Reconciling Conflicting Approaches for the Tunneling Time Delay in Strong Field Ionization

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Several recent attoclock experiments have investigated the fundamental question of a quantum mechanically induced time delay in tunneling ionization via extremely precise photoelectron momentum spectroscopy. The interpretations of those attoclock experimental results were controversially discussed because the entanglement of the laser and Coulomb field did not allow for theoretical treatments without undisputed approximations. The method of semiclassical propagation matched with the tunneled wavefunction, the quasistatic Wigner theory, the analytical R-matrix theory, the backpropagation method, and the under-the-barrier recollision theory are the leading conceptual approaches put forward to treat this problem, however, with seemingly conflicting conclusions on the existence of a tunneling time delay. To resolve the contradicting conclusions of the different approaches, we consider a very simple tunneling scenario that is not plagued with complications stemming from the Coulomb potential of the atomic core, avoids consequent controversial approximations and, therefore, allows us to unequivocally identify the origin of the tunneling time delay as well as to confirm it with the backpropagation method being most known for predicting vanishing tunneling time.