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Theory of ultrafast electron diffraction: the role of the pulse properties.[1] JOHN SIPE, ANIA MICHALIK, EUGENE SHERMAN, Department of Physics and Institute of Optical Sciences, University of Toronto — We present a general formalism for scattering of electron bunches used in ultrafast electron diffraction (UED) experiments that incorporates characteristic parameters of the incident electron bunch. To perform the scattering calculation, we associate the classical distribution function, which describes the electron bunch just before scattering, with the asymptotic-in Wigner distribution. Using single-scattering and far-field approximations appropriate for typical UED experimental conditions, and considering the effects of the bunch parameters on the scattered signal, we derive two diffraction expressions. We derive a Fraunhofer type expression suitable for scattering from small samples, such as molecules, and a Fresnel type expression appropriate for scattering from large targets such as thin films. In our analysis we also identify the coherence length of an electron bunch. We present sample numerical calculation for scattering by nanosize particles based on our model, and discuss the effects of bunch and scattering target parameters on the diffraction signal.

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