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Neutrino-antineutrino pair production by hadronic bremsstrahlung[1]

SONIA BACCA, TRIUMF

I will report on recent calculations of neutrino-antineutrino pair production from bremsstrahlung processes in hadronic collisions and consider temperature conditions relevant for core collapse supernovae. Earlier studies on bremsstrahlung from neutron-neutron collisions [1,2] showed that the approximation used in typical supernova simulation to model this process differs by about a factor of 2 from predictions based on chiral effective field theory, where the chiral expansion of two-body forces is considered up to the next-to-next-to-next-to-leading order [3]. When the density of neutrons is large enough this process may compete with other non-hadronic reactions in the production of neutrinos, in particular in the case of μ and τ neutrinos, which are not generated by charged-current reactions. A natural question to ask is then: what is the effect of neutrino pair production from collisions of neutrons with finite nuclei? To tackle this question, we recently have addressed the case of neutron-α collisions [4], given that in the P-wave channels the neutron-α scattering features a resonance near 1 MeV [5]. We find that the resonance leads to an enhanced contribution in the neutron spin structure function at temperatures in the range of $0.1 - 4$ MeV. For significant density fractions of α in this temperature range, this process is competitive with contributions from neutron-neutron scattering. [1] S.Bacca, K.Hally, C.J.Pethick, A.Schwenk, Phys. Rev. C, 80 032802 (2009) [2] S.Bacca, K.Hally, M.Liebendoerfer, A.Perego, C.J.Pethick, A.Schwenk, Astrophys. J. 758, 34 (2012) [3] D.R.Entem, R.Machleidt, Phys. Rev. C 68, 041001 (2003) [4] R.Sharma, S.Bacca, A.Schwenk, Phys. Rev. C 91, 042801(R) (2015) [5] R. A. Arndt and L. D. Roper, Phys. Rev. C 1, 903 (1970)

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