



# Simulation of High Harmonic Generation in Helium due to Bichromatic Counterrotating Circularly Polarized Laser Fields



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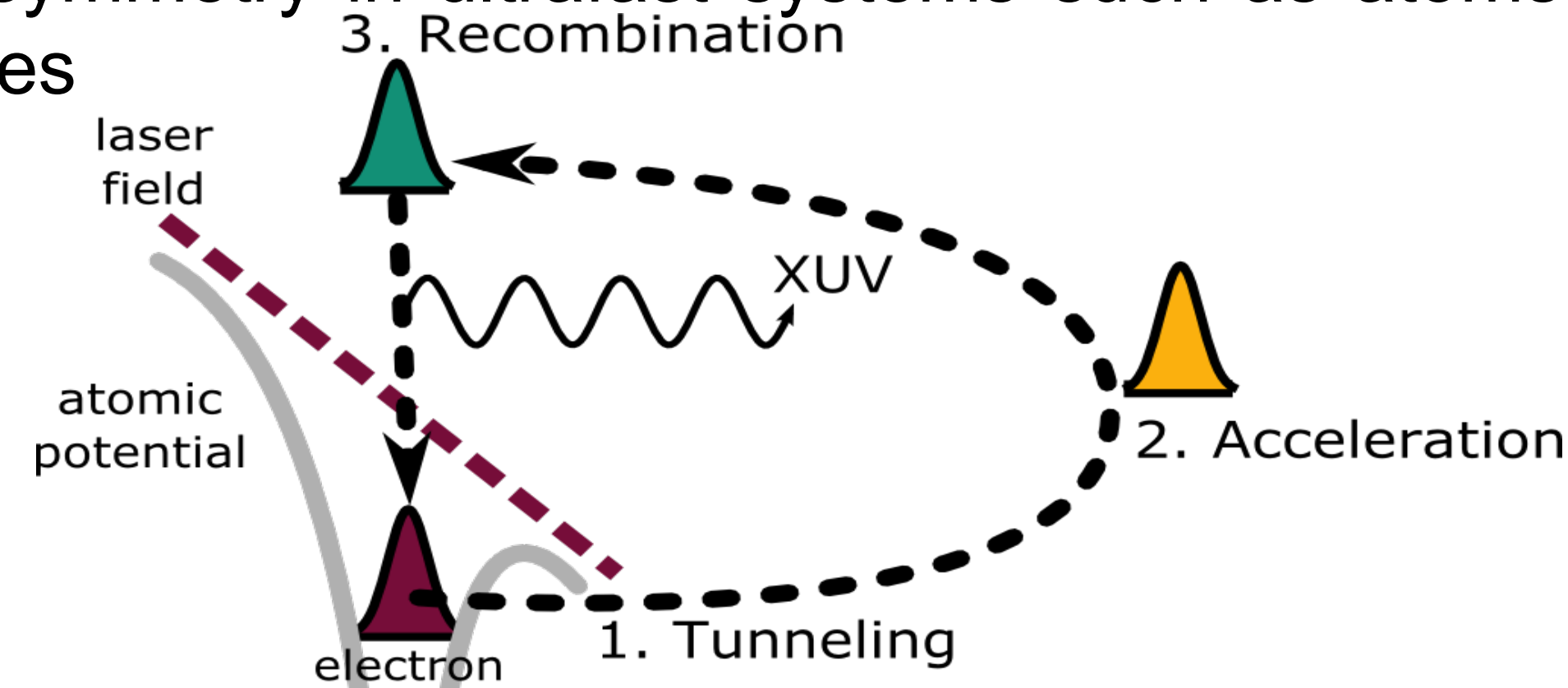
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## Introduction

- High Harmonic Generation (HHG) has been used for decades as a source of high energy photons
- HHG due to bichromatic circular polarization enables analysis of symmetry in ultrafast systems such as atoms and molecules



- Third harmonic selection rule is expected
- Consecutive attosecond bursts of linear polarization is predicted [1]

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## Methods

### Stochastic Variational Method (SVM)

- Ground state is approximated with 300 explicitly correlated Gaussian basis functions
- Crank-Nicholson time propagator is then applied

