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Impact of chiral effects on core-collapse supernova dynamics

Chiral effects induced by quantum anomalies, such as the chiral magnetic effect, are expected to influence the dynamics of core-collapse supernovae (CCSN). These effects arise in strong magnetic fields and rapid flows, which are common in supernova cores. In this project, we investigate the potential impact of chiral neutrino radiation transport in CCSN, focusing on contributions from neutrinos near equilibrium. We use an approximate formula for the chiral corrections to the neutrino radiation energy-momentum tensor $\partial_\mu T^{\mu i}_{\rm rad}$ from the work of Yamamoto & Yang (2021). We investigate the potential contributions from these chiral corrections on self-consistent 2D CCSN simulations with neutrino transport. We find that some of the chiral correction terms can significantly contribute to momentum changes and, therefore, can have a crucial impact on the dynamics of the proto-neutron star around the core bounce. This effect might be one of the origins of the popular kick.

Section

High Energy

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