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An Asymmetric Exact Solution for Longitudinally Expanding Ideal Fluid

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Relativistic hydrodynamics has been successful in describing the evolution of Quark-Gluon Plasma, as well as understanding and predicting experimental measurements highlighting the collective behavior of the observed hadrons created in relativistic heavy-ion collisions. In parallel with the remarkable progress made in numerical fluid dynamics, the study of analytical solutions remains helpful in capturing intuitive pictures and important features.

In this work, we report a new exact and explicit ***analytical*** solution for relativistic ideal hydrodynamic equations. In this solution, the fluid expands in the longitudinal direction, and contains the plateau structure for finite rapidity range, and can be either ***symmetric*** or ***asymmetric*** (with respect to mid-rapidity). Both these features are controlled by two parameters in the solution, which allows flexibility in covering the longitudinal shape of p-A and A-A collisions. We further calculate the corresponding pseudorapidity distribution of hadron yields, and find good agreement with the experimental measurements in high-energy Pb-Pb, Au-Au, p-Pb, and d-Au collisions. We also stress the importance of exact solutions as a baseline for the assessment of non-equilibrium features, and for the validation of numerical simulations. Considering that this exact solution can be rapidity-asymmetric, this last point appears especially valuable.

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