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

Clayton Blythe\textsuperscript{1,2}, Jorge Salas\textsuperscript{1,2}, Cody Covington\textsuperscript{1,2}, and Kalman Varga\textsuperscript{1,2}

\textsuperscript{1}Vanderbilt University Department of Physics and Astronomy, Nashville, TN
\textsuperscript{2}Vanderbilt Institute of Nanoscale Science and Engineering, Nashville, TN

\textbf{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 \cite{1}

\textbf{Methods}

\textbf{Stochastic Variational Method (SVM)}
- Ground state is approximated with 300 explicitly correlated Gaussian basis functions
- Crank-Nicholson time propagator is then applied

\textbf{Time-Dependent Density Functional Theory}
- Uses a real-space grid representation
- Taylor time propagator is employed

\textbf{Bichromatic Counterrotating Laser Field}

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

\textbf{Parameters}

Parameters are in atomic units unless otherwise indicated.

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

\textbf{Results: Harmonics}

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

\textbf{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

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