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Compact Objects in Brans-Dicke Gravity

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Abstract: This paper aims to investigate the existence and properties of anisotropic quark stars in the context of self-interacting Brans-Dicke theory. In this theory, the gravitational constant in general relativity is replaced by a dynamical massive scalar field accompanied by a potential function. Researchers believe that strange stars may evolve from neutron stars when neutrons fail to endure the extreme temperature and pressure in the interior region. As a consequence they breakdown into their constituent particles known as quarks. In order to construct a well-behaved quark star model under the influence of massive scalar field, we formulate the field equations by employing the MIT bag model. The MIT bag model (strange quark matter equation of state) is the most suitable choice

for quark stars as it has successfully described the compactness of certain stellar bodies. Furthermore, the estimates of mass of quark stars based on the data from the cosmic events GW170817 and GW190425 support the choice of MIT bag model. The model is developed by considering three types of quark matter: strange, up and down. The bag constant involved in the model differentiates between false and true vacuum. We consider a static sphere with anisotropic fluid and employ the observed masses and radii of the strange star candidates (RXJ 1856-37 and PSR J1614-2230) in the matching conditions at the boundary to evaluate the value of bag constant. Further, we evaluate the impact of the massive scalar field on state parameters and investigate the viability (via energy conditions) as well as stability (through the speed of sound constraints) of the self-gravitating objects. It is found that the obtained values of the bag constant lie within the accepted range ($58.9MeV/fm^3\leq\mathcal{B}\leq91.5MeV/fm^3$). Moreover, the anisotropic structure meets the necessary viability and stability criteria.

Keywords: Anisotropy; Brans-Dicke theory; Quark stars.

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