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Accessing the shape of cluster pattern in ^{16}O+^{16}O and d+Au collisions from STAR experiment

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Collectivity in small collision systems at both RHIC and the LHC have attracted considerable attention regarding the origin of azimuthal anisotropy and the light nuclei structure. Recent measurements have established a geometry-driven picture through the comparison of $v_2\{2\}$ and $v_2\{4\}$ in d+Au and ^{16}O+^{16}O collisions at $\sqrt{s_{\rm NN}} = 200$ GeV at STAR, underscoring the important role of the initial-state geometry [1]. As this geometry is directly shaped by the underlying nuclear structure, ab-initio models have investigated several observables and suggest that the v_n–$[p_{\rm T}]$ correlations and $[p_{\rm T}]$ fluctuations are particularly sensitive to the intrinsic structure of ^{16}O, in particular, its possible α-clustering configurations [2,3].

With data from STAR, we present systematic measurements of the v_n–$[p_{\rm T}]$ correlations and $[p_{\rm T}]$ fluctuations in both d+Au and ^{16}O+^{16}O collisions at $\sqrt{s_{\rm NN}} = 200$ GeV. The results are compared with theoretical predictions incorporating different ab-initio nuclear structure inputs, including configurations with and without α clustering. These comparisons offer new insight into the cluster patterns of light nuclei across energy scales and shed light on initial conditions of quark-gluon plasma and collective dynamics in small relativistic collision systems.

[1] STAR Collaboration, “Engineering the shapes of quark-gluon plasma droplets by comparing anisotropic flow in small symmetric and asymmetric collision systems”, arXiv: 2510.19645

[2] C. Zhang, J. Chen, G. Giacalone, S. Huang, J. Jia, Y.-G. Ma, Physics Letters B 862, 139322 (2025)

[3] S. Huang, J. Jia, C. Zhang, Physics Letters B, 870, 139926 (2025)

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