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Neutron Stars in Palatini $f(R) = R + \alpha R^2$ and $f(R, Q) = R + \alpha R^2 + \beta Q$ Theories - Talk in Modified Gravity Phenomenology

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Adding corrections quadratic in the curvature, like R^2 or $Q = R_{\mu\nu}R^{\mu\nu}$, to the Gravity Lagrangian can make the theory perturbatively renormalizable as a quantum field theory or even produce early time inflation. Testing such modifications to gravity is challenging, but can be done by astrophysical observations. Based on our findings in [1], this talk will focus on observable traces of modifications to gravity in the mass-radius relation of neutron stars. Focusing on $f(R) = R + \alpha R^2$ and $f(R, Q) = R + \alpha R^2 + \beta Q$ theories in the Palatini formalism, where α and β control the strength of the modification, we show that the influence on the properties of a neutron star can be sizeable for certain combinations of α, β and some equations of state (EoS). Furthermore, we show that the main factors that influence the deviation from the GR result are, apart from α and β, the first and second derivative of the EoS, which go into the stellar structure equations. As a consequence, knowledge of the exact neutron star EoS is required to discriminate between GR and modified gravity theories. However, as soon as the neutron star EoS is known, observations of the mass and radius of neutron stars can be used to test modifications to GR of the Palatini $f(R)$ and $f(R, Q)$ type.

[1] https://arxiv.org/abs/2102.05722

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