Contribution ID: **17** Type: **Poster**

Quantum statistical fluctuation of energy and baryon number in subsystems of hot and dense relativistic gas

Wednesday, 6 April 2022 17:54 (4 minutes)

We discuss the quantum fluctuations of energy in subsystems of hot relativistic gas for both scalar and spin half particles. For small subsystem sizes, we find a substantial increase of fluctuations compared to those known from standard thermodynamic considerations. However, if the size of the subsystem is sufficiently large, we reproduce the result for energy fluctuations in the canonical ensemble. Interestingly for spin half particles, the results for quantum fluctuation depend on the form of the energy-momentum tensor used in the calculations, which is a feature described as pseudo-gauge dependence. However, for sufficiently large subsystems the results obtained in different pseudo-gauges converge and agree with the canonical-ensemble formula known from statistical physics. Although different forms of the energy-momentum tensor of gas are a priori equivalent, our finding suggests that the concept of quantum fluctuations of energy in very small thermodynamic systems is pseudo-gauge dependent. On a practical side, our results can be used in the context of relativistic heavy-ion collisions to introduce limitations of the concepts such as classical energy density or fluid element. Also, the results of our calculations determine a scale of coarse-graining for which the choice of the pseudo-gauge becomes irrelevant. In a straightforward way, our formula for quantum fluctuation can be applied in other fields of physics, wherever one deals with the hot and relativistic matter.

Further using the formalism developed to obtain the fluctuation of energy we also estimated the quantum features of the baryon number fluctuations in subsystems of a hot and dense relativistic gas of fermions. Our results for the baryon number fluctuation also suggest that for small system size quantum mechanical effects can be significant. Such a system size dependence of quantum statistical fluctuation can be helpful to shed new light on the experimental data, particularly for a small system probed in the heavy-ion collision experiments.

Primary authors: DAS, ARPAN (Institute of Nuclear Physics Polish Academy of Sciences Krakow, Poland); Prof. RYBLEWSKI, Radoslaw (Institute of Nuclear Physics Polish Academy of Sciences Krakow, Poland); Mr SINGH, Rajeev (Institute of Nuclear Physics Polish Academy of Sciences Krakow, Poland); Prof. FLORKOWSKI, Wojciech (Jagiellonian University)

Presenter: DAS, ARPAN (Institute of Nuclear Physics Polish Academy of Sciences Krakow, Poland)

Session Classification: Poster Session 1 T07_1

Track Classification: Correlations and fluctuations