Elliptically polarized high-order harmonics generated in aligned CO_2 molecules

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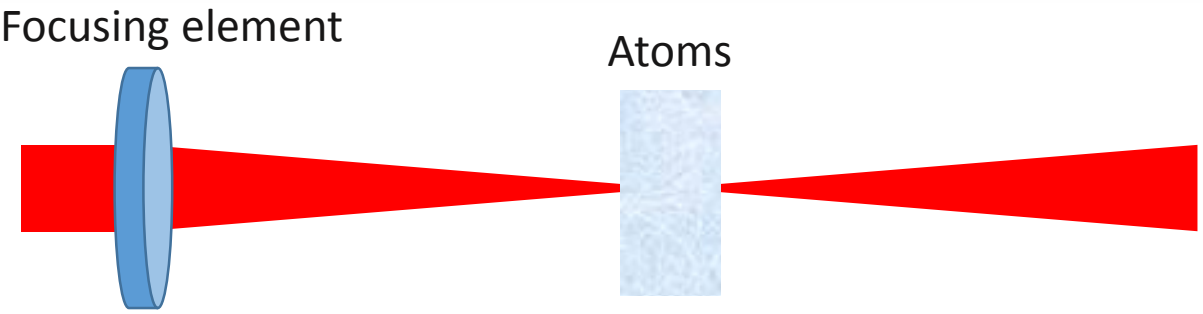
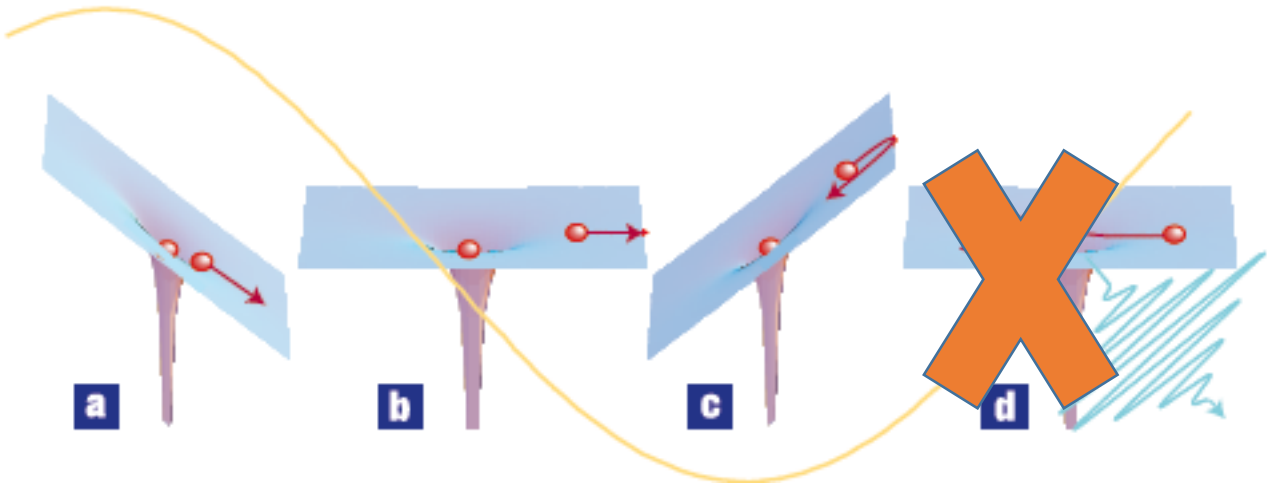
Circular driving laser pulse



Circular polarized laser pulse

No HHG in isotropic media



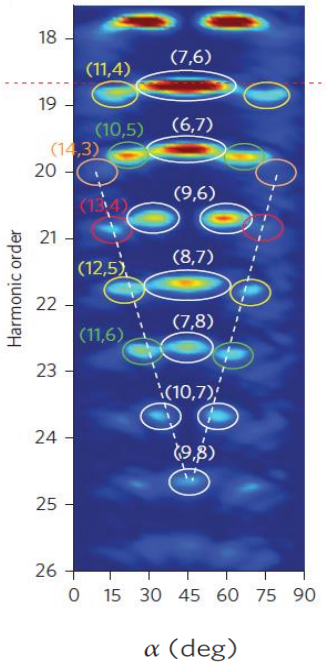
No recollision process

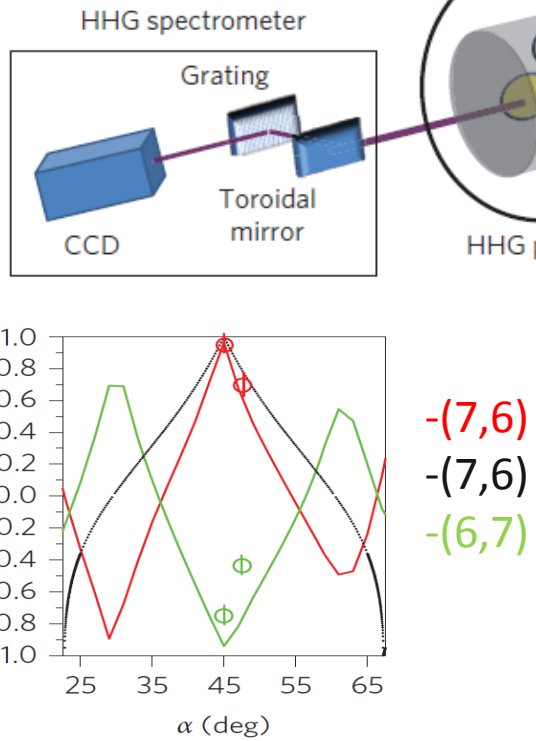
Alternate approaches: Change driving field

