Light diffraction at relativistic intensities

Longqing Yi[1]

[1]Tsung-Dao Lee Institute, Shanghai Jiao Tong University, Shanghai 200240, China

When a high power laser beam irradiates a small aperture on a solid foil target, the strong laser field drives surface plasma oscillation at the periphery of this aperture, which acts as a "relativistic oscillating window", see Fig. 1 below [1]. The diffracted light that travels though such an aperture contains high-harmonics of the fundamental laser frequency. When the driving laser beam is circularly polarized, the high-harmonic generation process facilitates a conversion of the spin angular momentum of the fundamental light into the intrinsic orbital angular momentum of the harmonics. By means of theoretical modeling and fully 3D particle-in-cell simulations, it is shown the harmonic beams of order n are optical vortices with topological charge $|l| = n - 1$, and a power-law spectrum $I_n \propto n^{-3.5}$ is produced for sufficiently intense laser beams, where I_n is the intensity of the nth harmonic.

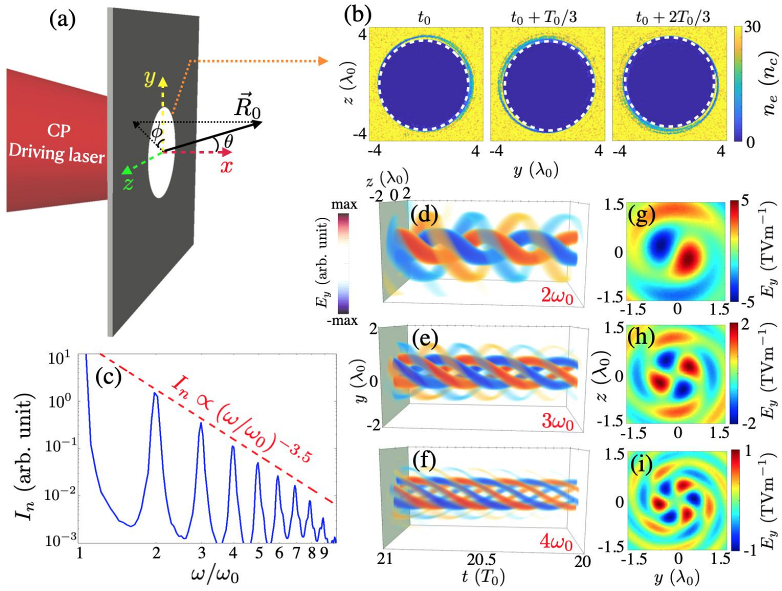

Fig. 1 (a) An intense CP laser is focused on a foil with a small aperture, the laser fields drives surface electron oscillation on the rim (b): the three snapshots are separated temporally by a third of laser period (T_0), from left to right, and the white dashed lines represent the boundary of an oscillating window. (c) The spectrum of the diffracted light, the red dashed line represents a fitted power-law spectrum $I_n \propto n^{-3.5}$. (d-f) show the second, third, and fourth harmonic fields, respectively. The field distributions in the 2D planes marked by dark green color in (d-f) are shown in (g-i), respectively.

References

[1] L. Q. Yi, High-Harmonic Generation and Spin-Orbit Interaction of Light in a Relativistic Oscillating Window, Phys. Rev. Lett. **126**, 134801 (2021)