On Locating the Critical End Point in the QCD Phase Diagram

Content :

Location of critical end point (CEP) and mapping the entire QCD phase boundary still exists as one of the most interesting and studied problems of heavy-ion physics. We present here one method based on the self-consistent formulation of quasiparticle model. In quasiparticle models, all effects of the interactions among the partons are manifested in the thermal mass of the partons, so the system may be treated as an ideal gas of the massive quarks and gluons. We use the formulations of the two such quasiparticle models and extend their applications for the description of quark gluon plasma (QGP) at non-vanishing baryon chemical potentials. The thermodynamical quantities calculated from these models are compared with the values obtained from lattice simulations and a good agreement between model calculation and lattice QCD data suggests that the values of the parameters used in the paper are consistent. A new equation of state (EOS) for a gas of extended baryons and pointlike mesons is presented here which incorporate the repulsive hard-core interactions arising due to geometrical size of baryons. A first order deconfining phase transition is constructed using Gibb's equilibrium criteria between the hadron gas EOS and quasiparticle model EOS for the weakly interacting quark matter. This leads to an interesting finding that the phase transition line ends at a critical end point beyond which a crossover region exists in the phase diagram. Our calculation suggests that the origin of CEP is connected with a hard core volume assigned to baryons existing in the hadron gas. Moreover, we find that the critical point lies at TC = 166 MeV, μC =155 MeV and the value of the critical chemical potential is found to be lowest than the values given by any other effective models. We stress that the phase boundary obtained here depicts a deconfining phase transition in contrast to chiral boundaries obtained in the other effective model calculations. Furthermore, we have used our EOS for the hadron gas to obtain a freeze-out curve for the hot and dense fireball. This leads to an interesting conclusion that CEP determined by us lies in close proximity to the freeze out points being scanned by RHIC energies.

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