Counter rotating laser fields

$\omega + 2\omega$

800 nm and 400 nm

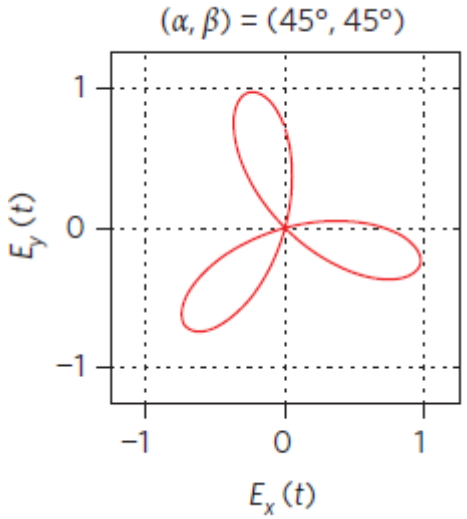




-(7,6)

-(7,6)

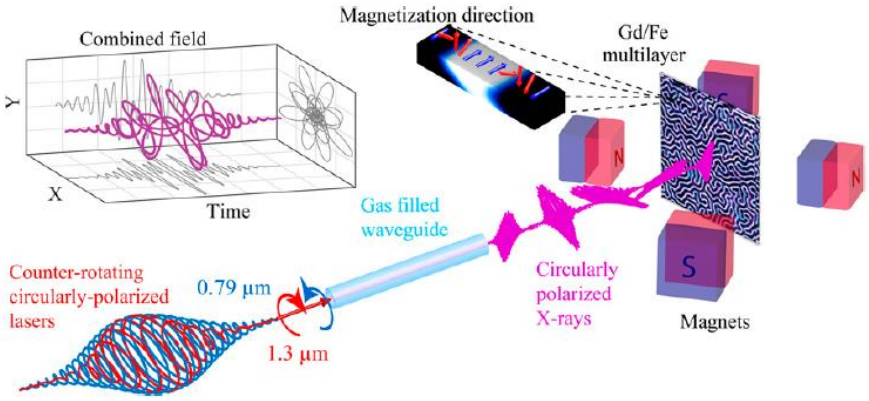
-(6,7)

