Effects of Short-Range Correlations on Quarkyonic Matter

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A quarkyonic model can be regarded as theoretically complete only if it incorporates short-range correlations. These correlations induce the scattering of nucleons to momenta exceeding the Fermi momentum, thereby altering the momentum-space occupation distribution that underlies the quarkyonic framework. In this work, we focus on investigating the impact of the nucleon momentum distribution on the properties of quarkyonic matter. More specifically, we examine to what extent the emergence of a high-momentum tail, due to the short-range nucleon-nucleon correlations, in the momentum distribution, for momenta exceeding the Fermi momentum, affects the fundamental properties of quarkyonic matter, such as the energy density, pressure, and speed of sound, among others. In particular, due to short-range correlations, nucleons exhibit momentum components extending beyond the Fermi momentum. In fact, at high densities, the behavior of the momentum distribution has been established, both experimentally and theoretically, to follow a characteristic $\sim 1/k^4$ dependence at large momenta. To the best of our knowledge, the aforementioned effect on quarkyonic matter has not yet been systematically investigated in the existing literature. An additional motivation for the present study arises from the fact that this specific feature of the momentum distribution has been experimentally confirmed. We therefore conjecture that heavy-ion collision experiments may provide valuable insight into the possible existence of quarkyonic matter. Consequently, the inclusion of this effect in theoretical calculations is essential and should not be overlooked.

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