Neutrino Pair Emission from Cooper Pair-Breaking and Recombination in Superfluid Quark Matter

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Abstract

Superfluidity in neutron star interiors has a major effect on the star's thermal evolution through suppressions of neutrino (ν) emission processes and specific heats. However, below the critical temperature T_c, Cooper pairs may continuously break and recombine, resulting in the emission of $\nu\overline{\nu}$ pairs with a rate that exceeds the standard (baryon or quark) modified Urca rate. For the low energy Standard Model neutrino–matter interactions, we find that both vector and axial channels give comparable emissivities in relativistic quark matter, in contrast to baryonic matter in which the predominant contribution is from the vector channel (Flowers *et al.*, ApJ 205 (1976) 541). We compare $\nu\overline{\nu}$ emissivities from s–wave and p–wave pairing in baryonic and quark matter, and discuss their effects on neutron star cooling curves.