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Constraining the initial stages of heavy-ion collisions with high-$p_\perp$ theory and data

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Commonly, only low-$p_\perp$ sector is used to infer the features of initial stages before QGP thermalization. On the other hand, recently acquired wealth of high-$p_\perp$ experimental data paves the way to utilize the high-$p_\perp$ particles energy loss in exploring the initial stages. However, the results of such explorations are up to now either inconclusive or questionable. We here concentrate on high-$p_\perp$ R_{AA} and v_2 observables, and study the effects of four different commonly considered initial stages scenarios, which have the same temperature profile after - but differ in the temperature profiles before - thermalization. For the study, we use our recently developed DREENA framework, which is a fully optimized computational procedure in which our state-of-the-art dynamical energy loss is employed. Contrary to the common expectations, we surprisingly obtain that high-$p_\perp$ v_2 is insensitive to the initial stages of medium evolution, being unable to discriminate between different scenarios. On the other hand, R_{AA} is notably sensitive to these conditions, strongly preferring later thermalization times and free streaming during the initial stages of QGP formation. Moreover, we also reconsider the validity of widely-used procedure of fitting the energy loss parameters for different initial-stage cases to reproduce the experimentally observed R_{AA}. We here find that the reported sensitivity of v_2 to different initial-stage scenarios is mainly an artifact of the R_{AA} fitting, with no real physical process to support it. Therefore, such a procedure may lead to erroneous conclusions, masking the underlying nature of jet-medium interactions. Consequently, the simultaneous study of high-$p_\perp$ R_{AA} and v_2 is necessary for imposing reliable constraints on the initial stages.

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