Interference or not: analysis of the Young's experiment for a single-cycle pulse: Erratum

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In the paper published in the J. Europ. Opt. Soc. Rap. Public. 1, 06016 (2006), the model that has been used to describe the spectral distribution of the field followed by the diffraction calculations does not lead to a pulse with a "single" cycle but to a pulse of many cycles. In this paper, we present a discussion on the subject and implications in the interpretation of the results. [DOI: 10.2971/jeos.2008.08006e]

Keywords: Ultrafast phenomena, scalar diffraction, interference

In the paper "Interference or not: analysis of the Young's experiment for a single cycle pulse" by G. Girieud and S.F.Pereira published in the J. Europ. Opt. Soc. Rap. Public. 1, 06016 (2006), the word "single" cycle has not been correctly used. According to the definition of the spectrum of the pulse $V(\Delta\omega)$ given after Eq. (3) on page 06016-2, where $\Delta\omega = \omega - \omega_0$, one can see that the spectrum has been defined with a frequency shift of ω_0. In this way, when one tries to retrieve the pulse in time by taking the inverse Fourier transform with respect to ω, one should have in mind that the Fourier transform should be multiplied by the oscillatory function $\exp(-i\omega_0 t)$ representing the oscillations of the electric field at the centre frequency ω_0. The result of the inverse Fourier transform of $V(\Delta\omega)$ multiplied by the oscillation factor at frequency ω_0 is plotted in Figure 1, for the envelope (dotted-black line) and the real field (solid-grey line). As one can see, the time trace has not one single oscillation but several oscillations within the pulse envelope.

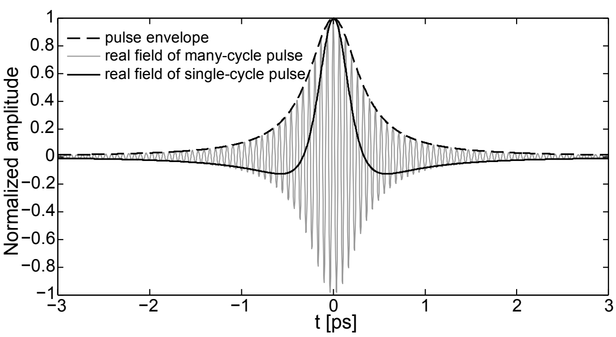

FIG. 1 The time trace of: the real field of a many-cycle pulse (solid-grey line) corresponding to the model used in the paper, the real field of a single-cycle pulse (solid-black line), and the envelope of both a many-cycle and a single-cycle pulse (dashed-black line).

In order to define a "single" cycle pulse, the spectrum should had been defined either with the frequency $\omega_0 = 0$ (thus no frequency shift) as it has been done in [1] or introduce the frequency shift $\omega_0 \neq 0$ and redefine the pulse with respect to this frequency, as it has been considered in [2, 3]. Following these definitions, one achieves the pulse with the real field of one oscillation (Figure 2, solid-black line), and an equal envelope to that of the many-cycle pulse.

When calculating the diffraction integral using the definition of the pulse as given in the article that corresponds to a many-cycle pulse (Figure 1, solid-grey line), one would expect the high frequency of oscillation that appear at the diffraction patterns of the two apertures (see Figure 4 of the article). If one would use instead the single-cycle pulse (Figure 1, solid-black line), those rapid oscillations would be replaced by an interference of a single pulse oscillations (compare the time evolution in Figure 2 and that in Figure 4 of the article), as effectively only the interference between two envelopes that can be observed.

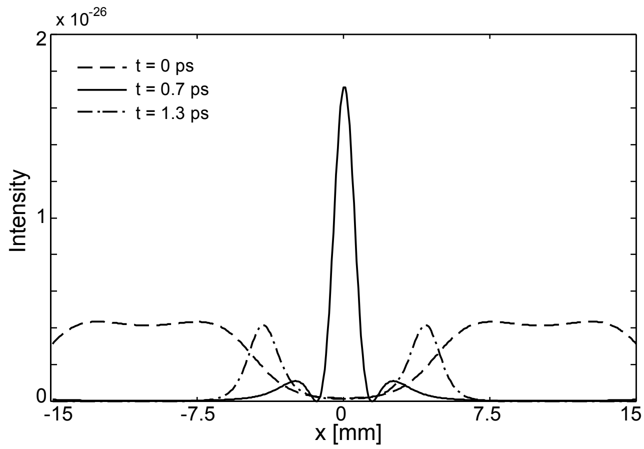

FIG. 2 Time evolution of the Young's interference for a single-cycle pulse, following times from: $t = 0$ ps (dashed line; compare to Figure 4b in the article), $t = 0.7$ ps (solid line; compare to Figure 4d in the article), and $t = 1.3$ ps (dash-dotted line; compare to Figure 4f in the article).

At the time shot before ($t = 0$ ps) and after ($t = 1.3$ ps) the interference takes place, the average spatial distribution of the

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diffraction patterns for the single-cycle and many-cycle pulse appears similar. In the presence of interference, the intensity modulation of a many-cycle pulse becomes very rapid (see Figure 4d of the paper), resulting in a substantially different intensity profile from that of a single-cycle pulse (Figure 2, solid line). The interference pattern of the single-cycle pulse has a higher visibility. Consequently, the intensity modulation in the spectral domain exhibits better resolved peaks that are desirable for many applications, such as spectroscopy.

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