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Inhomogeneous phases in phase diagram of various models

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The QCD phase diagram at high baryon density and moderate temperature is expected to exhibit a rich phase structure beyond the possible first-order transition. Inhomogeneous phases, i. e. phases characterized by spatially modulated condensates, is one of the most intriguing options. These phases, such as the chiral density wave or crystalline condensates are studied as a rule using model calculations, for example, in the framework of Nambu–Jona-Lasinio and quark-meson models. The studies indicate that the inhomogeneous region potentially covers the putative critical endpoint and connects the hadronic and quark-matter phases. Their presence can significantly alter the phase structure and its experimental implications. The status of inhomogeneous phases will be briefly reviewed and new results in quark matter with isospin and chiral imbalance will be discussed. The studies in effective models have their own problems. So the study of low-dimensional models is critical in this context owing to their relative simplicity and renormalizability. The inhomogeneous phases are thoroughly studied in (1+1)-dimensional models. The search for such phases in (2+1)-dimensional models is a recent endeavor, and current evidence suggests they are absent. We check this implication and then discuss (2+1)-dimensional models with one compactified spatial coordinate and study inhomogeneous phases in the crossover regime between these two low-dimensional models and found in what conditions the inhomogeneous phase is realized.

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