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Neutron Stars with BHF Modified Density-Dependent Nucleon Masses and Weakly Interacting Dark Matter

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The phenomenology community has extensively investigated the extreme conditions of matter within fermionic dark matter (FDM) admixed neutron stars using various effective field theories. A popular model in this context is hereby referred to as the $\sigma - \omega - \rho$ + FDM model, which incorporates fermionic dark matter interacting with baryonic matter through new scalar and vector mediators. However, previous studies have overlooked the impact of medium effects on the effective masses of nucleons. In this work, we address this oversight by taking into account a density-dependent effective mass for nucleons derived from the Brueckner-Hartree-Fock many-body approach. We systematically examine how this modification influences the equations of state of neutron star matter and, subsequently, the macroscopic properties of neutron stars, including their rotational characteristics. Our results demonstrate that incorporating the effective mass correction leads to improved agreement with recent experimental observations. Additionally, we derive constraints on the model parameters and provide predictions regarding the masses of neutron stars and the distributions of dark matter within the cores of neutron stars.

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