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Probing the nuclear deformation effects in Au+Au and U+U collisions from STAR experiment

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Nuclear deformation is an 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 that is charactorized by overall strength β_2 and triaxiality γ (prolate $\gamma = 0$, obolate $\gamma = \pi/3$ and triaxial otherwise). Collisions of deformed nuclei lead to large shape and size fluctuations in the initial state geometry, which after collective expansion, lead to enhanced fluctuation of elliptic flow v_2 and event-by-event mean transverse momentum $[p_{\mathrm{T}}]$. Therefore, detailed study of the v_2, and $[p_{\mathrm{T}}]$ and correlations beween them can constrain the deformation parameters (β_2, γ). A comparion of (β_2, γ) with those measured from nuclear structure experiment could then be used to constrain the hydrodynamic responses of heavy-ion collisions. In this poster, we present results of v_2, $[p_{\mathrm{T}}]$ fluctuations and $v_2^2 - [p_{\mathrm{T}}]$ correlation for harmonics $n = 2, 3, 4$ in modestly-deformed ^{197}Au+^{197}Au collisions at 200 GeV and highly-deformed ^{238}U+^{238}U collisions at 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 $v_2^2 - [p_{\mathrm{T}}]$ results remain positive over the full centrality in Au+Au collisions, while they change sign in 0-5\% central U+U collisions. The ratio of v_2 and c_2 between U+U and Au+Au in ultra-central collisions (UCC) are used to constrain the value of β_2, which leads to an estimate of $\beta_{2Au} \sim 0.18$. On the other hand, the value of γ can be constrained from the ratios of $v_2^2 - [p_{\mathrm{T}}]$ and c_3 between U+U and Au+Au. The enhancement of c_3 and the suppression of $v_2^2 - [p_{\mathrm{T}}]$ in UCC confirm that Uranum is prolate deformed with $\gamma \sim 0$. Comparison with state-of-art model calculations is discussed.

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