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Phenomenology of the nonlinear coupling of flow harmonics in heavy-ion collisions

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Precise measurements of higher-order coefficients of anisotropic flow ($v_n, n > 3$) are now available in Pb+Pb data collected at the Large Hadron Collider. Higher-order coefficients are interesting because they do not simply originate as a response of the medium to its initial geometry, but rather from an intricate nonlinear coupling of harmonics of lower order. Hence, they serve as a powerful tool for the investigation of those properties of the quark-gluon plasma which are independent of the (so far very uncertain) initial conditions of the hydrodynamic evolution, such as its viscosity and freeze-out conditions.

I review the state-of-the-art framework describing higher-order harmonics, and I show that it is incomplete: It does not allow for a consistent characterization of flow coefficients defined with more than one nonlinear contribution, such as hexagonal flow, v_6. More specifically, I show that the present determinations of the nonlinear response coefficients of hexagonal flow, reported in both theoretical and experimental analyses, have been carried out under hidden underlying assumptions, which spoil the physical interpretation of the final results.

With the aim of curing these issues, I present an improved framework which encompasses the existing one, and allows for an exact characterization of any flow coefficient defined with an arbitrary number of nonlinear contributions. I perform an explicit application of the new framework to recent experimental data: I derive exact formulas for the nonlinear response coefficients of v_6, which I then extract from ALICE data. Doing so, I obtain the first experimental determination of the nonlinear coefficient coupling v_6 to v_2 and v_4. This quantity turns out to present a very specific centrality dependence, that is not captured by existing viscous hydrodynamic calculations. Promising applications of the presented formalism to upcoming high statistics Run2 data will be emphasized.

Content type

Theory

Collaboration

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