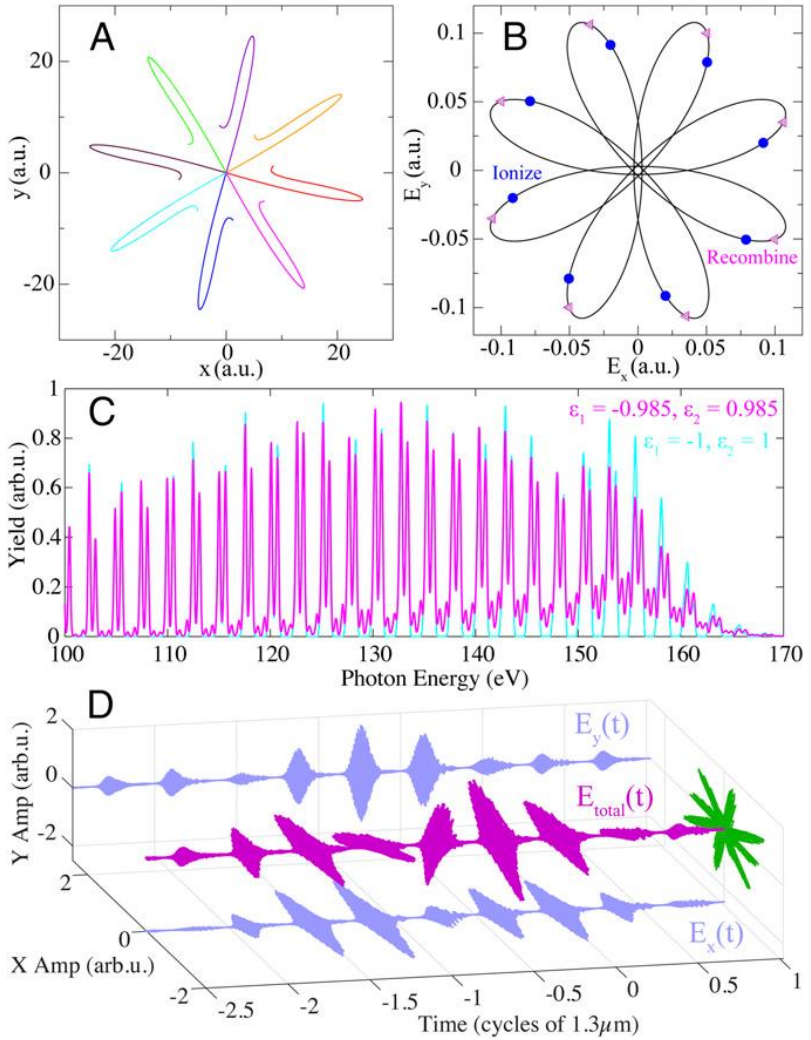


Fleischer2014

Alternate approaches
Change driving field

Counter propagating pulses

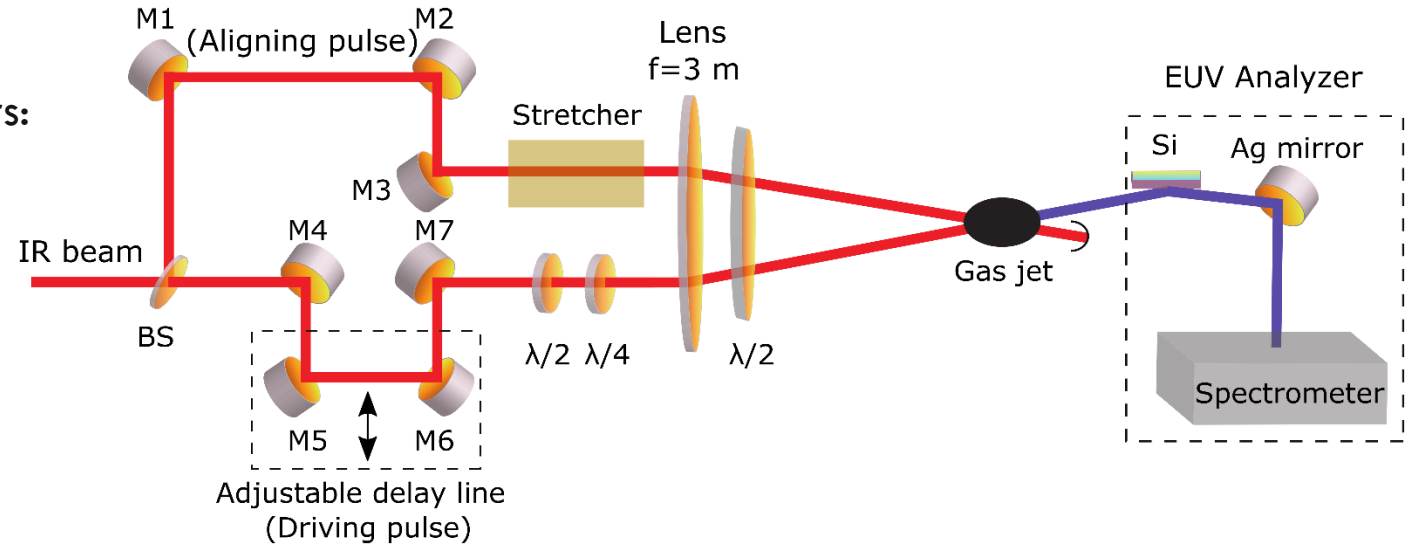




Fan2015

Alternate approaches
Change medium

Laser parameters:
λ_0: 800 nm
E_{pulse}: 25 mJ
τ_{pulse}: 30 fs
f_{rep}: 10 Hz

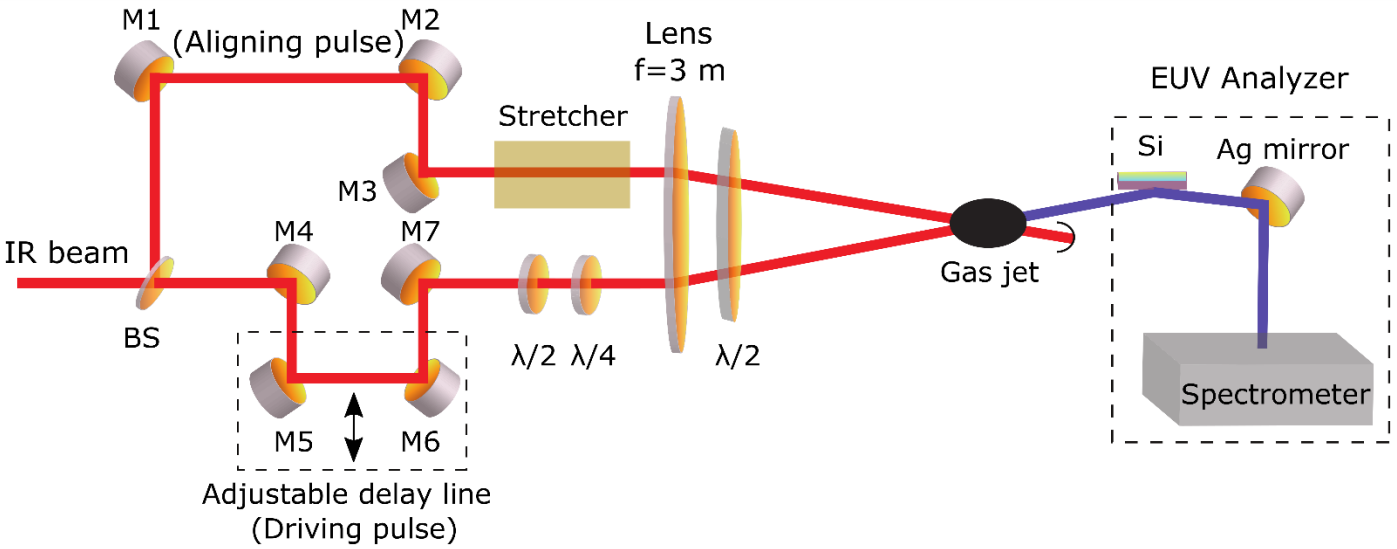


- HHG in CO_2 → EUV beam
- Adjustable delay τ → Controls angular distribution of CO_2 medium
- Polarization state of driving beam → Controls polarization state of XUV beam.

Skantzakis2016

Laser induced alignment in CO_2

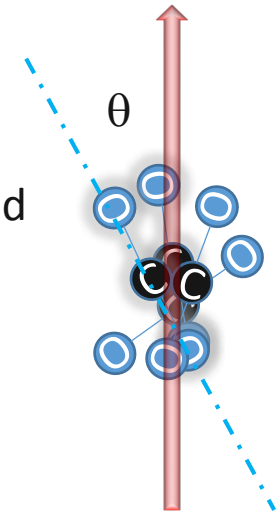
Laser parameters:
λ_0: 800 nm
E_{pulse}: 25 mJ
τ_{pulse}: 30 fs
f_{rep}: 10 Hz

