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Determine the unknown hexadecapole deformation of ^{238}U by relativistic heavy ion collisions

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The ^{238}U nucleus is well deformed with a large quadruple deformation $\beta_2 = 0.286$. However, its hexadecapole deformation $\beta_{4,\mathrm{U}}$ is not well determined, mainly because it is overshadowed by the large $\beta_{2,\mathrm{U}}$ in experimental observables that are typically sensitive to both. A recent study (Ryssens, et.al., Phys.Rev.Lett. 130, 212302) proposes a smaller β_2 for U to explain the v_2 differences between ^{238}U+^{238}U and ^{197}Au+^{197}Au collisions, and thereby a finite $\beta_{4,\mathrm{U}}$ to compensate the smaller $\beta_{2,\mathrm{U}}$ in order to still describe the experimental quadruple moment. This is, however, rather indirect as v_2 is nearly insensitive to β_4, and the v_2 differences between the two systems can simply be explained by a larger $\beta_{2,\mathrm{Au}}$ as our knowledge of the β_2 of odd-Z nuclei is poor. In this talk, we present three truly β_4-sensitive observables, the flow harmonic correlation $\mathrm{ac}_2\{3\}$, the event-plane correlation $\langle\cos(4\Phi_2-4\Phi_4)\rangle$, and the nonlinear response coefficient $\chi_{4,22}$. The $\chi_{4,22}$ observable is even insensitive to the quadruple deformation and the system size, providing an unique opportunity to precisely extract the $\beta_{4,\mathrm{U}}$ from relativistic heavy ion collisions.

Auteurs principaux: XU, Haojie (Huzhou University); WANG, Fuqiang (Purdue University)

Orateur: XU, Haojie (Huzhou University)

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