

3D Pion crystal from the chiral anomaly

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Including the effects of the chiral anomaly within Chiral Perturbation Theory at finite baryon chemical potential, it has been shown that neutral pions form an inhomogeneous phase dubbed the “Chiral Soliton Lattice” (CSL) above a certain critical magnetic field that could possibly be reached in magnetars and heavy-ion collisions. Beyond a second 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, suggesting that an inhomogeneous superconducting charged pion phase exists beyond this point. Applying similar methods originally used by Abrikosov, I will present results where we’ve constructed such a phase, and show the region where it is preferred in the baryon chemical potential-magnetic field phase diagram at zero temperature. This new phase has a non-zero baryon number density which is periodic in all three spatial dimensions.

Presenter: EVANS, Geraint (Institute of Physics, Academia Sinica, Taiwan)