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THEORY ON DYNAMICS OF ATOMS IN STRONG LASER FIELD

XIAO-MIN TONG

Center for Computational Sciences, University of Tsukuba,
Tsukuba, Ibaraki 305-8577, Japan
E-mail tong.xiaomin.ga@u.tsukuba.ac.jp

Abstract. Solving the time-dependent Schrödinger equation (TDSE) is a key procedure to understand most dynamics for atoms in strong field. In this talk, I will present a numerical method to solve TDSE using a second-order split operator combined with generalized pseudospectral method. Instead to solve the TDSE in differential form, I proposed a method to solve it in integral form (Tong et al, 2006). Mathematically the two equations are equivalent to each other while the proposed one can provide more physical insights. Based on this method, I will present three applications, which covers the main dynamics of atoms in strong laser fields.

The first one is the above threshold ionization. In this example, by restricting the ionization to a half cycle of the laser field and then propagating the liberated electron wave packet during the laser pulse, we show conclusively that low-energy-momenta structure in the photoelectron angular distribution originates from multiple scatterings of the tunnel-ionized electron with the ion (Tong et al. 2013).

The second is the high order hormonic generation (HHG). In this example, I will show how we simulated the atomic HHG efficiently and accurately since we need to integrate all the atomic HHGs at different positions in the gas target to get macroscopic HHG. In this step, we must solve TDSE hundreds or thousands of times for different laser intensities. The macroscopic HHG is obtained by summing over all the microscopic HHG with phase matching and self-absorption in two scales. One is in the laser wavelength scale, within which the laser peak intensity does not change while the propagation phase changes. Another is in the laser beam waist scale, within which the laser intensity and Gouy phase shift change. The details can be found in (Tong 2023).

The third one is an ongoing project on how to effective produce more exited Ar atoms in a two-color laser field. Since the laser parameter space is very large so we use genetic algorithm to search the optimize laser parameters. All these reply on a fast and accurate TDSE solver as we proposed. The details will be present in the conference.

References

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