Effects of the Symmetry Energy on Dark Neutron Decay in Neutron Stars

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We conduct a systematic investigation of the influence of the nuclear symmetry energy on the proposed neutron decay into dark matter within the cores of neutron stars. Unlike previous studies that considered only pure neutron matter, the present analysis is extended to encompass β-stable nuclear matter. Additionally, the interactions between dark matter and baryons are explicitly incorporated. Our findings indicate that the nuclear symmetry energy plays a critical role in shaping the total equation of state (EoS) for dense neutron star matter containing dark sector components. The strength of interactions among dark matter particles, as well as between dark matter and baryons, is shown to be pivotal in determining both the composition and macroscopic properties of neutron stars. Under certain conditions, we observe that the substitution of neutrons with protons and dark matter particles, particularly in the regime of weak interactions, can lead to a notable softening of the EoS. In contrast, stronger interaction strengths result in a comparatively moderate modification of the EoS of pure neutron star matter. The concurrent tuning of interaction strengths alongside the symmetry energy parameters may facilitate a more accurate reproduction of recent observational data relevant to neutron star properties.

References

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