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Inequivalence of Phase and Time Delay in High Harmonic Generation with Short Pulses[1] DIAN PENG, LIANGWEN PI, ANTHONY STARACE, University of Nebraska - Lincoln — When mixing two (or more) laser pulses, the phase difference and the time delay are two crucial parameters. For long pulses, the relative phase and the time delay are equivalent: for example, $\cos(\omega_1 t) + \cos(\omega_2 t + \phi) = \cos(\omega_1 t) + \cos[\omega_2(t + \phi/\omega_2)]$, i.e. in the extreme case of infinitely long pulses, the phase ϕ can be viewed as a time delay ϕ/ω_2 between the two pulses. However, for ultra short pulses, this equivalence breaks down: the carrier-envelope phase can't be viewed as equivalent to a time delay between two pulse envelopes. Our quantum simulations show that the inequivalence of the phase and the time delay in short pulses can result in significantly different high-order harmonic generation spectra, with up to an order of magnitude difference in intensity and up to about 10 harmonic orders of difference in cutoff energy. Further analysis shows the underlying physics of such difference. Exposing this inequivalence directly for the first time, our work provides new insights into pulse shaping and related issues for both experimentalists and theorists.

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