Theory & Computation

Orbital Angular Momentum Coupling in Elastic Photon-Photon Scattering

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In this Letter, we investigate the effect of orbital angular momentum (OAM) on elastic photon-photon scattering in a vacuum for the first time. We define exact solutions to the vacuum electromagnetic wave equation which carry OAM. Using those, the expected coupling between three initial waves is derived in the framework of an effective field theory based on the Euler-Heisenberg Lagrangian and shows that OAM adds a signature to the generated photons thereby greatly improving the signal-to-noise ratio. This forms the basis for a proposed high-power laser experiment utilizing quantum optics techniques to filter the generated photons based on their OAM state.

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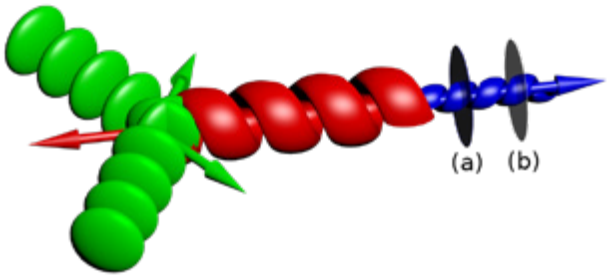

A sketch of the proposed geometry for the experiment showing the three main initial beams. The $2\omega_0$ (green) beams have a flat phase front whereas the ω_0 (red) beam has a helical front arising from the nonzero OAM. The figure illustrates the generated $3\omega_0$ (blue) spiral photons. (a) and (b) are the frequency and OAM filters, respectively, which will be used to remove background noise.