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Nonadiabatic effect in laser-induced quantum tunneling MIN LI, Huazhong University of Science and Technology, KUNLONG LIU, Max-Planck-Institute for Microstructure Physics, SIQIANG LUO, YANG LI, YUDI FENG, BAOJIE DU, YUEMING ZHOU, PEIXIANG LU, Huazhong University of Science and Technology, INGO BARTH, Max-Planck-Institute for Microstructure Physics
— The nonadiabaticity of quantum tunneling through an evolving barrier is relevant to resolving laser-driven dynamics of atoms and molecules at an attosecond timscale. We propose and demonstrate a novel scheme to detect the nonadiabatic behavior of tunnel ionization studied in an attoclock configuration, without counting on the laser intensity calibration or the modeling of the Coulomb effect. In this scheme, the degree of nonadiabaticity for tunneling scenarios in elliptically polarized laser fields can be steered continuously simply with the pulse ellipticity, while the critical instantaneous vector potentials remain identical. We observe the characteristic feature of the measured photoelectron momentum distributions, which matches the distinctive prediction of nonadiabatic theories. Our experiments demonstrate that the nonadiabatic initial transverse momentum at the tunnel exit is approximately proportional to the instantaneous effective Keldysh parameters in the tunneling regime. Our study clarifies a long-standing controversy over the validation of the adiabatic approximation and will substantially advance studies of laser-induced ultrafast dynamics in experiments.

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