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Impact of asymmetric bosonic dark matter on neutron star properties

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We propose a novel model of asymmetric bosonic dark matter (DM) with self-repulsion mediated by the vector field coupled to the complex scalar particles. By adopting the two fluid formalism, we study different DM distribution regimes, either, fully condensed inside the core of the star or, otherwise, distributed in a dilute halo around the neutron star (NS). We show that DM condensed in a core leads to a decrease of the total gravitational mass and tidal deformability compared to a pure baryonic star with the same central density, which we will perceive as an effective softening of the equation of state (EoS). On the other hand, the presence of a DM halo increases the tidal deformability and total gravitational mass.
As a result, DM could affect the NS properties by softening or stiffening the EoS. We demonstrate how observational data on compact stars could be employed to place constraints on strongly interacting matter at high densities. Moreover, we examine the limit where DM accrued in a core could cause the gravitational collapse. An implication of the proposed EoS and tests against astrophysical and GW observations are performed for DM particles in a MeV-GeV mass-scale, various interaction strength, and relative DM fractions inside NSs.

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