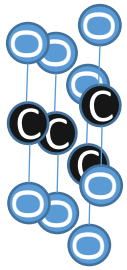


Threshold intensity for ionization

$$I_{thr}[W/cm^2] = 4.0 \times 10^9 (I_p[eV])^4$$

Alignment of CO_2
Parallel to the laser field

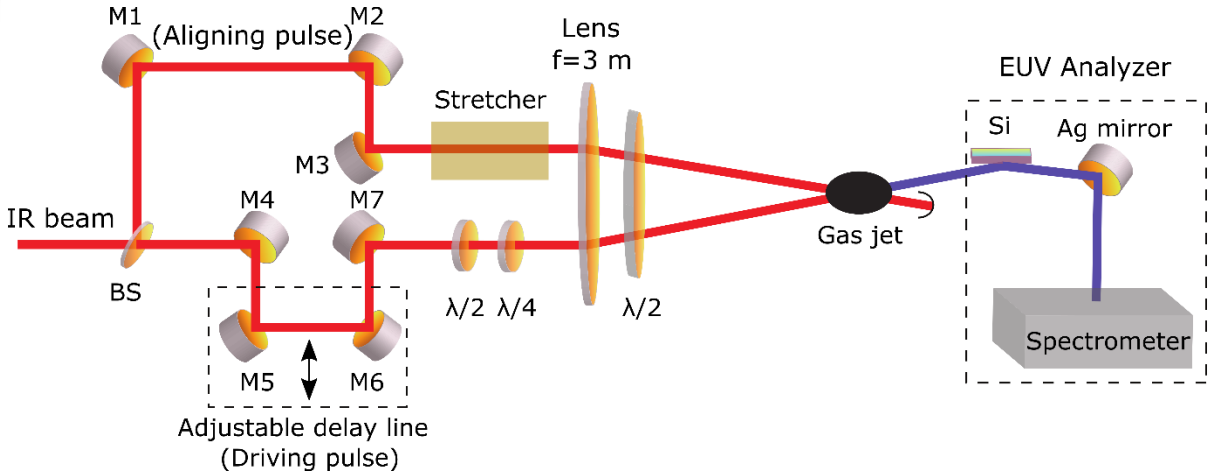




After alignment

Alignment pulse ≈7x10^{13} W/cm^2

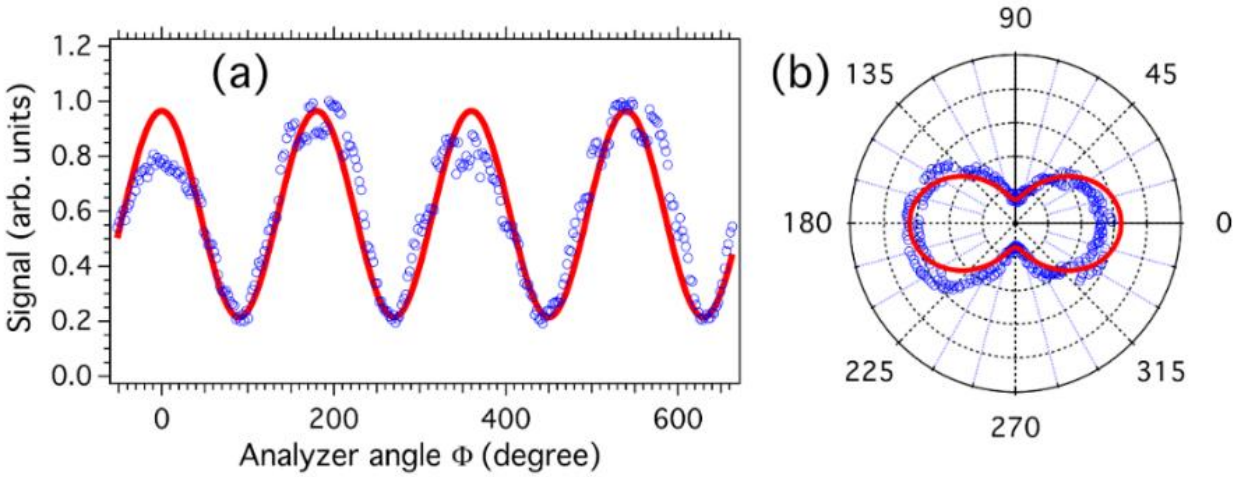
EUV analyzer characterization



Linearly polarized driving pulse in the absence of alignment pulse

HH 9 in CO_2 as a function of half waveplate angle

Extinction ratio ≈ 4.5



Revival in CO_2

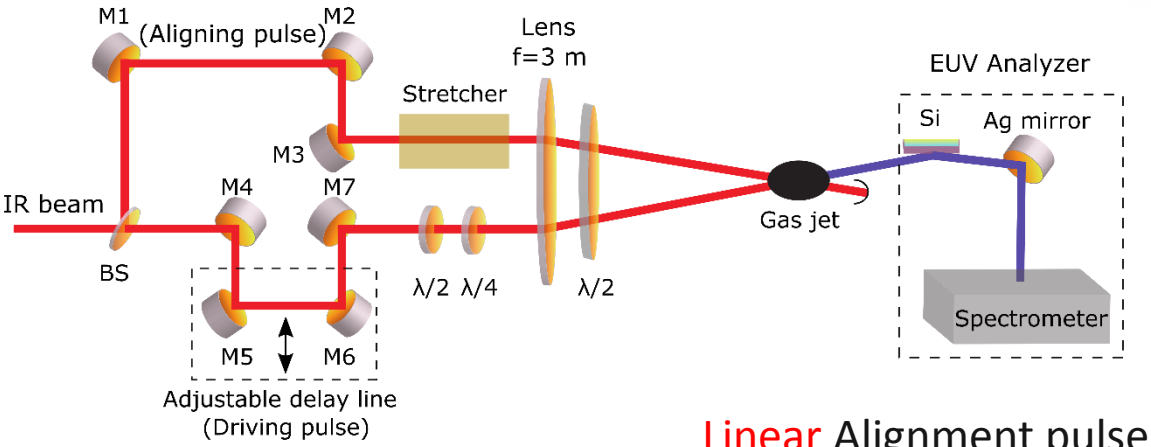
Laser parameters:

