field Laboratory, Tallahassee, Florida 32310, USA[3]
University College London, London, United Kingdom[4]

In conventional superconductors, the superconducting order parameter is spatially homogeneous. However, when the superconductivity is in the clean limit and the orbital effect is strongly quenched, so-called Fulde and Ferrell, and Larkin and Ovchinnikov (FFLO) phase with an inhomogeneous order parameter can be stabilized in fields above the Pauli limit H_{Pauli}. Highly two-dimensional layered organic superconductors are best candidates for the FFLO phase studies. In the FFLO phase, the order parameter is given by $\Delta(\mathrm{r}) = \Delta_0\cos(\boldsymbol{qr})$, where $\boldsymbol{q}$ is the center-of-mass momentum of the Cooper pairs. When a magnetic field is applied parallel to the layers, flux lines penetrate the insulating layers, forming Josephson vortices (JVs). The JVs are easily driven by a perpendicular current, leading to nonzero interlayer resistance in the SC phase.

When the wavelength of the FFLO order parameter oscillation $\lambda_{\mathrm{FFLO}} = 2\pi/q$ becomes commensurate with the JV lattice constant l, the JVs are collectively pinned and dips periodically appear in the field dependence of the interlayer resistance. This commensurability (CM) effect is a powerful tool to estimate the order parameter oscillation in the FFLO phase. So far, we have found the CM effects in the FFLO phases for three different layered organic superconductors [Fig. 1] [1,2]. For these superconductors, the FFLO phases appear above ~ H_{Pauli} at low temperatures. On reasonable assumptions, we can estimate λ_{FFLO}, which decreases as the field approaches H_{c2}.

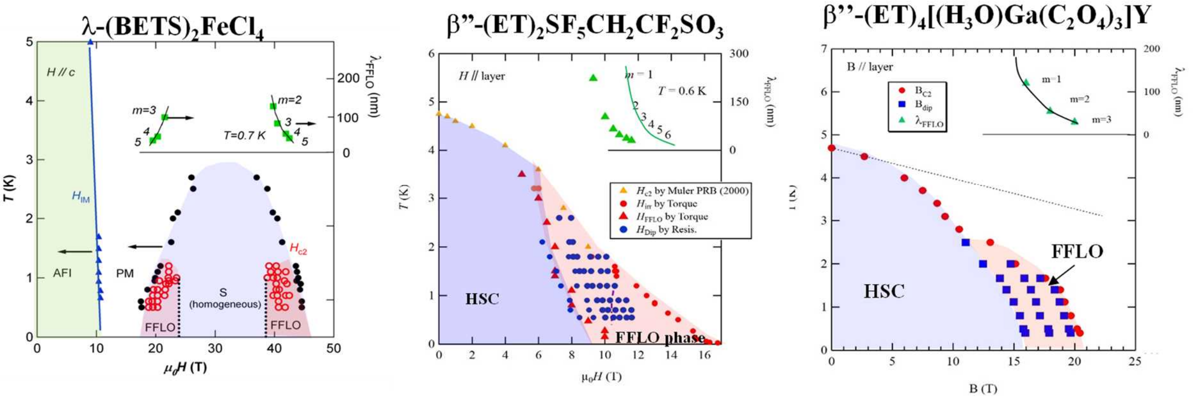

Figure 1: Superconducting phase diagrams for three different organic layered superconductors. Red regions show FFLO phases.

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Keywords: Organic superconductor, FFLO, high magnetic field