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(G*) Quark stars with a unified interacting equation of state in regularized 4D Einstein-Gauss-Bonnet gravity

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Since the derivation of a well-defined D→4 limit for 4D Einstein Gauss-Bonnet (4DEGB) gravity coupled to a scalar field, there has been interest in testing it as an alternative to Einstein's general theory of relativity. Using the Tolman-Oppenheimer-Volkoff equations modified for 4DEGB gravity, we model the stellar structure of quark stars using a novel interacting quark matter equation of state. We find that increasing the Gauss-Bonnet coupling constant α or the interaction parameter λ both tend to increase the mass-radius profiles of quark stars described by this theory, allowing a given central pressure to support larger quark stars in general. These results logically extend to cases where $\lambda<0$, in which increasing the magnitude of the interaction effects instead diminishes masses and radii. We also analytically identify a critical central pressure in both regimes, below which no quark star solutions exist due to the pressure function having no roots. Most interestingly, we find that quark stars can exist below the general relativistic Buchdahl bound and Schwarzschild radius R=2M, due to the lack of a mass gap between black holes and compact stars in the 4DEGB theory. Even for small α well within current observational constraints, we find that quark star solutions in this theory can describe extreme compact objects, objects whose radii are smaller than what is allowed by general relativity.

Keyword-1

general relativity

Keyword-2

compact stars

Keyword-3

modified gravity

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