λ_0: 800 nm

E_{pulse}: 25 mJ

τ_{pulse}: 30 fs

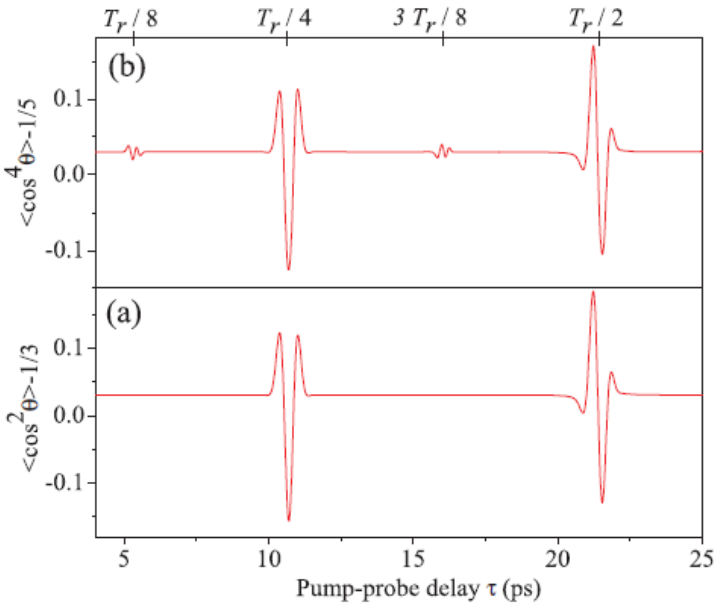
f_{rep}: 10 Hz

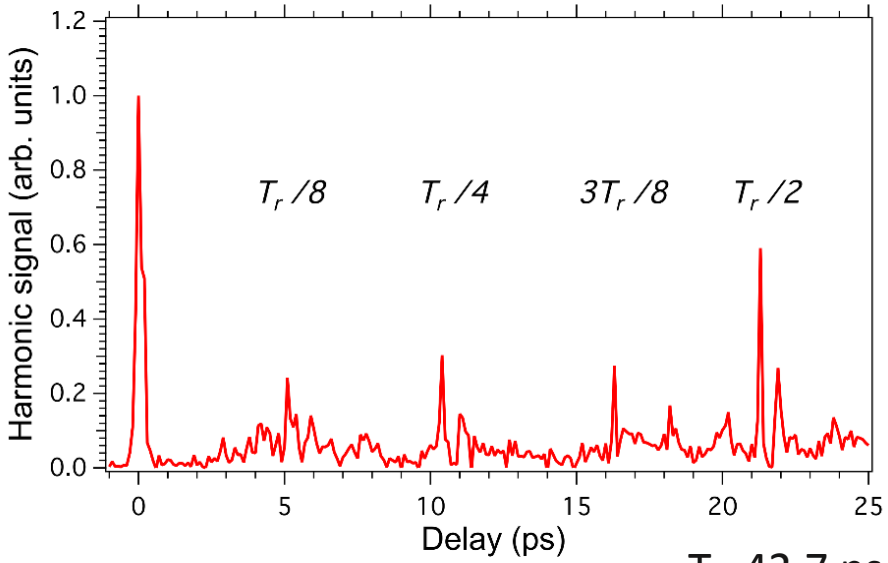


Linear Alignment pulse ≈7×10^{13} W/cm^2

Linear Driving pulse ≈10^{14} W/cm^2

Expectation values



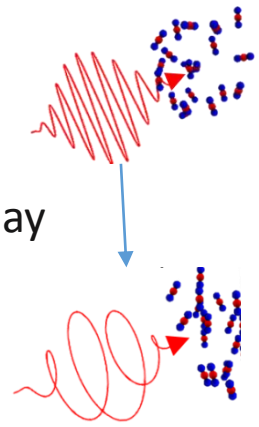


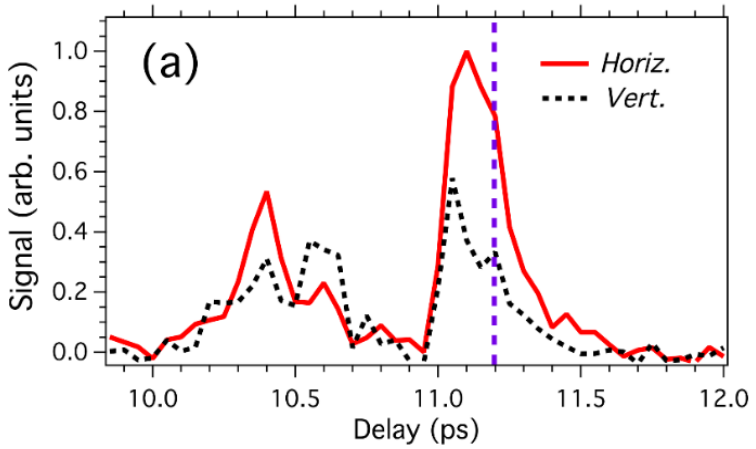
T_r=42.7 ps

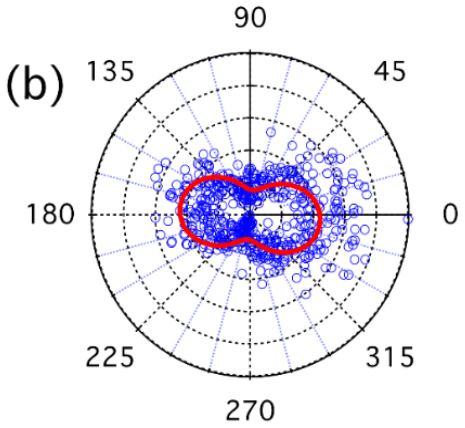
Houzet2013, Skantzakis2016

Harmonic generation with circular driving field

- Circularly polarized driving pulse
- HH 9 in CO_2

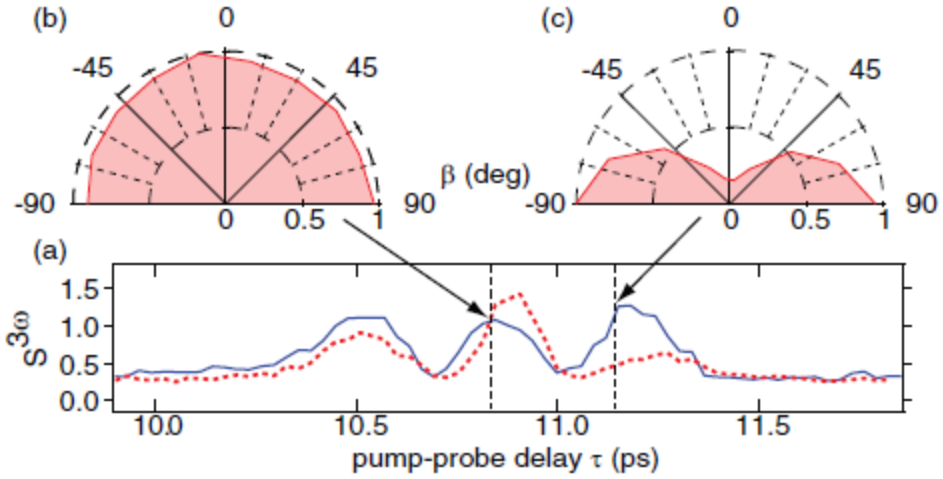






