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Dissipative effects in matter and metric perturbations: formal analysis

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Compact objects are usually described using the perfect fluid formalism. However, in astrophysical processes out of local equilibrium, dissipative effects become important to realistically describe the dynamics of the system.
In this work, we present for the first time the gauge-invariant non-spherical perturbations in a dissipative self-gravitating fluid in spherical symmetry. For this we use the Gerlach-Sengupta formalism to work with gauge-invariant metric perturbations, and the Gundlach-Martín-García approach to transform the tensor perturbation equations into scalar equations.
We calculate the dynamics of the dissipative contributions, e.g. bulk viscosity, heat flux, and anisotropic stress, using the Müller-Israel-Stewart equations in the gauge-invariant formalism.

We obtain the set of field equations for the evolution of matter and metric perturbations in the polar and axial sectors. In the former, we find two wave equations sourced by the anisotropic contributions, and the evolution of all matter perturbations for radiative modes ($l \geq 2$). In the latter, we find one wave equation coupled to the evolution of matter perturbations. Finally we comment on the contribution of dissipative effects in the lower-order multipoles ($l = 0, 1$) for both sectors.

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