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Erratum: Electron rescattering in strong-field photodetachment of F^- [Phys. Rev. A 91, 031404(R) (2015)]

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In Ref. [1] we used R-matrix theory with time dependence (RMT) to study strong-field dynamics of F^- in near-infrared linearly polarized laser pulses. We compared the photoelectron spectra with the results of the Keldysh-type approach (KTA) calculation for short pulses [2,3], which enabled us to identify features due to electron rescattering. In this Erratum we correct an error made in the KTA calculation and show that corrected KTA results are in better agreement with RMT for energies where rescattering is not important.

In the short-pulse KTA the detachment amplitude is given by

$$A_{\mathbf{p}} = -(2\pi)^{3/2} A \sum_{\mu=1}^{2(N+1)} (\pm)^l Y_{lm}(\hat{\mathbf{p}}_\mu) \frac{\exp[if(t_\mu)]}{\sqrt{-if''(t_\mu)}}, \tag{1}$$

where $\mathbf{p}$ is the photoelectron momentum, l and m are the orbital and magnetic quantum numbers of the bound electron wave function, and A is its asymptotic normalization constant (see Ref. [3]). The sum in Eq. (1) is over $2(N+1)$ saddle points t_μ on the complex time plane (for the N-cycle pulse with sine-squared envelope), $\mathbf{p}_\mu$ and $f(t_\mu)$ being the corresponding classical electron

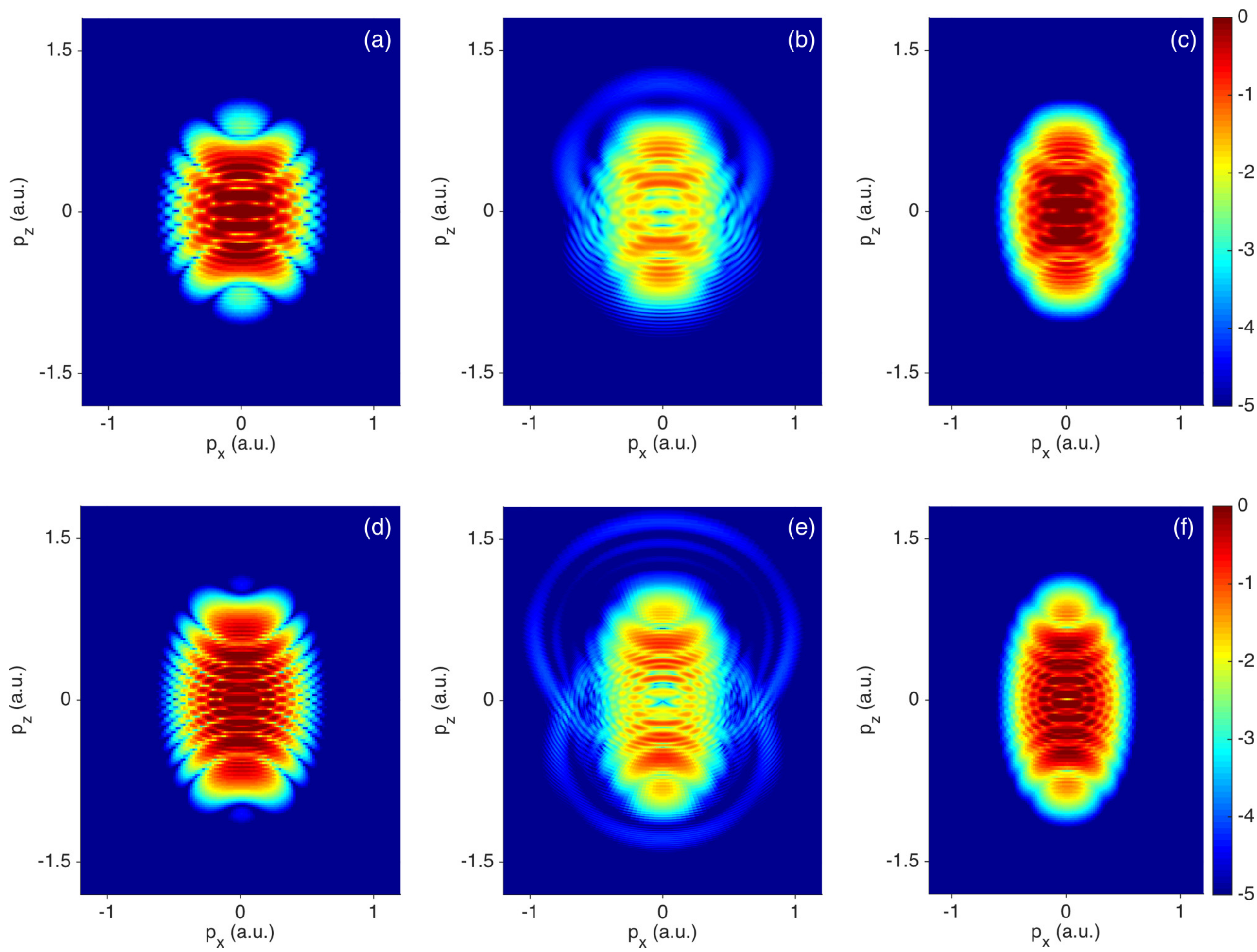

FIG. 1. Photoelectron momentum density plots for photodetachment of F^- by a short laser pulse consisting of four optical cycles with peak intensity of 1.3×10^{13} W/cm^2 and wavelengths 1300 nm (top) and 1800 nm (bottom). The left column shows the results of the KTA calculation without the phase factor, and the right column shows the KTA results with the correct phase factor. The numerical RMT simulations [1] are displayed in the middle column for comparison.