Ellipticity of harmonics varies with delay

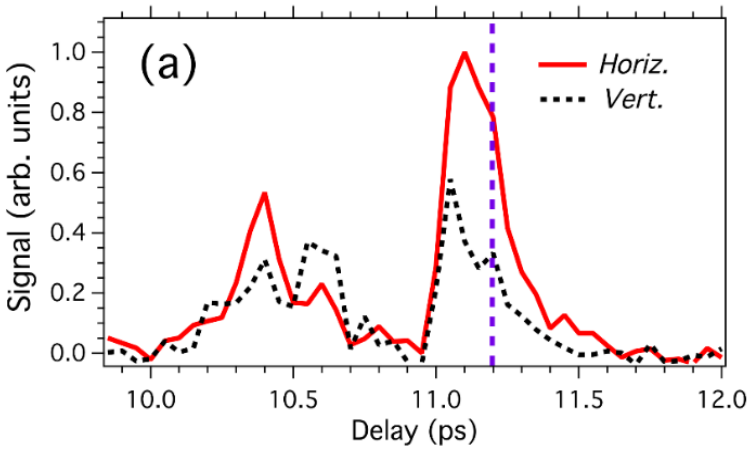
- Circularly polarized driving pulse
- HH 3 in CO_2

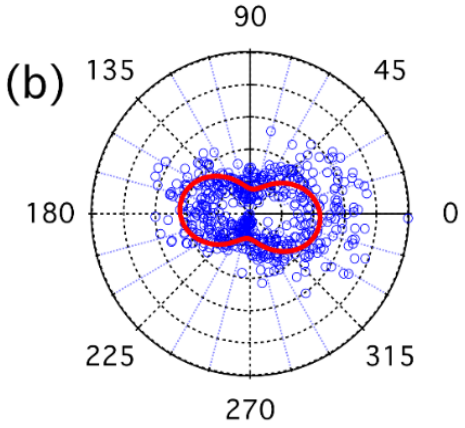


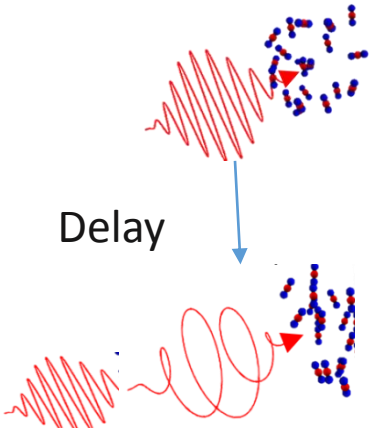
Houzet2013, Skantzakis2016

Towards circular polarized harmonics

Different conversion efficiency for orthogonal components.



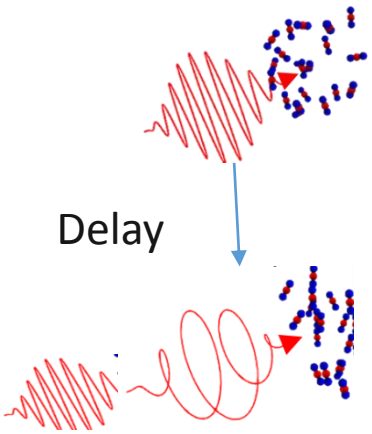


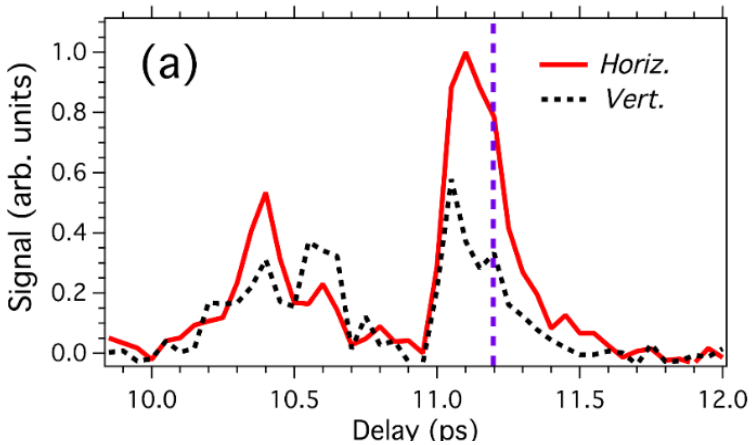


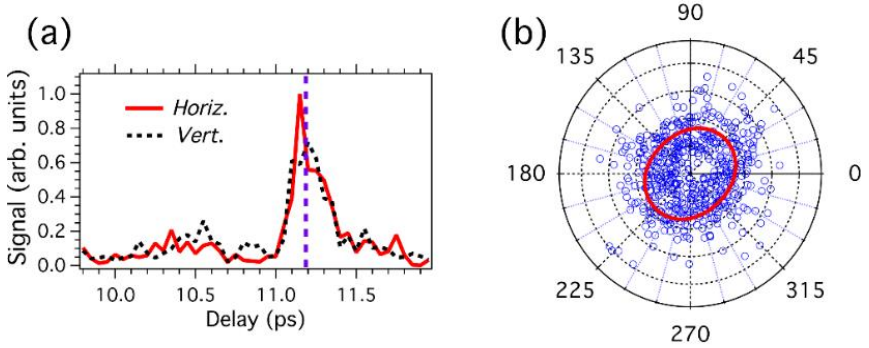
Add a small linear component

Towards circular polarized harmonics

Different conversion efficiency for orthogonal components.





