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Neutrino opacities in the NJL model with color superconductivity

Neutrino transport plays a critical role in the evolution of neutron star mergers and the cooling of neutron stars. In this work, the quark core in a hybrid star is modeled with a three-flavor NJL-type model that allows for color superconductivity (arXiv:2408.06704). The rich phase structure of dense quark matter heavily influences neutrino transport. We calculate the direct Urca neutrino opacities of quark matter in the unpaired and in the two-flavor superconducting (2SC) phase. At low temperatures, the contribution of the gapped quarks can be neglected and we show how the self-consistently calculated quark masses determine the density-window in which the direct Urca process is kinematically allowed. While the direct Urca window for the process $\nu + d \rightarrow u + e^-$ is closed at $T = 0$, the process $\nu + s \rightarrow u + e^-$ has a direct Urca threshold. To investigate the scenario of neutron star mergers, in which the temperature rises to 50-100 MeV, we take into account pair-breaking effects in the 2SC phase.

Category

Theory

Collaboration (if applicable)

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