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QCD and Relativistic Hydrodynamics from pp to AA (20+5)

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One of the biggest open questions in the study of nuclear collisions is the proper understanding of collective behavior and, in particular, whether a unified framework can be found which simultaneously describes the relevant features of this behavior in all collision systems. To date, a number of such frameworks have been proposed, including that of relativistic hydrodynamics. This approach models a collision's evolution using the equations of relativistic fluid dynamics, thereby attributing the observed collective behavior to the fluid-like evolution of the quark-gluon plasma (QGP).

In this talk I will review some recent challenges to the applicability of the hydrodynamic framework in nuclear collisions. These challenges, which become particularly acute in small systems, arise from the large gradients and non-equilibrium corrections present in nuclear collisions and the fact that, as recently demonstrated, these lead readily to violations of the hyperbolic character of the hydrodynamic equations of motion and/or of relativistic causality itself. Moreover, these challenges turn out to be present even in models which have been explicitly tuned to match the experimental data. I will suggest some broad implications of these results for the ongoing debate about the nature and origins of collectivity in nuclear collisions.

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