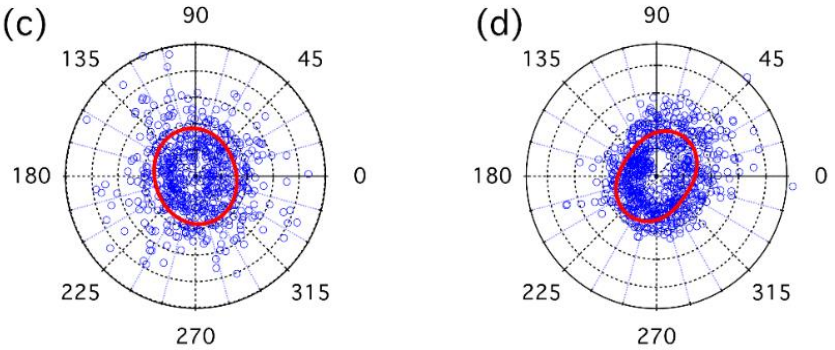


HH 9
τ=11.2 ps
ε=0.85

Add a small linear component

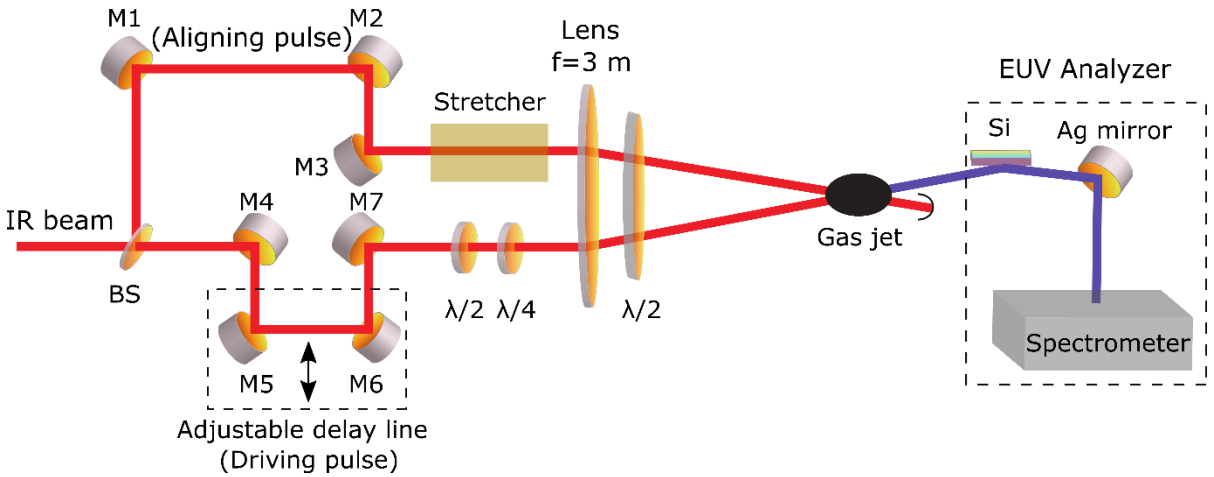
Calibrated PD used
- 4 pJ
- 2x10^6 photons/pulse)

HH 9
τ=11.12 ps
ε=0.8

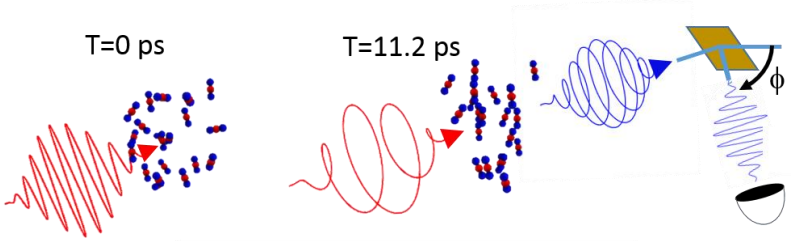


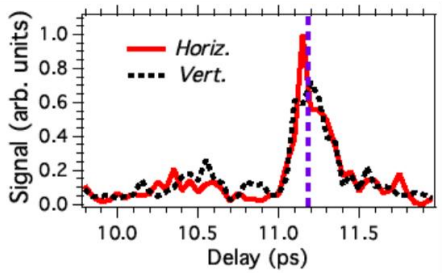
HH 7
τ=10.45 ps
ε=0.74

Conclusion



- First report of HHG using circularly polarized IR pulse.
- Generation of circularly polarized harmonics in aligned CO_2 molecule.
- Towards circularly polarized harmonics.





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E. Skantzakis[1], S. Chatziathanasiou[1,2], P. A. Carpeggiani[5], G. Sansone[3,4,5], A. Nayak[3], D. Gray[1], P. Tzallas[1,3], D. Charalambidis[1,2,3], E. Hertz[6] & O. Faucher[3,6]

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