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Exploring robust correlations between fermionic dark matter model parameters and neutron star properties: A two-fluid perspective

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We investigate the probable existence of dark matter in the interior of neutron stars.
Despite the current state of knowledge, the observational properties of neutron stars have not definitively ruled out the possibility of dark matter. Our research endeavors to shed light on this intriguing mystery by examining how certain neutron star properties, including mass, radius, and tidal deformability, might serve as constraints for the dark matter model.

In our investigation, we adopt a two-fluid approach to calculate the properties of neutron stars. For the nuclear matter EOS, we employ several realistic EOS derived from the relativistic mean field model (RMF), each exhibiting varying stiffness and composition. In parallel, we look into the dark matter EOS, considering fermionic matter with repulsive interaction described by a relativistic mean field Lagrangian. A reasonable range of parameters is sampled meticulously.

Our study primarily focuses on exploring correlations between the dark matter model parameters and different neutron star properties using a rich set of EOSs. Interestingly, our results reveal a promising correlation between the dark matter model parameters and stellar properties, particularly when we ignore the uncertainties in the nuclear matter EOS. However, when introducing uncertainties in the nuclear sector, the correlation weakens, suggesting that the task of conclusively constraining any particular dark matter model might be challenging using global properties alone, such as mass, radius, and tidal deformability.

Notably, we find that dark-matter admixed stars tend to have higher central baryonic density, potentially allowing for non-nucleonic degrees of freedom or direct Urca processes in stars with lower masses. There is also a tantalizing hint regarding the detection of stars with the same mass but different surface temperatures, which may indicate the presence of dark matter. With our robust and extensive dataset, we delve deeper and demonstrate that even in the presence of dark matter, the semi-universal C-Love relation remains intact. This captivating finding adds another layer of complexity to the interplay between dark matter and neutron star properties.

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Classification de Session: Theory of supernovae, neutron stars, and neutron star mergers

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