Generalized Beth-Uhlenbeck equation of state for the nonideal quark plasma

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A microscopic decription of the equation of state for dense hadronic matter including the phase transition to quark matter is a long standing problem relevant for cosmology, heavy-ion collisions and the astrophysics of compact stars and supernovae.
Traditional approaches construct a phase transition from separately given models for hadronic and quark matter phases. They cannot be trusted in the phase transition region and fail to predict a critical point (CP) in the QCD phase diagram.
Functional renormalization group approaches based on effective chiral Lagrangians improve the situation substantially but are not yet developed to describe hadrons as composite particles and thus cannot address the effects of bound state dissociation, such as the role of continuum correlations in the vicinity of the phase transition.
We report recent progress in deriving and solving a generalized Beth-Uhlenbeck equation of state for quark matter with mesonic and baryonic correlations that does not suffer from these problems.
We thus provide a theoretical framework for developing experimental strategies to find the CP of QCD matter in current and future experiments with energy scan programs: STAR@RHIC, NA61@CERN, CBM@FAIR and NICA@JINR.

NPP 2011: Scientific-coordination session "Non-Ideal Plasma Research"
November 23-24, 2011, Presidium RAS, Leninsky avenue, 32a, Moscow
http://www.ihed.ras.ru/npp2011/
