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Probing QGP through correlations and fluctuations of collective observables

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The matter produced in an ultra-relativistic heavy-ion collision, dubbed as the QGP, posses a temperature 10^5 times that of Sun's core and survives for a very short time (10^{-22} s), producing thousands of particles which exhibit collective motion described by some global observables, e.g. charged particle multiplicity(N_{ch}), mean transverse momentum per particle ($[p_T]$), harmonic flow (V_n) etc. Fluctuations and correlations between these observables contain crucial information of the QGP medium as well as of the nuclear properties. We study in hydrodynamic model p_T-dependent event-by-event fluctuation of V_n probed by the factorization breaking coefficient, which shows decorrelation at higher p_T-bins. We study the fluctuation of $[p_T]$ in ultra-central Pb+Pb collision and explain the sudden fall in the ATLAS data over a narrow range of multiplicity. We show in our model that this sharp fall is a consequence of the underlying thermalization assumption of the system. We also study the observable $v_0(p_T)$, first introduced by Teaney et al., which is similar to anisotropic flow in terms of its collective nature and, it correlates the spectra with the event-by-event mean transverse momentum per particle ($[p_T]$). We present model predictions for charged and identified particles. Additionally, we show how $v_0(p_T)$ can be used to capture the p_T-acceptance effect of different collective observables. Through these above-mentioned studies, we present an overall picture how correlations and fluctuations of the collective observables can be used to study the dynamics and properties of the QGP medium.

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