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Can dark matter–relativistic neutrino interactions generate viscosity in the dark matter fluid?

This work studies the cosmological effects of interactions between dark matter and relativistic neutrinos in the linear regime of cosmological perturbation theory. Both species are described as interacting imperfect fluids, with the aim of analyzing how their coupling modifies the evolution of perturbations. In particular, we consider a dark matter–neutrino scattering process mediated by a massive vector boson. From this interaction, we compute the corresponding scattering amplitude and construct the collision term entering the Boltzmann equation, allowing for a non-negligible momentum transfer from neutrinos to dark matter. The analysis focuses on determining whether this interaction induces a multipole hierarchy in the dark matter distribution function. Special attention is given to the quadrupole perturbation, which is associated with anisotropic stress and therefore with dissipative effects such as dark matter viscosity. This framework provides a way to explore how interactions in the dark sector may modify the effective fluid description of dark matter and leave imprints on the evolution of cosmological perturbations.

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