Contribution ID: **15**

Type: **not specified**

Hot β-equilibrium hadronic matter in the neutrino-trapped regime within the framework of relativistic mean-field theory

Thursday 14 September 2023 11:30 (30 minutes)

We investigate the thermodynamic properties of the hot β-equilibrated hadronic matter, which consists of neutrons(n), protons(p), electrons(e), electron neutrinos(ν_e), muons(μ), and muon neutrinos(ν_e). To describe such matter, we use an improved version of the relativistic mean field theory (RMF) at a finite temperature, where, in addition to the effective fields of σ-, ω-, and ρ-mesons, the scalar-isovector δ-meson effective field is also taken into account.

For different values of temperature T in the range of 0-100 MeV, the dependences of pressure P, energy density ε, entropy density S, and baryon chemical potential μ_B on the baryon number density n_B are determined. We studied the effect of temperature on the splitting of the effective masses of the proton and neutron due to the presence of the δ-meson field.

The temperature dependencies of the parameters of the first-order phase transition from hadronic matter to strange quark matter are studied. In this case, the Nambu - Jona-Lasinio (NJL) local SU (3) model was used to describe the quark phase.

A phase diagram is obtained corresponding to the equilibrium coexistence of hadron and quark phases in the T-μ_B plane. The thermodynamic parameters of the critical endpoint in the phase coexistence curve are found. Four different areas were identified in the T-n_B plane. The area of existence of matter with a purely hadronic structure. The area of existence of matter with a purely quark structure. The region corresponds to the crossover transition between the hadron and quark phases. And, finally, the range of values (T,n_B), does not correspond to any structure.

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