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Quantum Corrections to the Gravitational Interaction of Massless Particles

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Abstract
Donoghue's effective field theory of quantum gravity is extended to include the interaction of massless particles. The collinear divergences which accompany massless particles are examined first in the context of QED and then in quantum gravity. A result of Weinberg is extended to show how these divergences vanish in the case of gravity. The scattering cross section for hypothetical massless scalar particles is computed first, because it is simpler, and the results are then extended to photons. Some terms in the cross section are shown to correspond to the Aichelburg-Sexl metric surrounding a massless particle and to quantum corrections to that metric. The scattering cross section is also applied to calculate quantum corrections to the bending of starlight, and though small, the result obtained is qualitatively different than in the classical case. Since effective field theory includes the low-energy degrees of freedom which generate collinear divergences, the results presented here will remain relevant in any future quantum theory of gravity.