### Time-Dependent Density Functional Theory

- Uses a real-space grid representation
- Taylor time propagator is employed

### Bichromatic Counterrotating Laser Field

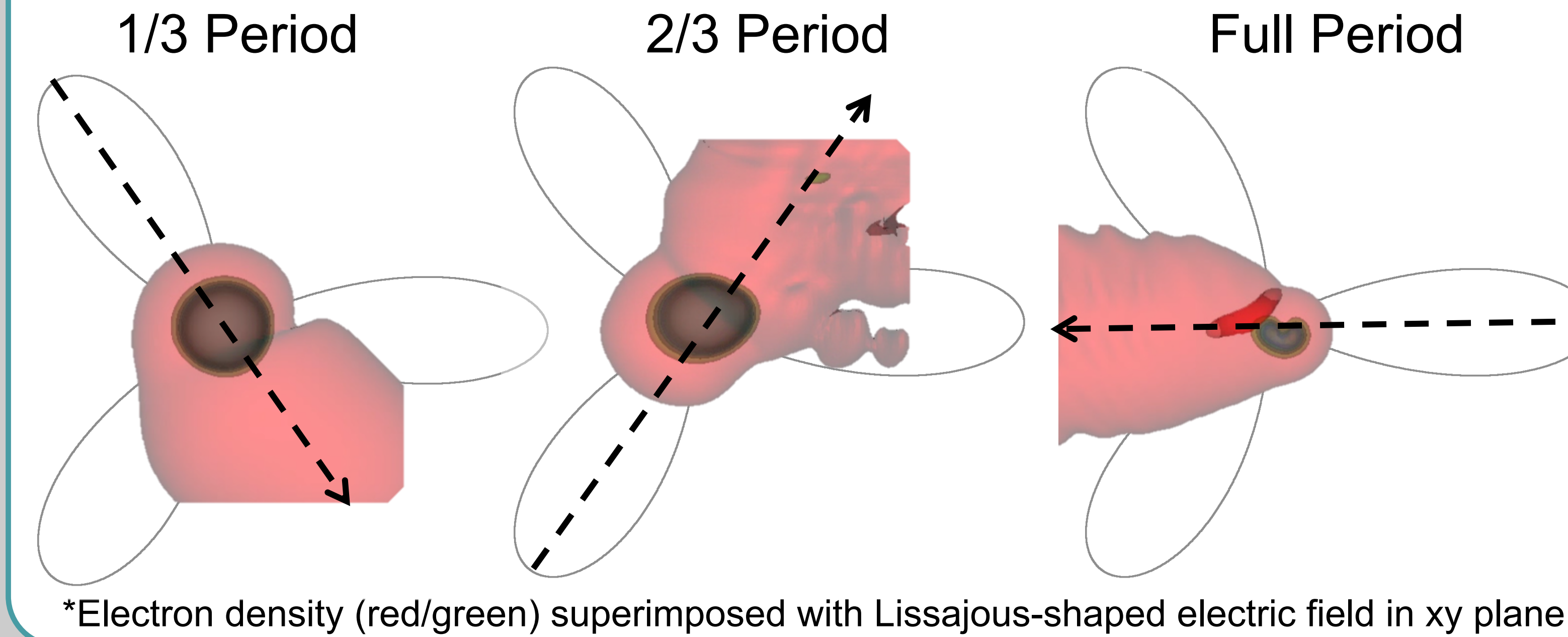
$$E(t) = E_{ir} f(t) [\cos(\omega t) + \cos(2\omega t)] \hat{x} + E_{ir} f(t) [\sin(\omega t) - \sin(2\omega t)] \hat{y}$$

### Parameters

Parameters are in atomic units unless otherwise indicated

Parameter	Symbol	Value	Notes
Laser frequency	$\omega$	0.0569	(wavelength = 800 nm)
Laser electric field	$E_{ir}$	0.0215	( $I = 1.658 \times 10^{13} \text{ W/cm}^2$ )
Laser envelope $f(t)$	$\sin^2$		(24 fs fwhm)
Propagation time	$T$	1033	(48 fs)
Absorbing boundary	$x_0$	$\pm 36$	
Keldysh parameter	$\gamma$	3.56	(dimensionless)

