

The matter Lagrangian of a non-perfect fluid

The Lagrangian of matter is a crucial component in the action of relativistic gravity theories with matter couplings, such as general relativity. Particularly in alternative gravity theories featuring non-minimal curvature-matter couplings, the matter Lagrangian explicitly figures in the field equations. Consequently, its precise value is necessary to fully compute these field equations. In this study, we demonstrate that the plus or minus sign of the total energy density, comprising the internal energy density and the rest energy density, is an appropriate value for the matter Lagrangian of a non-perfect fluid. The sign is contingent on the metric signature and the definition of the matter action, and its value remains independent of the gravitational model, selected thermodynamic variables, equation of state, or thermodynamic fluxes.

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