Dynamical Lorentz Symmetry Breaking in a Quadratic Theory of Gravity

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This work explores the renormalization of scale-free quadratic gravity coupled to the bumblebee field and its potential for dynamically breaking Lorentz symmetry. We conduct one-loop renormalization of the model and calculate the associated renormalization group functions. Furthermore, we compute the one-loop effective potential for the bumblebee field, demonstrating that it acquires a non-trivial vacuum expectation value (VEV) through radiative corrections—a phenomenon known as the Coleman-Weinberg mechanism. This spontaneous breaking of scale invariance, driven by the non-zero VEV of the bumblebee field, leads to Lorentz symmetry violation. As a result, the non-minimal coupling between the bumblebee and gravitational fields induces a spontaneous generation of an Einstein-Hilbert term via radiative corrections, suggesting a possible link between the Planck scale and Lorentz violation phenomena.

Keywords: quantum gravity, renormalization group, Lorentz symmetry breaking.

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