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Spinodal instability of baryon-rich quark matter

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The spinodal instability of a baryon-rich quark matter is studied in both the Nambu-Jona-Lasino (NJL) and the Polyakov-Nambu-Jona-Lasino (PNJL) model. We first obtain via the linear response theory the boundary of the spinodal region and calculate the growth rate of unstable modes. We find that at the mean-field level, the boundary of spinodal instability shrinks with the wave number of unstable modes and is also reduced by both the vector interaction and quantum effect. We then numerically solve the transport equations derived from the NJL Lagrangian to study density fluctuations in a quark matter that is confined in a static box. Appreciable higher-order density moments are seen as a result of the first-order phase transition in the baryon-rich quark matter. Also, the skewness of the quark number event-by-event distribution for quarks in a small sub-volume of the system becomes appreciable. Allowing the quark matter to expand as in heavy ion collisions, we find the presence of a first-order phase transition slows down the expansion and result in the appearance of density clumps that can lead to enhancements in density moments, anisotropic flows, and the dilepton yield.

Summary

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