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Beam focus and longitudinal polarization influence on electron spin dynamics in counterpropagating laser beams

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In recent years, the sole light-based interaction with the spin of a free electron (polarization and spin detection) has been discussed for the case of electron diffraction in counterpropagating laser beams [1,2]. The quantum dynamics of the electron in such a standing light wave of the so-called Kapitza-Dirac effect [3,4] is commonly solved for the approximation of two counterpropagating plane wave laser beams. In our recent work [5], we investigate the effect of beam waist corrections to the plane-wave ansatz on the quantum dynamics of the electron and its spin by a perturbative approach.

We particularly pay attention on the influence of a small longitudinal polarization component in Coulomb gauge, which would be zero when simply averaged along the transverse direction of the laser beam. We conclude in our study that the longitudinal polarization component and transverse field inhomogenieties from beam focussing have no significant influence in the regime of XFEL beams, but may play a role for optical fields.

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