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White Dwarfs as Astrophysical Probes of $f(Q)$ Gravity

White dwarfs provide a complementary laboratory for testing gravity in a density regime distinct from neutron stars and black holes. We investigate their equilibrium structure within the covariant formulation of symmetric teleparallel $f(Q)$ gravity, where gravitational interactions are described through the nonmetricity scalar Q rather than spacetime curvature. Static, spherically symmetric configurations of cold, completely degenerate electron matter are considered using the quadratic model $f(Q) = Q + \alpha Q^2$, with α controlling deviations from general relativity. The resulting modified stellar structure equations are solved numerically together with the Chandrasekhar equation of state. We analyse the effects of nonmetricity corrections on the metric potentials, pressure, density, enclosed mass, nonmetricity scalar, and mass–radius relation. Negative values of α generate unstable or nonphysical high-density configurations, whereas nonnegative values yield regular stellar solutions. Increasing α produces increasingly significant departures from general relativity at high central densities and systematically lowers the maximum supported mass relative to the Chandrasekhar limit, while also modifying the corresponding radius and internal profiles. For $\alpha = 5 \times 10^{18} \text{ cm}^2$, the model predicts a maximum mass of $1.3519 M_\odot$ and a radius of 2228.85 km, compatible with the observational constraints associated with the ultra-massive white dwarf ZTF J1901+1458. These results demonstrate that precise mass–radius measurements of white dwarfs can constrain quadratic nonmetricity corrections and provide an independent astrophysical test of modified gravity.

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