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Evidence For Inhomogeneous Superconductivity In Organic Superconductor

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Over 40 years ago it was predicted independently by Fulde and Ferrell and by Larkin and Ovchinnikov that if orbital limiting of the superconducting state in a magnetic field could be suppressed, superconductivity could persist beyond the Clogston-Chandrasekhar limit, which is the limit where the magnetic Zeeman energy dominates pair breaking of Cooper pairs. It was also predicted that above the Clogston-Chandrasekhar limit, the superconducting state could be inhomogeneous, such that the order parameter would become spatially modulated. Using a tunnel diode oscillator, we have measured the rf penetration depth in a number of quasi 2D organic superconductors as a function of temperature and magnetic field. By applying a magnetic field exactly parallel to the conducting layers, we have been able to suppress the orbital limiting of the superconducting state, and stabilize superconductivity above the Clogston - Chandrasekhar limit. By sweeping the magnetic field in a pulsed magnet at different temperatures, we have mapped out phase diagrams for a number of organic materials. In three different materials we have found phase diagrams that are consistent with inhomogeneous superconductivity, containing what we label an FFLO state, after the authors who predicted it. We will show additional evidence for the FFLO state by analyzing data taken with the magnetic field at angles near but not exactly parallel to the conducting layers.