

Dear editor,

We submit our manuscript titled “High-order fluctuations of temperature in hot QCD matter” for consideration as a Letter in *Physical Review Letters*.

Recent new measurements at the RHIC and LHC reveal that event-by-event mean transverse momentum fluctuations of charged particles, closely related to the temperature fluctuations, serve as an ideal probe of QCD thermodynamics. In this letter, a new thermodynamic state function is introduced to describe the thermodynamics for the relevant heavy-ion collision experiments for the first time, which allows us to compute the temperature fluctuations from the basic thermodynamic relations. We find that the temperature fluctuations are suppressed remarkably as the system transitions from the hadron resonance gas (HRG) to the quark-gluon plasma (QGP) with increasing temperature or baryon chemical potential, alongside a negative skewness. These results offer a novel approach to the high-baryon-density thermodynamics and the QCD phase diagram.

Note that these findings are general and do not depend on the specific models used. They arise from the fact that the heat capacity of the QCD matter increases significantly from the HRG phase to the QGP phase.

We believe this work meets the high standards of PRL due to its fundamental insights and potential impact on heavy-ion physics. We look forward to your consideration.

Sincerely yours,

Jinhui Chen, Wei-jie Fu, Shi Yin, and Chunjian Zhang