Interference Features of Electron Wavepacket in Intense Laser Fields with Arbitrary Polarization

R Ooi

1Department of Physics, University of Malaya, 50603, Kuala Lumpur, Malaysia
Contact Email: rooi@um.edu.my

We study an electron in intense laser fields with arbitrary elliptical and linear polarization. We analyze the variations of the momentum distributions in 3D and dependence the phase of the electron wavefunction on time, polarization and intensity. Although the system is an elementary one, the results consist of new and interesting features like destructive interference and squeezing, never identified before and will help understand the physics in relativistic regime and the evolution of an electron’s spin in high fields. Unlike previous works [1,2], this is possible through innovation in our computational technique.

Relativistic and spin effects are fully taken into account by using the covariant form of the full Dirac equation [3]. The spin is taken into account by Pauli matrices and the negative energy particle is accounted by the spinors. The theory may be extended to two laser beams to study interesting scattering mechanisms and to X-ray regime.

We also consider non-trivial initial states such as superposition between the spin up and spin down states. For initial Gaussian wavepacket we obtain analytical expressions for the time dependent wavepacket. For non-trivial initial states such as superposition between the spin up and spin down states with same and opposite signs of energy, we find interesting features and dynamics. This enables us to learn more about quantum entanglement at high energies.

The magnetic component of the laser field at such high intensity plays an important role on the wavepacket and is accounted self consistently with the electric field by the vector potential. Understanding of the effects of magnetic component of the high intensity laser field on the electron wavepacket’s phase may be useful for novel electron interferometry.

References