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Report on the thesis **"Thermodynamics of Mott dissociation of hadronic matter within a generalized Beth-Uhlenbeck approach"**
of Dipl.-phys. Aleksandr Dubinin

The investigation of the thermodynamics of the QCD phase transition from hadron-to-quark matter is a very actual field in strong interaction particle physics. Important informations on the high temperature and low density region of strongly interacting matter were already obtained in existing heavy-ion experiments (RHIC Brookhaven, CERN SPS), respectively are expected at planned accelerators (NICA JINR Dubna, CBM FAIR Darmstadt).

An important problem in the theoretical exploration of the hadron-to-quark phase transition is the formation and Mott dissociation of hadronic bound states of quarks incorporating chiral symmetry breaking and restoration and quark confinement. As is well-known, the standard numerical investigation of the phase transition within Lattice QCD (LQCD) is restricted to vanishing or low baryon density due to the sign problem. A successful alternative approach is offered by effective chiral quark models of the Nambu-Jona-Lasinio (NJL) type which incorporate the chiral symmetry of the fundamental QCD Lagrangian as well as its spontaneous (and explicit) breakdown and the generation of a dynamical quark mass. Using standard techniques of path-integral bosonization including fluctuations of collective meson and diquark fields, one can then derive effective low-energy meson-diquark Lagrangians and calculate corresponding mass spectra in dependence on temperature and baryon density. However, a well-known deficiency of the NJL model is its lack of quark confinement. An improvement towards an effective (partial) confinement can be achieved within so-called Polyakov-NJL (PNJL) models by coupling colored objects like quarks and diquarks to a Polyakov loop of a given gluon background field. If the Polyakov loop is close to zero, one gets a suppression of quarks and diquarks resembling confinement. An alternative way, also considered in this thesis, is to model confinement by the introduction of an IR-cutoff in the momentum integrals of correlation functions.

The main subject of this thesis of A.Dubinin is the investigation of the thermodynamics of the Mott dissociation of hadronic matter on the basis of effective NJL/PNJL quark models and the generalized Beth-Uhlenbeck (BU) approach. The latter one incorporates the in-

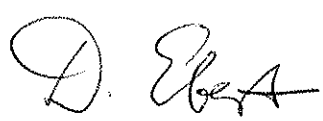
medium properties of matter in the scattering phases of two-quark meson/diquark correlation functions. In this scheme one finds, in particular, an important interplay of resonant states with non-resonant ones in the continuum of scattering states in accordance with the Levinson theorem. A particular interesting result of the thesis is the demonstration of the Polyakov-loop suppression of diquark abundance in a quark-meson-diquark plasma below the chiral restoration temperature. Note that the corresponding explorations were restricted to the case of a normal phase without color superconductivity. Another new interesting result, obtained within a (2+1)-flavor PNJL-model, is the anomalous low-energy state found in the K^+-channel which might be related to the strange matter "horn" effect. Finally, using LQCD data for the temperature dependence of quark masses as input as well as an ansatz for the generic behaviour of hadron masses, widths and and phase shifts and including virial corrections by parton rescattering, the thesis derives an effective Mott-Hadron Resonance Gas (MHRG) model based on the "Φ-derivable" approach to the cluster virial expansion. The predictions of the resulting semi-empirical model are shown to be in surprisingly good agreement with recent LQCD simulations.

There arise the following questions:
-Does the obtained very good agreement of the effective MHRG model with LQCD strongly depend on the clever incorporation of numerous input data from LQCD?
-Why the mentioned discrepancy with the pseudocritical temperature is expected to be cured just by including higher order quark interactions?
- Does the possible use of full quark propagators, dressed by hadronic backreactions, automatically respect the Goldstone theorem in the NJL model ?

Probably due to time pressure, there exist numerous misprints in the English text, which the author is recommended to improve before publication. Furthermore, for consistency, the following sign relations should be checked:
-comparision of signs in expressions (2.5) and (2.11)
-comparision of relative signs within the square bracket of eq(6.1) and in the curly bracket of the thermodynamical potential Omega in Sect.6.6.
These remarks should, however,not diminish the significance of the work.

In conclusion, the thesis of A. Dubinin contains important new results concerning the thermodynamics of the QCD hadron-to-quark(gluon) matter phase transition. Special emphasis was put on the study of the formation and Mott dissociation of composite mesons and diquarks within a generalized Beth-Uhlenbeck approach. The thesis is adequately written. Its results are published in 7 journal articles and 3 preprints. The list of references is rather complete and reflects the literature on this topic. To my opinion, the thesis thus meets all necessary requirements and demonstrates the ability of the candidate for scientific work.

It is a pleasure to recommend the thesis of Aleksandr Dubinin to the faculty of Physics and Astronomy of the University of Wroclaw for defendence.



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