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Quantum fluctuation of energy and its pseudo-gauge dependence in subsystems of hot relativistic gas

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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. As 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. 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 hot and relativistic matter.

Is this abstract from experiment?

No

Name of experiment and experimental site

N/A

Is the speaker for that presentation defined?

Yes

Details

N/A

Internet talk

No

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