Canadian Association of Physicists

Association canadienne des physiciens et physiciennes

Contribution ID: **2646** Type: **Invited Speaker / Conférencier(ère) invité(e)**

Vector beams, high harmonic generation and sub-focal spot coherent control

Tuesday, 4 June 2019 13:15 (30 minutes)

Abstract: We use intense vector beams to generate high harmonics or to create solenoidal currents in solids or gases. We predict THz magnetic fields reaching the scale of those only available at user facilities.

In the visible and infrared we can transform Gaussian beams into beams with spatially dependent polarization and/or phase structures. Orbital angular momentum is given to a beam when the phase varies by 2npi around its profile. One might ask if orbital angular momentum is conserved during high-harmonic generation? We show the conservation of orbital angular momentum [1] during high harmonic generation and show how the conservation of angular momentum leads to a method for coupling a controlled orbital angular momentum on any harmonic [2]. Our results open a pathway for attosecond science with similarly structured light.

Besides shaping the wave fronts, a Gaussian beam can also be transformed into beams with complex polarization states –so called vector beams.
We use an 800 nm, 2 mJ pulse, 35 fs pulse and a Q-plate (illustrated in the inset) to produce a vector beam with each quadrant circularly polarized, with adjacent quadrants delayed in phase by pi/2 and with different handedness for adjacent quadrants (encoded in red and blue in the figure). As such a vector beam propagates, it transforms into a beam with linearly polarized segments as illustrated (bottom left) and measured (bottom, middle). We transform this beam via high-harmonic generation to photon energy of 40 eV creating a new vector beam with linearly polarized segments and also with adjacent quadrants phase delayed by npi/2 where n is the harmonic order. For symmetric nonlinear media, this beam likewise transforms as it propagates into a beam with circularly polarized segments as illustrated in the 3-dimensional figure.

Cylindrical symmetric vector beams can be efficiently compressed to few cycles in hollow-core fibers and we conclude by discussing opportunities that arise from sub-focal spot coherent control with vector beams [3] allowing THz solenoidal magnetic field generation.

[1] G. Gariepy, et al, "Creating High-Harmonic Beams with Controlled Orbital Angular Momentum", Phys. Rev. Lett. 113, 153901 (2014)
[2] F. Kong, et al, "Controlling the orbital angular momentum of high harmonic vortices", Nat. Commun. 8, 14970 (2017)
[3] S. Sederberg, F. Kong, and P. B. Corkum, "Ultrashort Magnetic Impulses Driven by Coherent Control with Vector Beams", Arxiv 1901.07444v1 (2019)

Primary author: Prof. CORKUM, Paul (University of Ottawa)

Presenter: Prof. CORKUM, Paul (University of Ottawa)

Session Classification: T3-7 Frontiers in optics (DAMOPC) | Frontières en optique (DPAMPC)

Track Classification: Symposia Day - Optical Science