Comment on "How to observe coherent electron dynamics directly" Reply

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Comment on “How to observe coherent electron dynamics directly”

The main results of Ref. [1] rely on the assumption of the validity of Eq. (1) in Ref. [1]. In essence, that equation is meant to establish a connection between the time-dependent electron density of a nonstationary electronic system and the observable x-ray scattering pattern associated with that system. The authors of Ref. [1] claim that their Eq. (1) rests exclusively on the assumption that the electronic dynamics to be imaged are much slower than the duration of the x-ray pulse employed to probe those dynamics. (This is in addition to the assumption of nonresonant x-ray probe conditions.) The purpose of this Comment is to point out that Eq. (1) in Ref. [1] is generally invalid; a short pulse duration is in addition to the assumption of nonresonant x-ray probe time delay), and the constant \( \zeta \) depends, among other things, on the spectrum of the incoming x-ray beam and on the spectral response of the x-ray scattering detector. Equation (2) may be easily verified by using the results of Ref. [2]. (One may arrive at the same conclusion by applying the analyses of Refs. [3] and [4].) The key point here is that the right-hand side of Eq. (2) cannot be written in the form

\[
\int d^3x \int d^3x' \langle \Psi, t_d | \hat{n}(x) \rangle \langle \Psi, t_d | \hat{n}(x') \rangle | \Psi, t_d \rangle e^{iQ \cdot (x-x')},
\]

which, up to a prefactor, is Eq. (1) from Ref. [1] in the notation employed here. In other words, the requirement of a short pulse—or slow electronic dynamics—does not ensure that the final state reached in the photon collision process equals the electronic wave-packet state right before the collision. Finally, we would like to mention that analogous considerations have been shown to apply to time-resolved electron scattering [5].

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