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Imprint of nuclear structure on identified particles in high energy heavy ion collisions

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The encoded nuclear structures related to flow fluctuations can be investigated at a fixed impact parameter in ultra-relativistic ion collisions through the concept of factorization breaking. This phenomenon is explored by analyzing momentum-dependent correlations among flow harmonics across distinct kinematic bins, specifically in terms of pseudorapidity (η)[1] or transverse momentum (pT)[2]. The influence of various β deformations on these momentum-dependent coefficients has been observed previously [3]. Our findings indicate a sensitivity to triaxiality for $pT > 1.5$ GeV in ultra-central U+U collisions. Notably, we find that the imprint of deformation is evident in the behavior of identified particles. We report a significant shift in the crossing point of observable ratios, specifically $\pi^{\pm}/p(\bar{p})$ and $\pi^{\pm}/K^{\pm}$. This new observable reveals that the crossing point occurs at higher p_T values for quadrupole-deformed nuclei and higher ratio values for triaxiality in U+U and Au+Au collisions, as determined using the TRENTO+VISH(2+1D) framework. Furthermore, the structural effects can also be observed in lighter nucleus collisions, such as O+O and Ne+Ne (as well as O+Pb and Ne+Pb), which we propose for future LHC runs. Our analysis demonstrates that factorization breaking effectively differentiates between the structures of ^{16}O and ^{20}Ne, as derived from the Nuclear Lattice Effective Field Theory (NLEFT) model, utilizing 3D-MCGlauber+Music simulations. It is noteworthy that the tendencies of identified particles exhibit significant differences compared to heavier nuclei, such as ^{238}U and ^{197}Au.

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