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Study of the hot nuclear matter and supernovae remnants using relativistic mean field model

Modern study of infinite nuclear matter based on relativistic mean-field (RMF) model bestow us with new dimensions in understanding the nature and behavioral aspects of compact astrophysical objects. It is well known that the compact stars are the remnants of the supernova explosion and ideal laboratory to explore the formulated theories of dense matter objects. We provide an approach to explore the nuclear and thermal properties of hot nuclear matter and newly born proto-neutron star with equation of state (EoS) being the main ingredient. We extend the RMF formalism to finite temperature and examine the variation of various nuclear and thermal properties like phase transition temperature, incompressibility, symmetry energy and its derivatives for infinite nuclear matter. We studied all these properties using most popular NL3, IU-FSUand recently developed G3 parameter sets. We did a comparative analyzation i.e. how differently these nuclear properties varies for the prescribed NL3, G3 and IU-FSU forces. The cooling mechanism of the newly born proto-neutron star through direct Urca process has also been explored. The observation of Einstein Observatory (HEAO-2) first supported the fact that neutrino emissivity enhanced by direct Urcaprocess is mainly responsible for the rapid cooling of newly born dense star. We observed here that the EoS plays an important role to investigate the cooling rate of hot dense object and neutrino emissivity is higher for that parameter set which provides softer EoS. Different cooling rates for NL3, G3 and IU-FSU parameter sets emphasized on the importance of EoS in the dynamics of supernova explosion and thermal stabilization of the newly born star. We also deliberate the effect of temperature on the Mass-Radius profile of Proto-Neutron star with two different perspectives i.e. fixed temperature and constant entropy.

Reference:- Ankit Kumar, H. C. Das, S. K. Biswal, Bharat Kumar and S. K. Patra, Eur. Phys. J.C (2020) 80, 775; DOI: https://doi.org/10.1140/epjc/s10052-020-8353-4

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