Mechanical and chemical-diffusive instabilities in high density strange nuclear matter

A. Lavagno[1], G. Gervino[2]

[1]Politecnico di Torino and INFN Torino

[2]Universitá di Torino and INFN Torino

One of the very interesting aspects in nuclear astrophysics and in the heavy-ion collisions experiments is a detailed study of the thermodynamic properties of strongly interacting nuclear matter away from the nuclear ground state. At high temperature (about 170 MeV) and very low baryon density a deconfined matter of quark-gluon plasma (QGP) is expected and confirmed by QCD lattice calculations. In the absence of a converging method to approach QCD at finite density one has often to resort to effective and phenomenological model investigations to obtain qualitative results.
The main goal of this contribution is to show that thermodynamic instabilities and phase transitions can take place at finite net baryon density and temperature, where the onset conditions of deconfined QGP should not still realized. Similarly to the low density nuclear liquid-gas phase transition, we show that a high density phase transition is characterized by pure hadronic matter with both mechanical instability (fluctuations on the baryon density) that by chemical-diffusive instability (fluctuations on the strangeness concentration).
The analysis is performed by requiring the Gibbs condition of the global conservation of baryon number and zero net strangeness in the framework of an effective relativistic mean field theory with the inclusion of the Delta (1232)-isobar resonances, hyperons and the lightest pseudoscalar and vector meson degrees of freedom. The main goal is to investigate how the constraints on the global conservation of the baryon number, electric charge fraction, and strangeness neutrality, in the presence of Delta-isobar degrees of freedom, hyperons, and strange mesons, influence the behavior of the EOS in a regime of finite values of baryon density and temperature. Moreover, we show the relevance of Delta-isobars for different coupling constants and how their presence influences several particle ratios and strangeness production for three different parameters sets, compatible with experimental constraints. Referring to QCD finite-density sum rule results, which predict that there is a larger net attraction for a Delta-isobar than for a nucleon in the nuclear medium. It turns out that in this situation hadronic phases with different values of strangeness content may coexist, altering significantly meson-antimeson ratios.

[l] A. Lavagno, D. Pigato, Phys. Rev. C **86**, 024917 (2012).
[2] Drago, Lavagno, Pagliara, Phys. Rev. D **89**, 043014 (2014).
[3] Drago, Lavagno, Metger, Phys. Rev. D **93**, 103001 (2016).