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Coalescence Like Sum Rules from Hydrodynamics

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Hadronization in ultra-relativistic heavy-ion collision (UHIC) experiments can be effectively described by the quark coalescence mechanism. Within this framework, sum rules for flow coefficients naturally emerge, wherein the flow harmonic v_n of a hadron is expressed as the sum of the corresponding v_n of its constituent quarks. The application of these sum rules requires the consideration of number-of-constituent-quark (NCQ) scaling.
In this work, we test the validity of these sum rules using hadrons generated from a hydrodynamic model at $\sqrt{s_{NN}} = 200\, GeV$. Despite not employing quark coalescence for hadronization in Hydro framework—instead utilizing the Cooper-Frye freezeout formalism, we observe that the sum rule behavior is still reproduced. To understand this within the hydrodynamic context, an expression for the v_2 is derived from the Cooper-Frye formalism. Using this expression, we relate the elliptic flow v_2 of one hadron to the v_2 of two other hadrons. The relative contributions are found to depend on the masses of the hadrons involved. We find that although these weight coefficients differ from those obtained via the quark coalescence mechanism, the sum rules remain valid in both approaches. A comparative analysis reveals that the agreement improves at high p_T , consistent with expectations.

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