On the Observability of Coulomb-Assisted Quantum Vacuum Birefringence

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We consider the scattering of an X-ray free-electron laser (XFEL) beam on the superposition of a strong magnetic field $\mathbf{B}_{\rm ext}$ with the Coulomb field $\mathbf{E}_{\rm ext}$ of a nucleus with charge number Z. In contrast to pure Delbrück scattering (Coulomb field only), the magnetic field $\mathbf{B}_{\rm ext}$ introduces an asymmetry (*i.e.*, polarization dependence) and renders the effective interaction volume quite large, while the nuclear Coulomb field facilitates a significant momentum transfer $\Delta\mathbf{k}$. For a field strength of $B_{\rm ext} = 10^6$ T (corresponding to an intensity of order 10^{22} W/cm^2) and an XFEL frequency of 24 keV, we find a differential cross section $d\sigma/d\Omega \sim 10^{-25}\ Z^2/(\Delta\mathbf{k})^2$ in forward direction for one nucleus. Thus, this effect might be observable in the near future at facilities such as the Helmholtz International Beamline for Extreme Fields (HIBEF) at the European XFEL.