Manipulating dynamical interference in photoionization processes by inhomogeneous strong-field

Hicham Agueny [1] **and Jan Petter Hansen**

Department of Physics and Technology, Allegt. 55, University of Bergen, N-5007 Bergen, Norway

Synopsis We investigate dynamic interference in photoionization processes by intense spatially inhomogeneous fields. Simulations from numerical solutions of the three-dimensional (3D) time-dependent Schrödinger equation show that the phenomenon manifests by a multiple peak structure in the momentum distribution of the ejected electron. Its sensitivity to the inhomogeneity strength of the laser field offers the possibility to manipulate the mechanism.

Ultrafast laser pulses can easily exceed atomic field strengths of 10^9 V/cm, opening new doors in the investigation and control of ultrafast processes. Laser-induced Stark shift is one such process. The latter leads to an energy shift of atomic energy levels in an oscillating electric field, which affects electronic transitions. We refer to the energy level shifts as dynamical Stark effect [1]. Because of the non-perturbative nature of the mechanism, it becomes an increasingly important tool for controlling and measuring quantum systems [2].

In this context, subcycle dynamical Stark effect induced by a few-cycle near infrared laser field was investigated and measured using attosecond transient absorption spectroscopy [3]. Furthermore, a strong dynamic interference induced by intense high-frequency laser pulses and caused by the dynamical Stark effect in the continuum has been observed by Demekhin and Cederbaum [4].

Because of the importance of the effect to induce quantum features as we gain more understanding of ultrafast processes, we will address its impact on the photoionization process by intense spatially inhomogeneous fields. Simulations from numerical solutions of the 3D-time-dependent Schrödinger equation exhibit interference patterns in the momentum distribution of the ejected electron (see Fig. 1).

During the conference, we will present results for the above-mentioned process for both linear and circular polarizations, and show how the inhomogeneity strength influences the dynamical interference. The study will be addressed for the hydrogen atom and will be extended to both diatomic and triatomic systems. Dependence of the dynamical interference on the pulse ellipticity will also be addressed. The phenomenon will be discussed by examining the momentum-space geometry which is a basic principle for the attosecond streak camera [5].

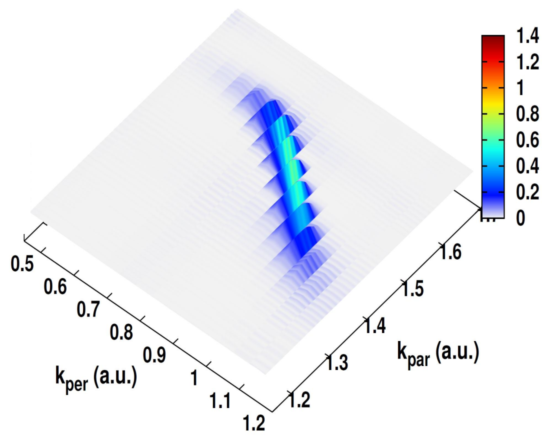

Figure 1. Map of the ejected electron momentum distribution on the k_{par}-k_{per} plane (parallel and perpendicular momentum components). The process is studied for hydrogen atom exposed to Gaussian-shaped pulses of 18 fs duration, carrier frequency of 53.60 eV and peak intensity of 7 10^{16} W/cm^2 (homogeneous field and linear polarization case).

References

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[1] E-mail: hicham.agueny@uib.no