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Collision Parameter Probability Distribution Prediction in Heavy Ion Collision with Kolmogorov-Arnold Network

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Nuclear deformity has been known to introduce fluctuations in the initial geometry and multiplicity in heavy-ion collisions. As the centrality bin is often calculated based on the multiplicity, this fluctuation is propagated as a larger correlation uncertainty between collision parameters and experiment observables. The aim of this study is to establish a framework to construct the probability distribution function of the collision parameters based on the anisotropic flow and multiplicity. Since the effect of the collision parameter is more prominent for a deformed nucleus, we focus on Xe-Xe collision at 5.44 TeV.

We employ TRENTo which is based on the Glauber model to sample initial geometry. The degree of deformity is defined by β_2 coefficient which is fixed to 0.162 for Xe. We assume elliptical flow is linearly related to eccentricity as $\nu_2 = \kappa_2 \varepsilon_2$ with fixed $\kappa_2 = 0.18$. On top of the impact parameter, the initial geometry also depends on the collision orientation due to the nucleus deformity. The nucleus orientation is measured as the spin and tilt angle of the colliding nucleus with respect to the collision axis.

Finally, we feed the sampled collision events into Kolmogorov-Arnold Network (KAN) to construct the collision parameter probability distribution function in order to fit ν_2 measured from experiments. Although we see a limited success in reproducing experimental data, which is partly due to the limitation of our model that did not include hydrodynamic simulation, we have established a framework that can be further expanded by pairing it with a more realistic model to construct other collision parameters

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