Interferometric Probing of Photoionization Dynamics and Resonant Control of Photoemission Delays

D Bharti[1], J.C. del Valle[2,3], A Bondy[2,4], R Moshammer[1], T Pfeifer[1], K Bartschat[4], A Harth[1,5]

[1]Max-Planck-Institute for Nuclear Physics, D-69117 Heidelberg, Germany

[2]Department of Physics and Astronomy, Drake University, Des Moines, IA 50311, USA.

[3]Instituto de F´ısica, Universidad Nacional Autonoma de Mexico, Ciudad de Mexico, 04510, Mexico

[4]Department of Physics, University of Windsor, Windsor, ON N9B 3P4, Canada

[5]Department of Optics and Mechatronics, Hochschule Aalen, D-73430 Aalen, Germany

Corresponding author: bharti@mpi-hd.mpg.de

Recent advances in attosecond science have enabled probing the timing of electron emission during photoionization with unprecedented precision. Here, phase-resolved measurements of photoemission dynamics are performed using two-color interferometric techniques, where the electron phase is studied as a function of emission angle, photon energy, and laser intensity.

By extending the RABBITT method to a multi-sideband detection scheme, we access detailed information about continuum–continuum transition dynamics and the interference between different ionization pathways. Special emphasis is placed on the role of resonant multi-photon pathways, where Stark shifts induced by the IR field detune coupled resonances and modify the emission phase. A three-sideband analysis enables the separation of direct and resonance-assisted contributions to the photoemission delay.

Experimental measurements in helium and argon reveal strong intensity-dependent variations in the photoemission phase, attributed to the competition between direct ionization and resonant channels. These results are supported by ℓ-dependent single-active-electron (SAE) calculations and few-level model simulations, which capture the essential features of the observed phase evolution.

This study shows how interferometric techniques can be used not only to measure but also to control photoemission delays by tuning external laser parameters, providing new insights into attosecond-resolved electron dynamics in atomic systems.

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