Influence of the properties of protoneutron stars on the minimum and maximum mass of neutron stars and the delayed collapse

K.Strobel and M. K. Weigel

The minimum and maximum mass of protoneutron stars and neutron stars are investigated utilizing for the description of hot and cold dense matter either relativistic (including hyperons) or non-relativistic equations of state, respectively. The protoneutron star (PNS) is born after the gravitational collapse of the iron core of a massive evolved star and consists of hot, lepton rich matter. Due to the loss of neutrinos such a PNS evolves - in general - in some minutes into a cold, lepton poor neutron star (NS). However a further possibility is the delayed collapse to a black hole (BH), if either its initial mass high enough or due to the post bounce accretion, respectively. The aim of our study is the determination of the minimum and maximum mass of NSs and furthermore the possibility of BH formation. It turns out that the mass limits of NSs are significantly determined by the early stages of the PNS (0.1 - 1s for the minimum mass; 0 - 30s for the maximum mass) and not by the (standard) determination of these quantities via the outcome of the Tolman - Oppenheimer - Volkoff equation (TOV) for cold NS - matter! Our result for the minimum mass is an increase of the TOV - results for cold neutron star matter by a factor of ten (due to dynamic instabilities), i.e. approximately one solar mass. The maximum baryonic mass of NSs (for $T = 0$) is in most cases decreased by several percent due to the limitations of the mass maxima of the PNSs. Furthermore we find that the delayed collapse of a PNS into a BH during leptonization is not only possible due to the softening components, as for instance, hyperons, but also for stars with a pure nucleonic - leptonic composition. These result were obtained for the first time by additionally taking into account the period of 0.1 - 1s after core bounce.

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