# Longitudinal scaling of observables in heavy-ion collision models

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## Introduction

Scale invariance in experimental observables from heavy-ion collisions at the Relativistic Heavy Ion Collider has provided interesting insights about particle production mechanism in these reactions. The longitudinal scaling of pseudorapidity distribution of charged particles $dN_{ch}/d\eta$ is observed when plotted as a function of pseudorapidity ($\eta$) shifted by the beam rapidity ($\eta - ybeam$) for a wide range of collision systems ($e^+ + e^-, p + p, d + A, andA + A$) and beam energies[1, 2]. This phenomena is often called limiting fragmentation. The scaling in $dN_{ch}/d\eta$ can be understood from the microscopic picture. Such scaling is also observed for elliptic flow ($v_2$) of charged hadrons in A + A collisions. This is very striking observation, as $v_2$ is expected to be sensitive to the initial conditions, expansion dynamics, and degree of freedom of the system, all of which potentially varies with collision system and colliding energy. Hence the physical interpretation of longitudinal scaling of $v_2$ is counterintuitive. Recent studies [3] suggest that the simultaneous observation of longitudinal scaling of $v_2$ and $dN_{ch}/d\eta$ can be reconciled only if the system formed in heavy-ion collisions are weakly coupled. This is contrary to the other indirect estimations of the shear viscosity to entropy ratio ($\eta/s$) which suggests the system is strongly coupled [4].

## Results

We present a study of longitudinal scaling of $dN_{ch}/d\eta$ ,$v_2$ and average transverse momentum ($< p_T >$) using transport models UrQMD and AMPT for Au + Au collisions at center of mass energies ($\sqrt{s_{NN}}$) of 19.6, 62.4, and 200 GeV and Pb + Pb collisions at $\sqrt{s_{NN}}$) = 2.76 TeV. All these model calculation show scaling for $dN_{ch}/d\eta$ and $< p_T >$. However, the longitudinal scaling of $v_2$ is only predicted by the AMPT model with string melting scenario as shown in the Fig. 1. This models includes partonic effects and quark coalescence as a mechanism of hadronization.
We will also discuss the possibility of longitudinal scaling of $v_2$ within two extreme scenarios of models with hydrodynamic and the collision less limits.

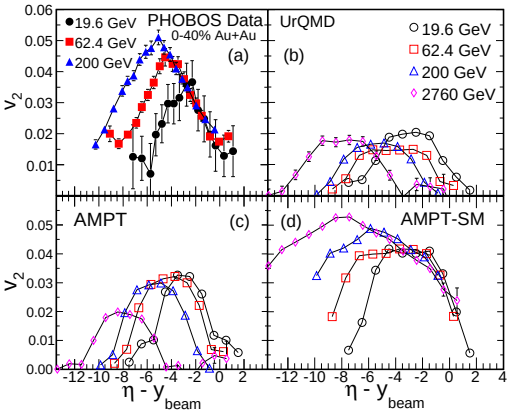


FIG. 1: $v_2$ of charged particles vs $\eta - y_{beam}$ for $0 - 40\%$ centrality

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## References

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