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Perturbative predictions for color superconductivity on the lattice

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Recent developments in methods to overcome the sign problem in finite density QCD such as the complex Langevin method give us hope to investigate color superconductivity (CSC) in cold dense QCD matter from first principles. In view of this situation, we obtain quantitative predictions for the parameter region for CSC from lattice perturbation theory, which is valid for QCD in a small box. In particular, we use 2-flavor Wilson fermions in addition to 4-flavor staggered fermions reported in APLAT 2020. Based on the Thouless condition, we calculate the coupling constant corresponding to the critical point of CSC as a function of the quark chemical potential without any ansatz for the shape of the Cooper-pair condensates. We find a characteristic behavior that the region of CSC extends towards weak coupling at the chemical potential corresponding to the energy levels of free quarks in the case of staggered fermions. Similar behavior is observed also in the case of Wilson fermions although the region of CSC slightly shrinks when the chemical potential is very close to the energy levels of free quarks.

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