First-order correction terms in the weak-field asymptotic theory of tunneling ionization

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The weak-field asymptotic theory (WFAT) of tunneling ionization in a static electric field [1,2] is developed to the next order in field. The first-order corrections to the ionization rate and transverse momentum distribution of ionized electrons are derived, which extends the region of applicability of the WFAT up to the boundary between tunneling and over-the-barrier ionization. The results apply to any atom or molecule treated in the single-active-electron and frozen-nuclei approximation. The theory is illustrated by calculations for atoms.

In the recently proposed weak-field asymptotic theory of tunneling ionization [1], the leading-order approximation for the ionization rate, Γ, of atoms and molecules in a static electric field was obtained. Working in the same theoretical framework in the deep tunneling regime, we derive the first-order terms of the asymptotic expansion for Γ, and also for the transverse momentum distribution of ionized electrons. The figure shows results for Ar as an example. Comparing the exact result with the zero-order WFAT(0) and the first-order WFAT(1) shows a clear improvement in the prediction.

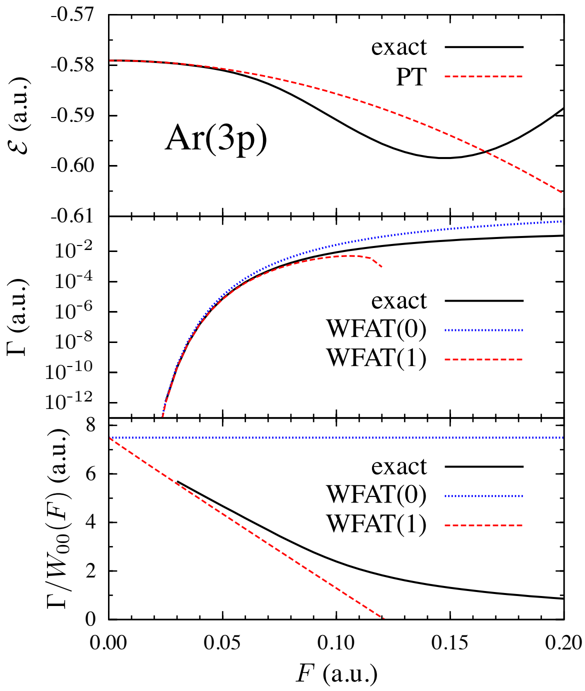

Figure 1. Energy (top) and ionization rate (middle) for Ar as a function of the electric field *F*. In the top panel PT denotes perturbation theory. Bottom panel: ratio of exact and WFAT results for Γ to the field factor $W_{00}(F)$ [2] without and with first-order correction to the rate.

By incorporating the first-order corrections, the WFAT will prove useful for the analysis of strong laser-matter interactions, where a reliable theory for tunneling is needed and exact results are not available.

References:

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