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Establishing the Range of Applicability of Hydrodynamics in High-Energy Collisions

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We simulate the space-time dynamics of high-energy collisions based on a microscopic kinetic description, in order to determine the range of applicability of an effective description in relativistic viscous hydrodynamics [1,2]. We find that hydrodynamics provides a quantitatively accurate description of collective flow when the average inverse Reynolds number Re^{-1} is sufficiently small and the early pre-equilibrium stage is properly accounted for. By determining the breakdown of hydrodynamics as a function of system size and energy, we find that it is quantitatively accurate in central lead-lead collisions at LHC energies, but should not be used in typical proton-lead or proton-proton collisions, where the development of collective flow can not accurately be described within hydrodynamics.

[1] V.E. Ambruș, S. Schlichting, C. Werthmann. To appear in Phys.Rev.D, arXiv: 2211.14379 [hep-ph]
[2] V.E. Ambruș, S. Schlichting, C. Werthmann. Phys.Rev.Lett. 130 (2023) 152301, arXiv: 2211.14356 [hep-ph]

Category

Theory

Collaboration (if applicable)

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