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Effect of finite system size on the thermodynamics of hot and magnetized hadron resonance gas

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Since few decades, considerable amount of research interest has been grown on the study of hot and/or dense 'strongly'interacting matter produced in the heavy ion collision (HIC) experiments at RHIC and LHC. On top of that, recently, another
contemporary research topic is the investigation of the effect of a strong
background magnetic field on various properties of QCD matter at extreme condition of high temperature and/or baryon density. Interestingly, a non-central or asymmetric HIC at RHIC and LHC energies has the potential to create strong magnetic field of the order of 10^18 Gauss or more. As the magnitude of the magnetic field is comparable to QCD energy scale, various novel phenomena owing to the rich vacuum structure of QCD could take place [1] such as chiral magnetic effect, magnetic catalysis, inverse magnetic catalysis etc.

Through the HIC experiments, it is possible to probe the bulk thermodynamic properties or the phase structure of QCD. The non-perturbative aspects of QCD restrict a first principle analytic calculation of the QCD thermodynamics especially in the low temperature region. The numerical lattice QCD (LQCD) based calculations [2] is one of the best alternatives to study the QCD thermodynamics, but is limited to the low baryon density region of the QCD phase diagram due to its 'sign'problem. On the other hand, the hadron resonance gas (HRG) model [3–5] is a statistical thermal model for studying the QCD thermodynamics at finite temperature, baryon density as well as external magnetic field [6–8]. Interestingly, at low temperature and small baryon density, the results from HRG model agrees well with the LQCD.

In the calculation of thermodynamic quantities, one generally assumes the system size to be infinite. However, in the HIC experiments, the created fireball has finite volume (few fm^3). So, it is justified to consider the boundary effects in the calculation of thermodynamical quantities pertaining to the HIC [9]. In this presentation, we will be showing the calculation of various thermodynamic quantities like energy density, longitudinal and transverse pressure and magnetization of an ideal HRG of finite size in presence of external magnetic field. The formalism of generalized Matsubara prescription [10] will be used to incorporate the finite size effect whereas the effect of external magnetic field will enter through the Landau quantization of the dispersion relations of charged hadrons.

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