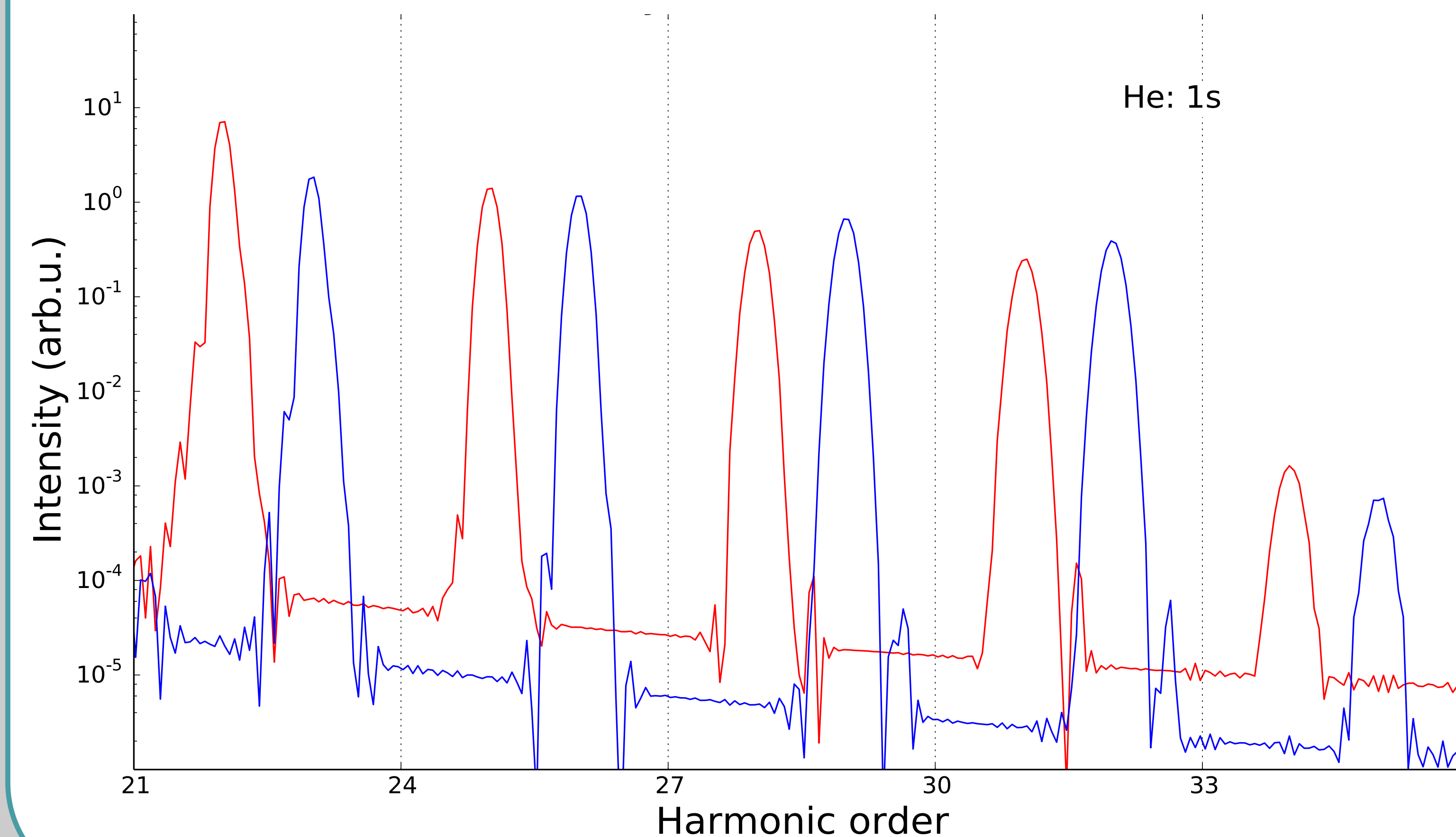
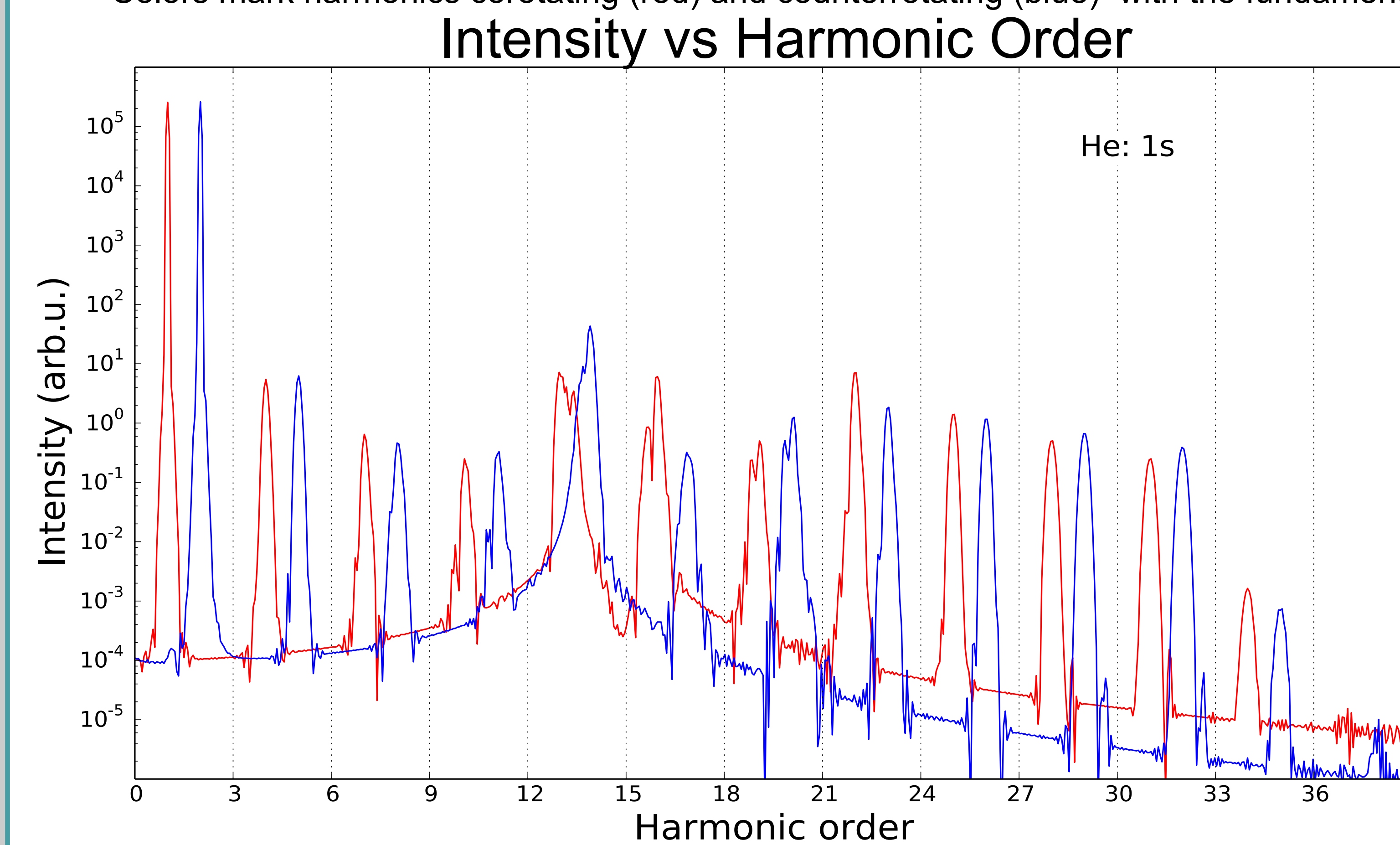
## Time Evolution of Electron Density



