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Chiral anomaly induced charged pion superconductivity

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Determining the phase structure of nuclear and quark matter in external magnetic fields is not only of theoretical interest but also experimentally motivated by the large magnetic fields found in heavy-ion collisions and compact star physics. In Chiral Perturbation Theory, neutral pions form an inhomogeneous phase dubbed the "Chiral Soliton Lattice" (CSL) above a certain critical magnetic field as a consequence of the chiral anomaly. Above a second, even higher critical field, the CSL becomes unstable to fluctuations of charged pions, implying they condense.

I will point out the similarity of this second critical field to the upper critical magnetic field in conventional type-II superconductors, leading to the possibility of an inhomogeneous, superconducting charged pion phase existing above this point. Applying similar methods originally used by Abrikosov, I will present results where we've constructed such a phase in the chiral limit, demonstrating that it is preferred and forms a hexagonal array of vortices. Its local effect on the baryon number density, which is non-zero and periodic like in the CSL will also be briefly discussed.

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