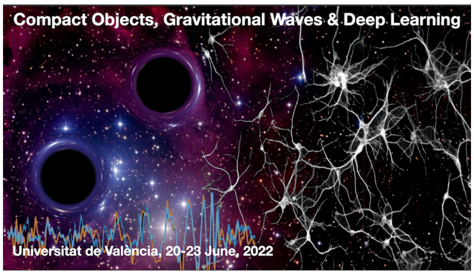

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Fermion-axion stars: static solutions and numerical evolutions

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The non-linear stability analysis of mixed stars made by fermionic and bosonic matter is a branch of investigation which allows us to prove the existence of neutron stars with accreted bosonic dark matter. Such hypothetical fermion-boson stars are gravitationally bound solutions of the Einstein-Klein-Gordon-Euler theory where we modeled the bosonic matter as a complex scalar field with a specific potential ⊠(⊠). The aim of our work is to study the non-linear stability using a particular choice of the scalar potential: the axion-like particle potential. Changing the potential of the bosonic matter, it is possible to have a completely different behavior of the solutions leading to the possibility to have new stable regions in the parameters space. The fermion-boson models are defined by the central rest-mass density for the fermionic matter ⊠⊠ and the central value of the scalar field ⊠⊠; in addition, the axion-like particle potential depends on two parameters: the mass of the scalar field ⊠⊠ and the decay constant ⊠⊠. After building such spherically-symmetric models called fermion-axion stars, we perform numerical relativity simulations to evolve and analyze them in the non-linear regime, confirming that the linearly stable configurations remain stable. We observe three different fates for the unstable models: there are models which collapse to black holes, others that migrate to different stable configurations and finally in a small region of the parameter space very close to the first unstable branch of pure axion stars there are models where the scalar field disperses, bringing with itself also the small fraction of baryonic matter forming those configurations.

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