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Transient effects of charge diffusion in relativistic resistive magnetohydrodynamics”

In this study, we investigate charge diffusion in relativistic resistive second-order dissipative magnetohydrodynamics. Our approach utilizes an evolution equation of charge diffusion current that ensures causality and stability, instead of the standard Navier-Stokes form of Ohm’ s law, which leads to transient effects in the charge-diffusion current depending on the electrical conductivity and charge-diffusion relaxation time. We apply our theory to a simplified 1+1-dimensional scenario for a heavy-ion collision, assuming matter and electromagnetic fields are transversely homogeneous. We investigate the cases of an initially nonexpanding fluid and a fluid initially expanding according to a Bjorken scaling flow. In the latter case, the breaking of scale invariance is quantitatively important only if the electromagnetic fields are sufficiently strong, with smaller values of conductivity resulting in the larger breaking of scale invariance. Our resulting equations of motion are stiff, requiring the development of an implicit-explicit Runge-Kutta method for numerical solution. We also discuss aspects of entropy production and stability from charge-diffusion currents.

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