The Role of Reflections in the Generation of a Time Delay in Strong Field Ionization

M Klaiber[1], D B Canario[1], K Z Hatsagortsyan[1], and C H Keitel[1]

[1] *Theoretical Quantum Dynamics and Quantum Electrodynamics, Max-Planck Institute for Nuclear Physics, 69117 Heidelberg, Germany*

Contact Email: klaiber@mpi-k.de

The problem of time delay in tunnelling ionization is revisited. The origin of time delay at the tunnel exit is analysed, underlining the two faces of the concept of the tunnelling time delay: the time delay around the tunnel exit and the asymptotic time delay at a detector. We show that the former time delay, in the sense of a delay in the peak of the wavefunction, exists as a matter of principle and arises due to the sub-barrier interference of the reflected and transmitted components of the tunnelling electronic wavepacket. We exemplify this by describing the tunnelling ionization of an electron bound by a short-range potential within the strong-field approximation in a "deep tunnelling" regime. If sub-barrier reflections are extracted from this wavefunction, then the time delay of the peak is shown to vanish. Thus, we assert that the disturbance of the tunnelling wavepacket by the reflection from the surface of the barrier causes a time delay in the neighbourhood of the tunnel exit.