Ionization of the hydrogen atom by short half-cycle pulses: Dependence on the pulse duration

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A theoretical study of the ionization of hydrogen atoms by short external half-cycle pulses (HCPs) as a function of pulse duration, using different quantum and classical approaches is presented. Total ionization probability and energy distributions of ejected electrons are calculated in the framework of the single distorted Coulomb-Volkov (CVA) and the doubly-distorted impulsive Coulomb-Volkov (ICV) approximations. We also performed quasiclassical calculations based on a classical trajectory Monte Carlo method in which the possibility of tunneling is included (CTMC-T). Quantum and classical results are compared to the exact solution of the time dependent Schrödinger equation (TDSE). We show that for high momentum transfers the ICV shows an improvement compared to the CVA, especially in the low-energy electron emission spectra, where CVA fails. In addition, ICV reproduces successfully the TDSE electron energy distributions at weak momentum transfers. CTMC-T results reveal the importance of tunneling in the ionization process for relative long pulses and strong momentum transfers but fail to overcome the well-known classical suppression observed for weak electric fields.