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# IS THE LIGHT TOO LIGHT?

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**Abstract.** The gravitational interaction of light is analyzed considering its dual characteristic nature, i.e. as an (electromagnetic) wave or as a particle (photon). Considered as an electromagnetic wave, the light can be source of gravitational waves belonging to the larger class of exact solutions of Einstein field equations which are invariant for a non-Abelian two-dimensional Lie algebra of Killing fields. It is shown that in the would be quantum theory of gravity they correspond to spin$-1$ massless particles.

## 1. Introduction

As described in Quantum Electrodynamics (QED), photon-photon scattering can occur through the creation and annihilation of virtual electron-positron pairs and may even lead to collective photon phenomena. Photons also interact gravitationally but the gravitational scattering of light by light has been much less studied. Purely general relativistic treatments of electromagnetic wave interactions have been made resulting in exact solutions [12, 13], but these calculations are different from pure scattering processes and do not address the interaction at single photon level. It is not clear to what extent, calculations of the gravitational cross-section using Quantum Filed Theory (QFT) methods are consistent with classical General Relativity (GR). First studies go back to Tolman, Ehrenfest and Podolsky [25] and, later, to Wheeler [27] who analysed the gravitational field of light beams and the corresponding geodesics in the linear approximation of Einstein equations. They discovered that null rays behave differently according whether they propagate parallel or antiparallel to a steady, long, straight beam of light, but they did not provide a physical explanation of this fact. Later, Barker, Bathia and Gupta [2], following a previous analysis of Barker, Gupta and Haracz [4], analyzed in QED the photon-photon interaction through the creation and annihilation of a virtual graviton in the center-mass system and they found that the