Analysis of Quark-Gluon plasma properties based on jets with ALICE experimental data

T. Kumaoka,[*1,*2] for the ALICE Collabolation

Quark-Gluon plasma (QGP) is defined as a matter phase at high temperatures and high densities. It is predicted using quantum chromodynamics. A few QGP evidences have been discovered through the LHC and RHIC experiments. However, QGP features are not revealed, and various measurements are performed to clarify QGP properties. Among these properties, the stopping power and jet quenching mechanism can be clarified by measuring the nuclear modification factor ($R_{\rm AA}$) in a wide jet transverse momentum ($p_{\rm T}$) range. $R_{\rm AA}$ is the ratio of the jet yield in nuclear-nuclear collisions to that in p-p collisions (Fig. 1). When $R_{\rm AA}$ is less than 1, it implies that jets are suppressed by the QGP created owing to nuclear collisions. Measured distributions can restrict theoretical models and clarify the jet quenching mechanism.

In this study, we measure $R_{\rm AA}$ in Pb-Pb collisions at $\sqrt{s_{\rm NN}} = 5.02$ TeV by using the ALICE experimental data of 2018. This data set possesses an integrated luminosity of 0.4 nb^{-1}, which is larger compared to the previous study.[1)] The data are expected to include rare high-$p_{\rm T}$ jets than the previous measurements, extending the $R_{\rm AA}$ measurements to the higher $p_{\rm T}$ region.[a)] Moreover, the large data statistics enables the study on $R_{\rm AA}$ at various centralities (Fig. 2), which were limited owing to the large number of background particles along the low $p_{\rm T}$ direction in the case of the previous study. As peripheral collisions provide a smaller background than central collisions, studies in the lower $p_{\rm T}$ region become possible. This study clarifies the correlation between the parton energy suppression and centrality.

Data quality requirements were applied to the data, and those marked as good demonstrate three times larger statistics than the previous study.[1)] Jets were reconstructed using the anti-$k_{\rm T}$ algorithm[2)] of the fast-jet package[3)] without any modification. The expected contribution to the jet $p_{\rm T}$ based on background particles was estimated for each jet on an event-by-event basis. By subtracting the background, we obtained jet $p_{\rm T}$ spectra for various centralities. Figure 3 shows the normalized jet $p_{\rm T}$ spectrum for various centralities. Moreover, it shows that jets are more suppressed in the central collisions compared with that in the peripheral collisions.

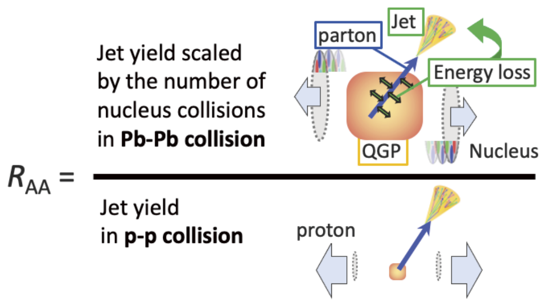

Fig. 1. $R_{\rm AA}$ definition. The numerator and denominator demonstrate the jet yields in heavy ion collisions and p-p.

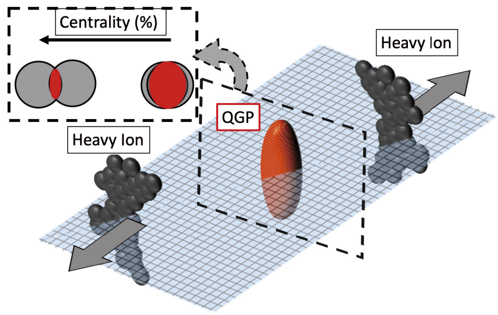

Fig. 2. Collision centrality. The overlap of heavy ions is known as centrality. In other words, centrality is defined as the percentile of the hadronic cross section corresponding to particle multiplicity, considering the count from the most central collisions.

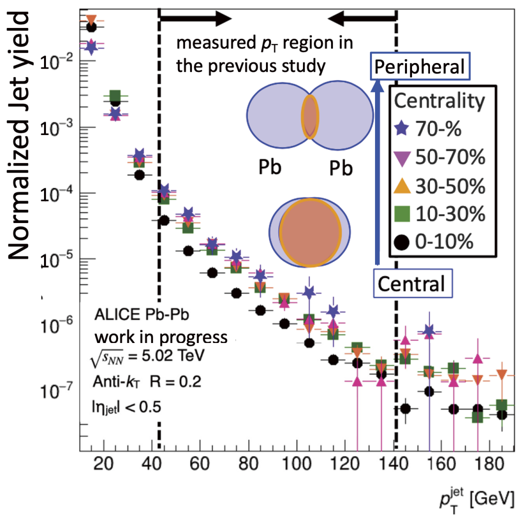

Fig. 3. Jet $p_{\rm T}$ spectrum for each centrality. The horizontal axis denotes jet $p_{\rm T}$ and the vertical axis denotes jet yields normalized by the pseudorapidity range and number of binary collisions. In the previous study, $R_{\rm AA}$ was measured in the area between the two dashed lines.

*1 Department of Physics, University of Tsukuba
*2 RIKEN Nishina Center

a) In this measurement, we will use the jet $p_{\rm T}$ spectrum in p-p collisions at $\sqrt{s} = 5.02$ TeV, which derived from the ALICE experiment conducted in 2018, as the denominator of $R_{\rm AA}$.

References

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2) M. Cacciari *et al.*, J. High Energy Phys. **4**, 063 (2008).
3) M. Cacciari *et al.*, Eur. Phys. J. C **72**, 1896 (2012).