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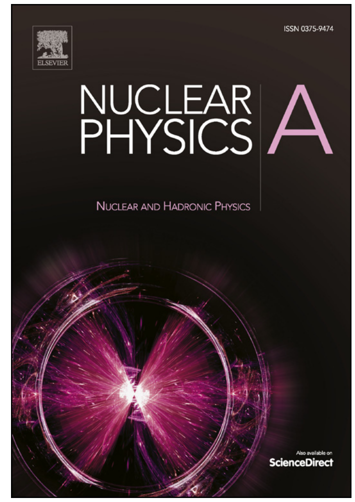

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Cooling of neutron stars in "nuclear medium cooling scenario" with stiff equation of state including hyperons

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Abstract

We demonstrate that the existing neutron-star cooling data can be appropriately described within "the nuclear medium cooling scenario" including hyperons under the assumption that different compact-star sources have different masses. We use a stiff equation of state of the relativistic mean-field model MKVORHϕ with hadron effective couplings and masses dependent on the scalar field. It fulfills a large number of experimental constraints on the equation of state of the nuclear matter including the $2\,M_{\odot}$ lower bound for the maximum compact-star mass and the constraint for the pressure from the heavy-ion particle flow. We select appropriate $^1S_0$ proton and Λ hyperon pairing gap profiles from those exploited in the literature and allow for a variation of the effective pion gap controlling the efficiency of the medium modified Urca process. The $^3P_2$ neutron pairing gap is assumed to be negligibly small in our scenario. The possibility of the pion, kaon and charged ρ-meson condensations is for simplicity suppressed. The resulting cooling curves prove to be sensitive to the value and the density dependence of the pp pairing gap and rather insensitive to the values of the $^1S_0$ neutron pairing gaps.

Key words: neutron stars, cooling, equation of state, hyperons, in-medium effects, neutrino

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