

# Signatures of Coriolis effects in molecular bichromatic circularly polarized high-order harmonic generation

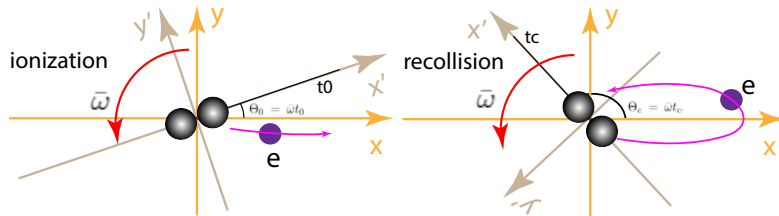
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High-order harmonic generation (HHG) opens up new frontiers in many areas of science [1]. Molecular systems due to additional degrees of nuclei have been shown to be good candidates for circularly polarized HHG [2]. We describe the circular HHG processes by circular polarization electron recollision model in a rotating frame [3,4]. In a bichromatic  $(\omega_1, \omega_2)$  circularly polarized laser pulse with its polarization in the  $(x, y)$  plane, the field-molecule Hamiltonian can be rewritten as  $H' = H'_0 + \bar{\omega}l_z + 2xE_0 \cos(\omega t)$  in a rotating frame at the rotating frequency  $\bar{\omega} = (\omega_2 - \omega_1)/2$  with the mean frequency  $\omega = (\omega_1 + \omega_2)/2$ , as illustrated in Figure 1. The coplanar bichromatic circular pulses in the rotating frame  $\bar{\omega}$  correspond to a linear driving field term  $2xE_0 \cos(\omega t)$ , in competition with a rotation angular momentum term  $\bar{\omega}l_z$  (around the  $z$  axis) responsible for Coriolis forces. The resulting cutoffs are given by  $N_m \hbar \omega_0 = I_p + 3.17U_p$ , where the ponderomotive energy defines  $U_p = (2eE_0)^2/4m_e\omega^2$ .

We discuss how the symmetry of the initial electronic state of molecules determines the harmonic properties in the presence of bichromatic counter-rotating circularly polarized laser pulses. Comparison of HHG for different molecular electronic states shows that harmonic orders and polarizations are dependent on the molecular orbital symmetry. We also present the effect of the initial electron wave packet localization on HHG processes. Results show that the property of harmonic polarization depends on the molecular bond distance, i.e., the electron wave packet distributions. By tri-circular pulses, circularly polarized HHG can be produced with extended cut-offs, which depend on the intensity ratio of fields and the field-molecule symmetry. The resulting modulation of HHG spectra arises from a combination of two bicircular fields with counter-rotating and co-rotating components. The dependence of HHG properties thus allows to reveal molecular dynamical symmetries. The results can be extended to more complex molecular systems, and in principle provide a way to control HHG and study molecular electron dynamical symmetry by bicircular fields



**Figure 1:** Circular polarization electron recollision of molecules ( $H_2^+$  as a model) in a rotating  $(x', y')$  frame with frequency  $\bar{\omega}$  by a bichromatic  $(\omega_1, \omega_2)$  circularly polarized laser pulse.

[1] Krausz F and Ivanov M 2009 *Rev. Mod. Phys.* **81** 163

[2] Yuan K J and Bandrauk A D 2013 *Phys. Rev. Lett.* **110** 023003

[3] Zuo T and Bandrauk A D 1995 *J. Nonlin. Opt. Phys. Mater.* **04** 533

[4] Yuan K J and Bandrauk A D 2018 *Phys. Rev. A* **97** 023408