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Gravitational corrections to two-loop beta function in quantum electrodynamics

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The quantization of Einsteins's general relativity leads to a nonrenormalizable quantum field theory. However, the potential harm of nonrenormalizability, can be overcome in the effective field theory (EFT) framework, where there is an unambiguous way to define a well behaved and reliable quantum theory of gravitation, if only we agree to restrict ourselves to low energies compared to the Planck scale. Although the effective field theory of gravitation is perfectly well-defined as a quantum field theory, some subtleties arise from its nonrenormalizability, such as the use of the renormalization group equations, as illustrated by the controversy involving the gravitational corrections to the beta function of gauge theories. In 2005, Robinson and Wilczek announced their conclusion that gravity contributes with a negative term to the beta function of the gauge coupling, meaning that quantum gravity could make gauge theories asymptotically free. This result was soon contested. It was shown that the claimed gravitational correction is gauge dependent, and a lot of subsequent research on the subject followed with varying conclusions. In this work we use the framework of effective field theory to couple Einstein's gravity to quantum electrodynamics and determine the gravitational corrections to the two-loop beta function of the electric charge. Our results indicate that gravitational corrections do not alter the running behavior of the electric charge, on the contrary, we observe that it gives a positive contribution to the beta function, making the electric charge grow faster.

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