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Entropy fluctuation from hydrodynamic noise

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In the hot and dense QCD matter, quarks and gluons are deconfined to form Quark-Gluon Plasma (QGP). The QGP, which existed in the early universe, can be created experimentally by the relativistic heavy ion collisions at RHIC and LHC. The dynamics of the QGP in these experiments is well described by relativistic hydrodynamics.
Recently event-by-event initial fluctuations have been included in the hydrodynamic models. In addition to these fluctuations, fluctuations originated from thermal noises arise during hydrodynamic evolution. To investigate this hydrodynamic fluctuation, causal fluctuating hydrodynamics is formulated very recently [1]. Applying this framework to the (0+1)-dimensional Bjorken expansion, we investigate total entropy fluctuations. Final entropy is fluctuating around mean value. More interestingly, we found that, in one event, entropy can decrease with time although its probability is quite small. The probability of the events with decreasing entropy and that with increasing entropy are related through ''fluctuation theorem" [2]. Through this theorem, we also calculate the entropy fluctuation and claim that the thermal noise gets more important in the smaller systems such as p-A and peripheral A-A collisions.

[1] K. Murase and T. Hirano, arXiv:1304.3243.
[2] D. J. Evans and D. J. Searles, PRE52, 5839 (1995).

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