ID de Contribution: **161** Type: **Seminar**

Exotic Baryons in Hot Neutron Stars

jeudi 21 septembre 2023 11:30 (20 minutes)

We study the nuclear isentropic equation of state for a stellar matter composed of nucleons, hyperons, and Δ-resonances. We investigate different snapshots of the evolution of a neutron star, from its birth as a lepton-rich protoneutron star in the aftermath of a supernova explosion to a lepton-poor regime when the star starts cooling to a catalyzed configuration. We use a relativistic model within the mean-field approximation to describe the hot stellar matter and adopt density-dependent couplings adjusted by the DDME2 parameterization. We use baryon-meson couplings for the spin-$1/2$ baryonic octet and spin-$3/2$ decuplet determined in a unified manner relying on SU(6) and SU(3) symmetry arguments. We observe that Λ is the dominant exotic particle in the star at different entropies for both neutrino-free and neutrino-trapped stellar matter. For a fixed entropy, the inclusion of new particles (hyperons and/or delta resonances) in the stellar matter decreases the temperature. Also, an increase in entropy per baryon (1 to 2) with decreasing lepton number density (0.4 to 0.2) leads to an increase in stellar radii and a decrease in its mass due to neutrino diffusion. In the neutrino transparent matter, the radii decrease from entropy per baryon 2 to $T = 0$ without a significant change in stellar mass.

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Classification de Session: Plenary