Phase Retrieval from Angular Streaking of XUV Atomic Ionization

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Angular streaking of XUV atomic ionization with a circularly polarized IR laser radiation has become a powerful tool for a shot-to-shot characterization of isolated attosecond pulses from free-electron laser sources [1,2]. This technique is analogous to the attosecond streak camera [3] in that XUV pulses are the primary source of ionization while it is common to the attoclock [4] in that the ionized electrons interact with a circularly polarized laser field which alters the photoelectron momentum distribution. Both the streak camera and the attoclock are senitive to the ionization phase that can be converted to the atomic time delay and the tunneling time, respectively. Here [5] we demonstrate, for the first time, an accurate phase retrieval of XUV atomic ionization by angular streaking.

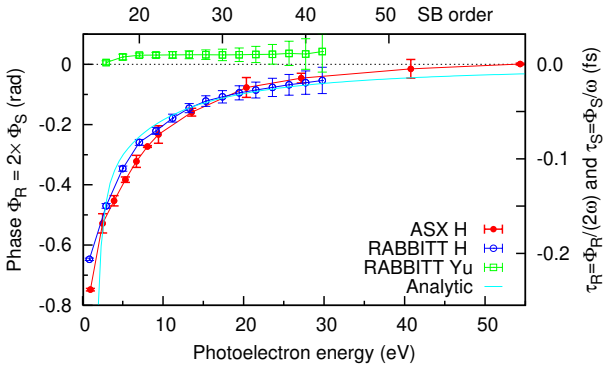

Figure 1: RABBITT phase Φ_R is compared with the twice the streaking phase $2\Phi_s$ obtained from the isochrone ansatz of [6]. Right axis shows Right axis: the RABBITT time delay $\tau_a = \Phi_R/(2\omega)$ is compared with the analytic model [7]

In our numerical simulations, we solve the time-dependent Schrödinger equation for an atom ionized by a short XUV pulse in the presence of circularly polarized laser radiation. Our qualitative analysis is based on the strong field approximation [6] and the lowest order perturbation theory [8]. The two alternative techniques suggest the phase retrieval methods that can be applied both to the simulated and experimental data. In simulations, the XUV/IR delay is systematically varied. In an experiment, a second ionization feature in the same target or a mixed target could be used as a reference.

We test the proposed technique by comparing the XUV ionization phase of the hydrogen atom delivered by angular streaking with the analogous set of data returned by a well established RABBITT (reconstruction of attosecond beating by interference of two-photon transitions) technique [9]. The two sets of data agree very well in a wide range of XUV photon energies as is shown in the Figure.

An analogous investigation conducted on the H_2 molecule [10] demonstrates sensitivity of the proposed technique to the molecular axis orientation and two-center interference effects.

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