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Dissipative Magnetohydrodynamics in accretion disks

We generalize the relativistic magnetohydrodynamic (MHD) theory recently derived in Ref. [1] to describe the dissipative dynamics occurring in accretion disks in presence of large magnetic fields. For this purpose we consider a relativistic dilute gas composed of electrons and ions described by the Boltzmann-Vlasov equation and simplify it using the 14-moment approximation. This procedure leads to an extended version of the MHD theory traditionally employed in astrophysics simulations [2,3] which typically considers only the parallel component of the shear-stress tensor aligned with magnetic field, B. In our framework, we consider all three distinct, non-degenerate components of the shear-stress tensor relative to B, each governed by unique dynamical equations. We demonstrate that this novel framework exhibits oscillatory behavior in strong magnetic fields that cannot be captured by the conventional MHD formulation, similar to what was observed in Ref. [1]. We finally compare both frameworks in the linear and nonlinear regimes. In particular, we analyze the equations in conditions that lead to firehose instability [4], which is usually observed in simulation-based frameworks.

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Category

Theory

Collaboration (if applicable)

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