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Causality violations in realistic nuclear collision simulations

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Hydrodynamic models are a central component of nuclear collision phenomenology. In this talk, I show that relativistic causality is violated in the early stages of state-of-the-art heavy-ion hydrodynamic simulations of nuclear collisions. Up to 75% of the initial fluid cells violate nonlinear causality constraints, while superluminal propagation is observed by up to 15% the speed of light. Only after 2-3 fm/c of evolution, do ~50% of the fluid cells become definitely causal. Inclusion of pre-equilibrium evolution significantly reduces the number of acausal cells, but it does not eliminate them. These findings show that relativistic causality imposes constraints on the available model parameter space of heavy-ion collision simulations.

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