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"The equation of state for non-ideal quark gluon plasma"

Original Research Article

I recommend the above-mentioned paper for the publication in the Physical Science International Journal, giving to this paper 9 points. However, I would like to make a few brief remarks, hoping that the author will find them useful in his future work on this subject.

1. In equation for the running coupling constant (5) it is given as a function of T/Λ_σ, while the corresponding figure (2) shows it as a function of T/T_c. In applications at finite temperatures the dependence on T/T_c is always preferable. Moreover, equation (5) reproduces the summation of the so-called main perturbative logarithms, and it is valid only in the high temperature limit. It cannot be continued to the region of low temperatures, namely $T \leq \Lambda_\sigma$ or, equivalently, $T \leq T_c$. In order to get an analytical expression for the running coupling constant explicitly useful at $T \geq \Lambda_\sigma$ or, equivalently, $T \geq T_c$, equation (5) should be re-written in more general form, namely

$$\alpha_s(T) = \frac{2\pi\nu}{1 + (11 - (2/3)n_f)\nu \ln(T/T_c)}, \tag{0.1}$$

where ν is fixed as follows: $\alpha_s(T_c) = 2\pi\nu$, and this expression provides a correct asymptotic formula (5) in the limit of high temperatures (but in terms of (T/T_c), of course). Let us emphasize that the expression (0.1) is the exact solution of the corresponding renormalization group equations for the running effective charge in the approximation of the main perturbative logarithms (see, for example Ref. [38] of the present paper).

2. I recommend also to clearly distinguish between the pure gluon plasma at $n_f = 0$ and the quark gluon plasma at $n_f \neq 0$. These two strongly coupling mediums have completely different phase transitions: at T_c the gluon plasma undergoes the first order phase transition, while for the quark gluon plasma it is only a smooth crossover. In all corresponding figures this principal difference is hardly to see explicitly. By the way, in figure (2) for the running effective charge as a function of T/T_c the curve for $n_f = 0$ cannot be identified.

3. The main problem of lattice thermodynamics is to cover low-temperature region because it suffers from big uncertainties in this region. Analytical approaches, in principle, should be free from this problem. However, from the figures presented in this paper it is not clear how both EoS obtained with the help of Mayer's cluster expansion theory and the phenomenological thermodynamic model are dealing with low temperatures. In other words, it is not clear how the linear rising term introduced into the free energy (4) works, especially as I understand it is supposed to be responsible for the behavior of all thermodynamic quantities at low temperatures.

3. And finally one more remark on the standard terminology used. In the heavy ion collision the liberation of quarks from bound states is not de-confinement phase transition. Being liberated from the bound states, nevertheless, they cannot be put on the mass-shell. They always remain off-mass-shell objects, temperature and density zero or not. De-confinement phase transition is the liberation of any colored object from the vacuum of QCD. This never happens, otherwise a lot of colored objects have to be discovered in the experiments with heavy ions collision. What we "see" in these experiments is, in fact, de-hadronization phase transition (for more detail explanation see recently published book by WS "The Mass Gap and its Applications").