Analyses of $(0.5\langle N_{\rm part}\rangle)^{-1}{\rm d}N_{\rm ch}/{\rm d}\eta$ distributions of PHOBOS and BRAHMS Collaborations by means of Ornstein-Uhlenbeck process

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Recently interesting data on ${\rm d}N_{\rm ch}/{\rm d}\eta$ in Au-Au collisions ($\eta = -\ln\tan(\theta/2)$) with the centrality cuts have been reported by PHOBOS and BRAHMS Collaborations [1, 2]. Their data are usually divided by the number of participants (nucleons) in collisions. Instead of this way, using the total multiplicity $N_{\rm ch} = \int({\rm d}N_{\rm ch}/{\rm d}\eta){\rm d}\eta$, we find that there are scaling phenomena among $(N_{\rm ch})^{-1}{\rm d}N_{\rm ch}/d\eta = {\rm d}n/d\eta$ with different centrality cuts at $\sqrt{s_{\rm NN}} = 130$ GeV and 200 GeV, respectively. To explain these scaling behaviors of ${\rm d}n/{\rm d}\eta$, we consider the stochastic approach named the Ornstein-Uhlenbeck process with two sources [3, 4]. The Langevin equation is adopted for the present explanation. Among ${\rm d}n/{\rm d}\eta$ at 130 GeV and 200 GeV, no significant difference has been found. The probability density $P(\eta,\, t) = {\rm d}n/{\rm d}\eta$ is expressed by

$$P(\eta,\, t) = \frac{1}{\sqrt{8\pi V^2(t)}}\left\{\exp\left[-\frac{(\eta+\eta_{\rm max}e^{-\gamma t})^2}{2V^2(t)}\right] + \exp\left[-\frac{(\eta-\eta_{\rm max}e^{-\gamma t})^2}{2V^2(t)}\right]\right\}.$$

where $\eta_{\rm max} = \ln\sqrt{s_{\rm NN}}/m_{\rm N}$, the vairance $V^2(t) = (\sigma^2/\gamma)(1-e^{-2\gamma t})$ and the factor $e^{-\gamma t}$ is the evolution parameters, respectively. The observed figures are reproduced by the above equation. Possible detection method of the quark-gluon plasma (QGP) through ${\rm d}N_{\rm ch}/{\rm d}\eta$ is considered.

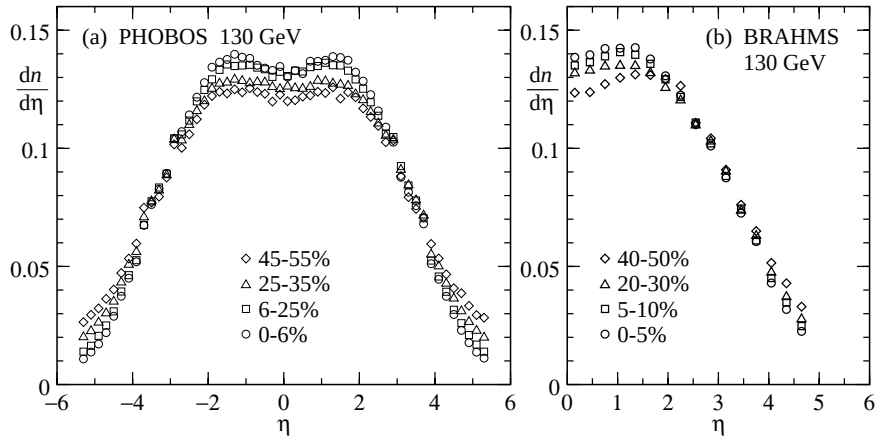

Figure 1: A set of ${\rm d}n/{\rm d}\eta$'s with different centrality cuts at $\sqrt{s_{\rm NN}} = 130$ GeV.

References

[1] B. B. Back *et al.* [PHOBOS Collaboration], Phys. Rev. Lett. **87** (2001) 102303.

[2] I. G. Bearden *et al.* [BRAHMS Collaborations], Phys. Lett. B **523**, 227 (2001).

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[4] M. Biyajima, M. Ide, T. Mizoguchi and N. Suzuki, "Scaling behavior of $(N_{\rm ch})^{-1}{\rm d}N_{\rm ch}/{\rm d}\eta$ at $\sqrt{s_{\rm NN}} = 130$ GeV by PHOBOS Collaboration and its implication — A possible explanation by the Ornstein-Uhlenbeck process —." A preprint (2001, March)