Ultrashort pulse excitation of two interacting electrons in a harmonic well

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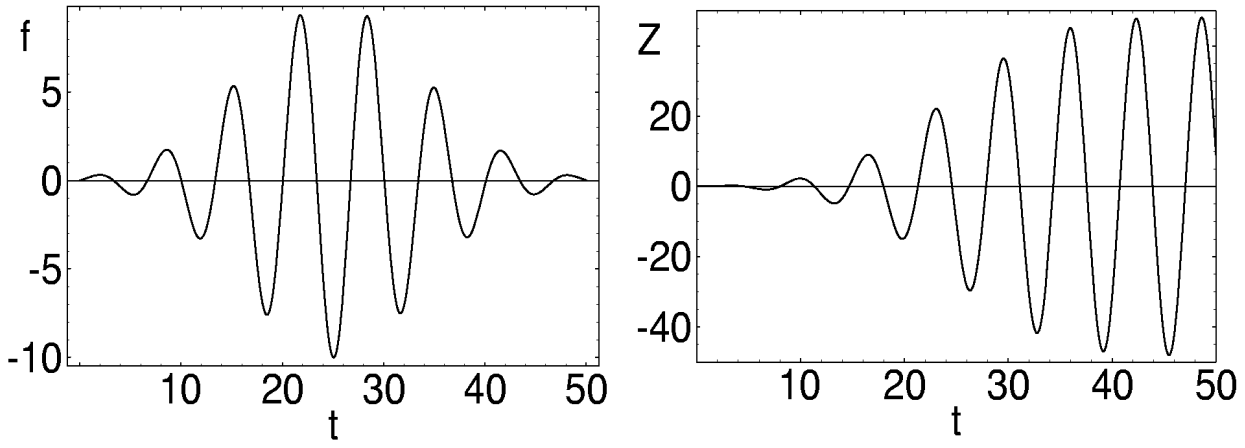
We investigate a system of two Coulomb interacting electrons trapped by a three–dimensional harmonic potential subject to an intense ultrashort laser pulse. This system can serve as a model for the pulse–driven dynamics of correlated electrons in atoms and quantum dots ('designer atoms'). Its significance is derived from the fact that this model is exactly solvable. Due to the separability of the time–independent problem in center of mass coordinates, its eigenfunctions and eigenvalues are obtained exactly [1]. Moreover, the Feynman propagator for the time–dependent system is analytically known, allowing for an accurate time evolution of the system [2]. Thus, the problem can be solved virtually exactly, making detailed investigations of correlation effects in strong–field laser excitation feasible. As an example, the figure shows the excitation of the electronic center of mass motion (right) by a typical ultrashort pulse (left, all quantities in atomic units).



Furthermore, knowing the exact solution of the system allows for tests of different approximate methods one often has to rely on. One such important method is the time dependent density functional theory (TDDFT) which is believed to incorporate the essential electron–electron correlation effects through the exchange–correlation potential. Since TDDFT is currently the method of choice for multielectron problems, such a test can lead to important insights into the accuracy of this method. Therefore, we will present a detailed comparison of the exact

solution with the TDDFT results. Finally, we will discuss applications to quantum dots where the harmonic potential represents an approximate confinement potential.

[1] M. Taut, *Phys. Rev. A* **48** 3561 (1993).
[2] A. K. Dhara and S. V. Lawande, *Phys. Rev. A* **30** 560 (1984).