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The breaking point of general relativity through f(R) scalaron gravity and higher dimensional Kaluza-Klein gravity near Sgr A*

The Galactic Center supermassive black hole, Sgr A* provides an ideal laboratory for testing general relativity (GR) and constraining its alternatives. In this work, we search for GR breaking points by estimating the pericenter shift of stellar orbits having a semimajor axis in the range of (45 - 1000)au. We work with theoretical scalaron field amplitude and coupling. The scalaron mass is taken in the range (10^{−22}–10^{−17}) eV. The breaking point of GR arises only for higher scalaron coupling resulting from the Hees et al. 2017 observations within a few tens of au to a = 1000 au. We also estimate the pericenter shift with a power-law potential V(r) ~ 1/r2 arising in five-dimensional gravity and obtain allowed ranges of the five-dimensional Planck mass through existing bounds on the parameterized post-Newtonian parameters coming from the orbits of S-2, S-38, and S-55. The breaking point for GR arises from a five-dimensional Planck mass of about 104 GeV. Constraint on this parameter, expected from the astrometric capabilities of existing and upcoming large telescopes, is also presented.

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