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Quasi-Static Solutions for Compact Objects in Chameleon Models

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It has been suggested that a scalar field φ non-minimally coupled to matter could be responsible for the observed accelerated expansion of the Universe. However, the fact that we are able to measure its effect only on cosmological scales but not on local ones, such as that of our solar system, might be the consequence of a screening mechanism. This is the essence of the Chameleon model. Understanding its viability requires solving the field equations in the transition regime where the scalar field transitions from a region of high density to the outer region where it plays the role of the Dark Energy. In this work we analyze quasi-static spherically symmetric solutions for objects such as standard stars and more compact objects like white dwarfs and neutron stars, by solving the Tolman-Oppenheimer-Volkoff equations coupled with the Klein-Gordon equation in a quasi static regime. We derive a solution that takes into account the background expansion without needing to introduce an artificial cosmic matter corresponding to a non-spatially flat metric. The interior of the star is characterized using a constant density (incompressible) model and a more realistic polytropic equation of state. The increase of compactness that we observe in case of a good screening (thin shell) allows to put serious constraints on the Chameleon mechanism and its viability using astrophysical compact objects.

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