Multiplicity distributions for Pb-Pb and p-Pb from a simple model

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(with J Dias de Deus and S Abreu)
the model

- a very simple model for distribution of rapidity extended objects (SPM strings or colour glasma fields) created in heavy ion collision

\[ \frac{\partial \rho}{\partial (-\Delta)} = \frac{1}{\delta} (\rho - A\rho^2) \], \quad \Delta = |y| - Y

- linear growth with distance to beam rapidity + asymptotic saturation

- standard (1845-1847) logistic equation for dynamics of populations
• Y-dependent limiting value of \( \rho \) determined by saturation condition

\[
\frac{\partial \rho}{\partial (-\Delta)} = 0 \quad \rightarrow \quad \rho_Y = \frac{1}{A}
\]

• separation between positive curvature (low density) and negative curvature (high density)

\[
\left. \frac{\partial^2 \rho}{\partial^2 (-\Delta)} \right|_{\Delta_0} = 0 \quad \rightarrow \quad \rho_0 \equiv \rho(\Delta_0, Y) = \frac{\rho_Y}{2}
\]

• integrating the logistic equation ...
the model

\[ \rho(\Delta, Y) = \frac{\rho_Y}{e^{\frac{\Delta - \Delta_0}{\delta}} + 1} \]
in the SPM particle density is proportional (once colour reduction factor taken into account) to the average number of participants from one nucleon in both dense and dilute regimes.

\[ \rho \propto N_A \]

normalized particle density at mid-rapidity related to gluon distribution at small-x.

:: will be reduced by r.c. effects in evolution [Albacete's talk]::

\[ \rho \propto e^{\lambda Y} \]

dense-dilute separation scale linearly decreasing with \( Y \) (from energy conservation).

\[ \Delta_0 = -\alpha Y , \quad 0 < \alpha < 1 \]

re-writing particle density in rapidity

\[ \rho \equiv \frac{dN}{dy} = \frac{N_A \cdot e^{\lambda Y}}{e^{\frac{|y|-(1-\alpha)Y}{\delta}} + 1} \]
Pb-Pb at the LHC (0-10% central)

\[ \sqrt{s} = 5.5 \text{ TeV} \]

\[ N_{Pb} = 173.3 \]

from Glauber calculation

\[ \lambda = 0.247 \]
\[ \alpha = 0.269 \]
\[ \delta = 0.67 \]

from fit to RHIC data


Brogueira, Dias de Deus, Pajares,

Kharzeev, Levin, Nardi,
p-Pb at the LHC (0-20% central)

- Formulae changed to account for asymmetric geometry, and shift of system CM relatively to LAB CM.

$$N_{part} = 13.07$$

from Glauber calculation

pseudo-rapidity distributions

- very large uncertainties: just pictures not predictions