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Quadratic gravity with propagating torsion and asymptotic freedom

Perturbative nonrenormalizability of gravity based on Hilbert-Einstein or Palatini actions prompted vast research in higher-derivative theories. The actions that are at least quadratic in curvature lead to a renormalizable theory, but they bring along the issue of possible unitarity violation from ghost and tachyonic degrees of freedom. Whether ghosts can or cannot be quantized consistently, is still a matter of debate. Tachyons, on the other hand, are generally considered unhealthy, and they can be avoided by an appropriate choice of couplings. Within the Wilsonian definition of the renormalization group flow, such choice leads to uncontrolled growth of the couplings in the UV.

I will consider a class of actions quadratic in curvature and torsion, which is a natural generalization of metric quadratic gravity. Using the heat kernel technique, I compute the torsion contributions to the one-loop counterterms. Vectorial and axial components of torsion preserve the qualitative picture of the renormalization group flow of the metric sector. However, there exists a specific nonminimal kinetic term for the pure tensorial (hook-antisymmetric traceless) component of torsion that switches the sign of the beta function of the R^2 term while preserving the negative sign in front of the Weyl^2 term. This behavior renders the gravitational couplings asymptotically free in the absence of tachyons.

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