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Shock Formation in Relativistic Viscous Fluid Dynamics

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We use a recently developed explicitly flux conservative formalism for the causal and stable hydrodynamic equations developed by Bemfica, Disconzi, Noronha, and Kovtun (BDNK) with the goal of investigating shock formation in relativistic viscous fluids. It is well known that the relativistic Euler equations can give rise to discontinuous solutions called shock waves, and attempts to show whether or not viscous theories also produce shocks have been made in recent years, including for Müller-Israel-Stewart (MIS) theories and BDNK itself. In order to solve the BDNK equations, we employ the widely used Kurganov-Tadmor scheme coupled with a Total Variation Diminishing Runge-Kutta scheme so as to alleviate oscillations in the solutions. We investigate shock formation in BDNK for large and small viscosities and probe the theory's dependence on the chosen hydrodynamic frame in 1+1 dimensional simulations in flat spacetime.

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