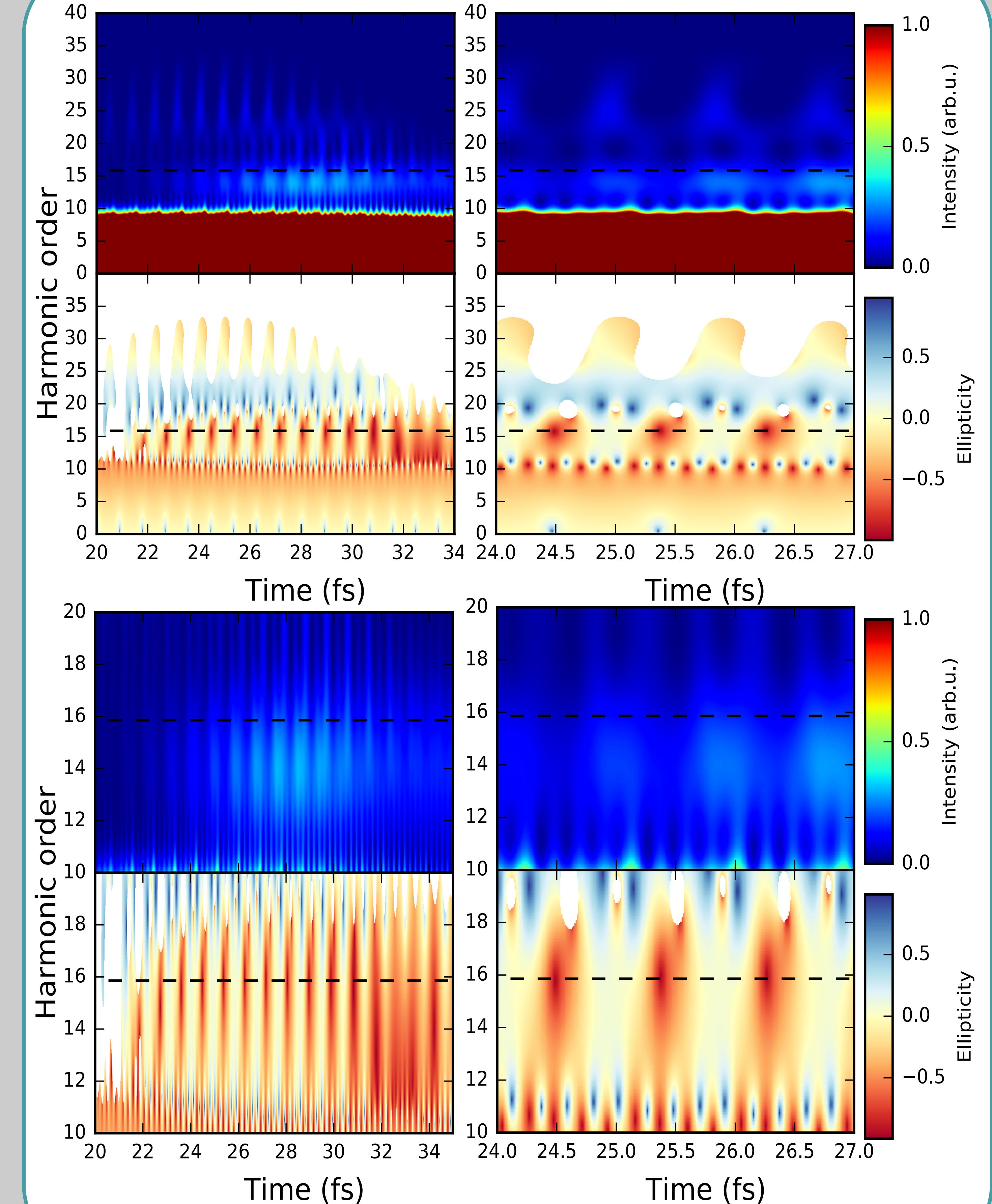
\*Electron density (red/green) superimposed with Lissajous-shaped electric field in xy plane

## Results: Harmonics

\*Colors mark harmonics corotating (red) and counterrotating (blue) with the fundamental



## Results: Spectrogram



\*Dashed line indicates Ionization Potential (15.86)

## Conclusions

- SVM accurately describes high harmonic generation
- Time Dependent Density Functional Theory failed to characterize higher harmonics
- Third harmonic selection rule confirmed
- Three linearly polarized attosecond bursts generated per cycle
- Further investigation of pulse shape, frequency, and intensity is warranted

## References & Acknowledgements

- Code source for analysis: Medisauskas *et al.*, Phys. Rev. Lett. **115**, 153001 (2015).
- Milosevic *et al.*, Phys. Rev. Lett. **A 62**, 011403(R) (2000).
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