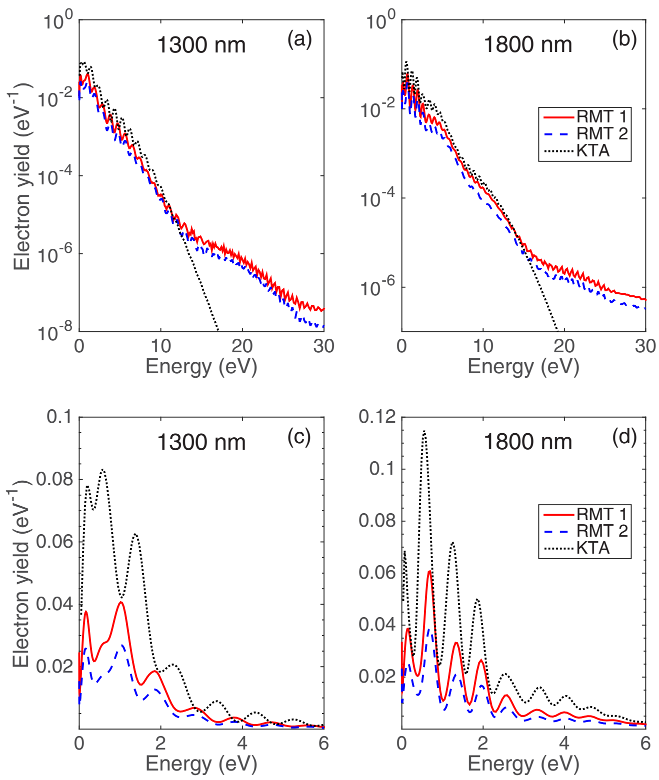

FIG. 2. Photoelectron energy spectra for photodetachment of F^- by a four-cycle laser pulse with intensity 1.3×10^{13} W/cm^2 at wavelengths 1300 nm [(a) and (c)] and 1800 nm [(b) and (d)]. Black dotted lines are the present (correct) KTA results; solid red and dashed blue lines are the results from two RMT models.

momentum and action, respectively. The phase factor $(\pm) \equiv \pm 1$ alternates between successive saddle points, corresponding to the electric field taking maximum absolute values in the positive and negative directions of the z (polarization) axis. Equation (1) generalizes the amplitude from Ref. [3] [Eq. (16)], which treated the short-laser-pulse detachment of s-wave electrons ($l = 0$), and that of Ref. [4] [Eq. (25)] where detachment by long periodic pulses was considered (with only two saddle points contributing to the amplitude for one period).

When the spherical function $Y_{lm}(\hat{\mathbf{p}}_\mu) \equiv Y_{lm}(\Theta,\varphi)$ in Eq. (1) is evaluated for the complex vector $\mathbf{p}_\mu$, the corresponding polar angle Θ is determined by

$$\cos\,\Theta = \sqrt{1 + p_\perp^2/\kappa^2}, \quad \sin\,\Theta = \mp i p_\perp/\kappa, \tag{2}$$

where $p_\perp$ is the component $\mathbf{p}$ perpendicular to the z axis, $\kappa = \sqrt{2|E_0|}$ (E_0 being the energy of the bound state in atomic units), and the sign in $\sin\,\Theta$ alternating in the same way as $(\pm)$ in Eq. (1). This gives rise to an additional m-dependent phase factor, and the final expression for the differential detachment probability of an electron from state lm reads

$$\frac{dw_{lm}}{d^3\mathbf{p}} = \frac{A^2}{4\pi}(2l+1)\frac{(l-|m|)!}{(l+|m|)!}\left|P_l^{|m|}\left(\sqrt{1+p_\perp^2/\kappa^2}\right)\right|^2 \left|\sum_{\mu=1}^{2(N+1)} (\pm)^{l+m} \frac{\exp[if(t_\mu)]}{\sqrt{-if''(t_\mu)}}\right|^2, \tag{3}$$

where $P_l^{|m|}$ is the associated Legendre function. This expression is similar to Eq. (33) from Ref. [4] in the case of a long pulse.

In the KTA calculations in Refs. [1,3] the phase factor $(\pm)^{l+m}$ in the sum in Eq. (3) was omitted. As a result, the detachment probability for p electrons ($l = 1$) was computed correctly for $m = \pm 1$ but incorrectly for $m = 0$ for which the interference contributions between the odd and the even saddle points were added with the wrong sign. Since $m = 0$ electron states give a dominant contribution to the detachment signal, this error affected the interference patterns of the photoelectron momentum and energy distributions presented in Refs. [1,3]. At the same time, the error in the total detachment probabilities was small.

Figure 1 presents the logarithmic photoelectron momentum densities on the (p_x, p_z) plane for photodetachment of F^- by a four-cycle pulse at intensity 1.3×10^{13} W/cm^2 and wavelengths 1300 and 1800 nm. We see that the KTA spectra obtained with the correct phase factor (right column) are quite different from those without it (left column) and are in better agreement with the RMT results (central column). The KTA result on the bottom right corrects the momentum distribution in Fig. 1(c) of Ref. [1]. (Of course, neither KTA calculation can reproduce the high-momentum rings, which are due to rescattering.)

Figure 2 shows the photoelectron energy spectra for the two pulses obtained from the correct KTA calculation and two RMT models. Comparing Figs. 2(a) and 2(b) with Fig. 2 of Ref. [1], we see the corrected KTA results are in better agreement with the

RMT calculations for all photoelectron energies up to the beginning of the rescattering plateau (at 12 eV for 1300 nm and 15 eV for 1800 nm). Figures 2(c) and 2(d) present the same spectra on the linear scale and correct Fig. 3 of Ref. [1]. The shape of the KTA spectrum in Fig. 2(d) agrees better with the RMT spectra, compared with the original (incorrect) result in Fig. 3 of Ref. [1].

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