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Hypernuclear Matter in Neutron Stars Using Realistic Λ Hyperon Potentials

The extraordinary densities achieved in the cores of neutron stars make them ideal astrophysical laboratories for investigating hypernuclear matter. Recent multi-messenger observations impose stringent constraints on the neutron star equation of state (EoS), allowing for quantitative tests of models that incorporate exotic components such as hyperons. For example, precise measurements of neutron star masses—such as PSR J0740+6620 with a mass of approximately 2.08 $M_\odot$—along with tidal deformability constraints from the binary neutron star merger GW170817, significantly narrow the range of viable EoSs.

In this work, we explore the presence of Λ hyperons in β-stable matter within neutron star cores using a potential-based ab initio approach. For both Λ–nucleon and Λ–Λ interactions, we employ spin- and parity-dependent potentials phenomenologically tuned by experimental data from hypernuclei. We analyze the impact of these interactions on the stiffness of the EoS and the resulting neutron star mass-radius relation. Special emphasis is placed on addressing the long-standing hyperon puzzle within this framework.

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