Study of nuclear deformation effects in Au+Au and U+U collisions from STAR experiment

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Nuclear deformation is a ubiqutous phenomenon for most atomic nuclei, reflecting collective motion induced by interaction between valance nucleons and shell structure. In most cases, the deformation has a quadrupole shape β that is axially and refection symmetric, either prolate $\beta > 0$ or oblate $\beta < 0$. Collisions of deformed nucleus lead to large shape and size fluctuations in the initial state geometry, which after collective expansion, lead to enhance fluctuation of harmonic flow v_n and event-by-event mean transverse momentum $[p_{\mathrm{T}}]$. Therefore detailed study of the v_n, and $[p_{\mathrm{T}}]$ and correlations beween them could probe the deformation parameter. In this talk, we present results of $[p_{\mathrm{T}}]$ fluctuations and $v_n^2 - [p_{\mathrm{T}}]$ correlation for $n = 2, 3, 4$ in near-spherical ^{197}Au+^{197}Au collisions at $\sqrt{s_{\mathrm{NN}}}$ = 200 GeV and highly-deformed ^{238}U+^{238}U collisions at $\sqrt{s_{\mathrm{NN}}}$ = 193 GeV. Significant differences for mean, variance c_2 and skewness c_3 of $[p_{\mathrm{T}}]$ fluctuations are observed between the two systems as a function of centrality. The recently proposed intensive skewness of $c_3 \langle [p_{\mathrm{T}}] \rangle / c_2^2$, sensitive to the initial size fluctuation, is found to differ significantly between the two systems, particular in the ultra-central collisions. The $v_2^2 - [p_{\mathrm{T}}]$ results remain positive over the full centrality in Au+Au collisions, while they change sign in 0-5% central U+U collisions. In contrast, the $v_3^2 - [p_{\mathrm{T}}]$ and $v_4^2 - [p_{\mathrm{T}}]$ results are nearly identical between these two systems. The sign-change of $v_2^2 - [p_{\mathrm{T}}]$ is used to provide novel ways to constrain β for Uranium nuclei in heavy ion collisions. Comparison with state-of-art model calculations is discussed.

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