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Cluster expansions and chiral symmetry at large density in 2-color QCD

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We study lattice $SU(N_c)$ gauge theories with massless staggered fermions at finite quark chemical potential μ . At strong coupling such theories have been studied with a variety of techniques such as mean field, monomer-dimer representations and MC simulations. Here we employ a new cluster expansion which has recently been shown to converge for large μ and small β . Extension to weaker coupling, however, does not appear feasible in the presence of complex fermion determinant. For theories with real determinant, however, such as 2-color QCD, we show how such large μ cluster expansions can be used to obtain information on the behavior of lattice observables in the weak coupling regime. We discuss the intertwined questions of presence of chiral symmetry and quarkyonic vs. superfluidity/superconductivity phases at large μ , and the problem of saturation, a lattice artifact, and means to circumvent it.

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