Superconductivity in Organic Conductors at Low and High Magnetic Fields

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Several criteria must be met in order that singlet superconductors survive to fields greater than the Pauli paramagnetic limit $H_P$ where inhomogeneous (Fulde-Ferrell-Larkin Ovchinnikov, FFLO) superconducting phases might be observed. Among these, the system must be in the clean limit and magnetic field-induced orbital suppression of superconductivity has to be avoided. These conditions apply to a number of organic superconductors, including the quasi-one dimensional (TMTSF)$_2$X, and the quasi-2D $\kappa$-(BEDT-TTF)$_2$Cu(NCS)$_2$. In both cases, the interlayer coherence length is sufficiently small that orbital coupling is diminished for in-plane fields, and superconductivity is observed to survive to fields significantly exceeding $H_P$. In the case of (TMTSF)$_2$X, triplet spin pairing, at least at high fields, is a possible explanation. Nevertheless, both systems are candidates for the observation of the FFLO state. The local spin susceptibility is probed with $^{77}$Se NMR measurements for (TMTSF)$_2$ClO$_4$ and $^{13}$C for $\kappa$-(BEDT-TTF)$_2$Cu(NCS)$_2$. The inferred distribution of hyperfine fields, as well as the field dependence of the relaxation rate, are discussed in this context. For the quasi-1D system, there is evidence for a rapid change from small spin susceptibility $\chi_s$ to that expected for the normal state at $H=H_P$. Experiments for the quasi-2D material are ongoing.

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