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Shear evolution in non-resistive magnetohydrodynamics with momentum dependent relaxation time

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Strong magnetic fields are expected to exist in the early stages of heavy ion collisions and there is also an increasing evidence that the energy dependence of the cross-sections can strongly affect the dynamics of a system even at a qualitative level. This led us to the current study where we developed second-order non-resistive relativistic viscous magnetohydrodynamics (MHD) derived from kinetic theory using an extended relaxation time approximation (ERTA), where the relaxation time of the usual relaxation time approximation (RTA) is modified to depend on the momentum of the colliding particles. A Chapman-Enskog-like gradient expansion of the Boltzmann equation is employed for a charge-conserved, conformal system, incorporating a momentum-dependent relaxation time. The resulting evolution equation for the shear stress tensor highlights significant modifications in the coupling with the dissipative charge current and magnetic field. The results were compared with the recently published exact analytical solutions for the scalar theory where the relaxation time is directly proportional to momentum. Our approximated results show a very close agreement with the exact results. This can lead us to transport coefficient calculations for various theories for which exact results are not yet known.

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