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Pinning down the nature of QCD phase transition through the measurement of specific heat and isothermal compressibility

Nature of QCD phase transitions in high energy collisions can be pinned down by studying the behaviour of thermodynamic response functions with respect to T and μ_B.
A first order phase transition is signalled by the divergence of specific heat (c_v), whereas for a second order or continuous transition, isothermal compressibility (k_T) diverges.
c_v is estimated at the kinetic freezeout hyper surface (at $T_{\rm kin}$), whereas k_T is at chemical freezeout hyper surface (at $T_{\rm ch}$).
Thus simultaneous measurements of c_v and k_T as a function of collision energy probes the exact nature of phase transition and can pin down the location of the Critical Point in the (T,μ_B) plane.

The heat capacity is expressed as, $C = \left(\frac{\partial E}{\partial T}\right)_V$, which implies $C^{-1} = \frac{(\langle T_{\rm kin}^2\rangle - \langle T_{\rm kin}\rangle^2)}{\langle T_{\rm kin}\rangle^2}$. Thus c_v can be experimentally probed through $\langle p_{\rm T}\rangle$ distribution.
Similarly, $k_T = \frac{1}{V}\left(\frac{\partial V}{\partial P}\right)$, which gives $k_T = \frac{\sigma_N^2}{N^2}\frac{V}{k_B T_{\rm ch}}$, where N and σ_N^2 are the number of charged particles and its variance. Thus k_T can be obtained through multiplicity fluctuation of charged particles.

c_v and k_T have been calculated from the mean transverse momentum ($\langle p_{\rm T}\rangle$) and charged particle multiplicity fluctuations, measured on an event-by-event basis [1,2,3]. Experimental results along with results from the hadron resonance gas (HRG) model and event generators will be presented.

(1) Sumit Basu, et al., Phys. Rev. C94, 034909 (2016).
(2) M. Mukherjee, et al., J. Phys. G: Nucl. Part. Phys. 43, 085102 (2016).
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Preferred Track

Correlations and Fluctuations

Collaboration

Not applicable

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