Thermodynamic properties at the kinetic freeze-out in the Au+Au and Cu+Cu collisions at the RHIC using the Tsallis distribution

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Event-by- The thermodynamic properties of charged particles, such as the energy density, pressure, entropy density, particle density, and squared speed of sound at the kinetic freeze-out in the Au+Au collisions from the relativistic heavy ion collider (RHIC) beam energy scan program ($\sqrt{s_{NN}}$=7.7--200 GeV) and in the Cu+Cu collisions at $\sqrt{s_{NN}}$=62.4, 200 GeV are studied using the thermodynamically consistent Tsallis distribution [1]. The energy density, pressure, and particle density decrease monotonically with the collision energy for the same collision centrality; These properties also decrease monotonically from the central to peripheral collisions at the same collision energy. While the scaled energy density ε/T^4 and scaled entropy density s/T^3 demonstrate the opposite trend with the collision energy for the same collision centrality. There is a correlation between ε/T^4 and s/T^3 at the same centrality, see Fig. 1. In addition, the

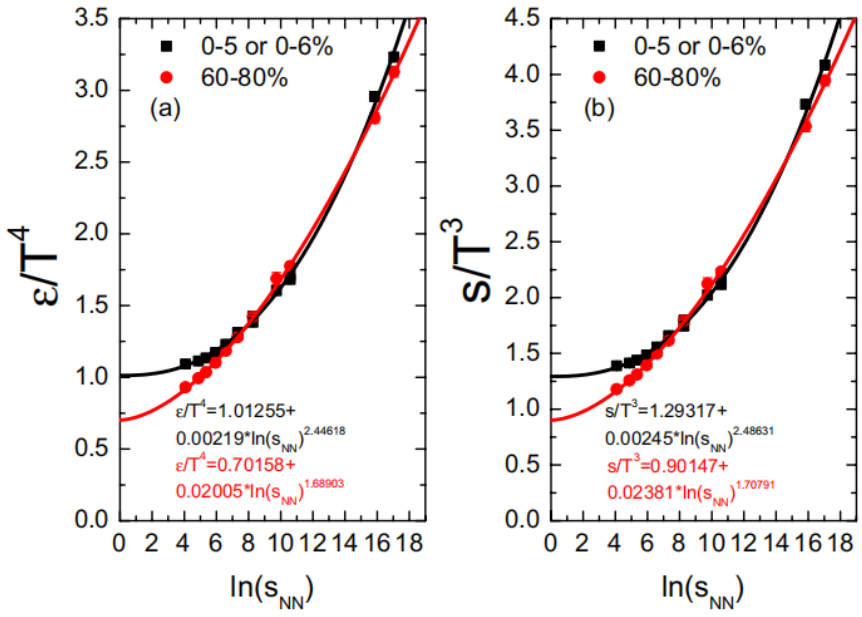

FIG. 1. (Color online) The scaled ε/T^4 and s/T^3 for the most central (black) collision and most peripheral (red) collision in the Au+Au collisions at $\sqrt{s_{NN}}$==7.7-200 GeV, and in the Cu+Cu collisions at $\sqrt{s_{NN}}$==62.4, 200 GeV, as a function of $ln(s_{NN})$. The lines are fitted with the expressions shown at the bottom of the figure. The parameters used to calculate the thermodynamic quantities for the Pb+Pb collisions are obtained from Ref. [2].

squared speed of sound was calculated to determine that all the collision energies share nearly the same value at different collision centralities.

[1] W.H. Wu, J.Q. Tao, H. Zheng, W.C. Zhang, X.Q. Liu, L.L. Zhu and A. Bonasera, Nucl. Sci. Tech. **34**, 151 (2023).
[2] M.D. Azmi, T. Bhattacharyya, J. Cleymans, M. Paradza, J. Phys. G: Nucl. Part. Phys. **47**, 045001 (2020).