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The effect of the Hagedorn states in the Hadron Resonance Gas model with the van der Waals interaction

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The hadron resonance gas (HRG) model which considers a grand canonical ensemble of all the experimentally established hadrons and resonance states, is very successful in reproducing the LQCD results of the hadronic phase of the strongly interacting matter. Various extensions of the HRG model have been made to improve its agreement with LQCD results. One such extension is the implementation of the van der Waals type of interaction between the baryons, known as the vdW-HRG model.
In this model, repulsive and attractive interactions have been considered through the van der Walls constants. Phase transition and the criticality are inbuilt in the van der Waals equation that depends on the choice of van der Walls constants. In literature, the van der Waals constants are extracted by comparing the lattice results. The extracted values of the van der Walls constants also depend on the hadronic list used in the HRG model.

In this work, we try to study the effect of the inclusion of the Hagedorn mass spectrum along with the experimentally established hadrons. Hagedorn mass spectrum is commonly used to compensate for the missing higher resonance states those are yet to be confirmed experimentally. We also compare our results by updating the hadronic list with the Quark Model predicted hadronic states. We find that the vdW-HRG model with the Hagedorn state describes the lattice result best for both zero and finite chemical potential. The Hagedorn states have a significant influence on the van der Waals parameters and hence on the thermodynamic and transport quantities. We also infer that there is a strong dependence of van der Waals parameters with the chemical potential.

Session

Heavy Ions and QCD

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