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Relativistic Electrons Effects on Wave Pocket Distortion and Momentum Recoil Due to Ultra Short Interaction

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ABSTRACT
We have studied the relativistic effects of electrons on wave packet and recoil of momentum when short interaction occurred. We have used macroscopic quantum electrodynamics to obtain the required results. The calculation of kinetic energy and interaction lengths were made during recoil of momentum. The Maxwell Lorentz technique was considered along with Maxwell-Schrodinger method for the study of problem. It was found that the kinetic energy was decreased when electron coil was dominant and produced scattering. The interaction length was increased due to effect of recoil on electron.

KEYWORDS
Relativistic, recoil, momentum, interaction, macroscopic, quantum electrodynamics.

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INTRODUCTION

Mullter et al.[1] and Vogel Sang et al.2 studied and found effect of slow electrons on holograph. Kozak et al.[4] and Tsesses et al.[5] shown that sub relativistic electrons supported the modulation process to obtain gating. Talebi et al.[6] presented that large interaction length was achieved by mesoscopic samples theoretically predicted and experimentally observed. Talebi et al.[7] studied that electron no recoil approximation broken down for replacing it and suitable Maxwell Lorentz[8-9] and Maxwell Schrodinger[10-12] numerical framework was developed. Some investigators[13-18] applied macroscopic quantum electrodynamics to modulate electron matter interactions. The model accounted for significantly reshaping of the electron beam accordingly in velocities and large interaction length regime. The evaluation of the energy loss of an electron scattered by an arbitrary mesoscopic sample was made and compared with its no recoil counterpart to which itself consistency reduced in the relativistic limit, their mutual discrepancy provided a quantitative assessment of the quantum trait of the interaction.

METHOD

We have considered the interaction of sub-relativistic narrow electron beam with mesoscopic samples. The achievement of micro sized interaction lengths was used. The spectroscopy technique was used for the safety of radiation damage of the sample. We have used generalized expression for the model. We have taken into consideration traveling of electron having dielectric permittivity in the frequency domain $\varepsilon\omega(r)$. The quantized field coupled to it for description through macroscopic quantum electrodynamics Hamiltonian is given by

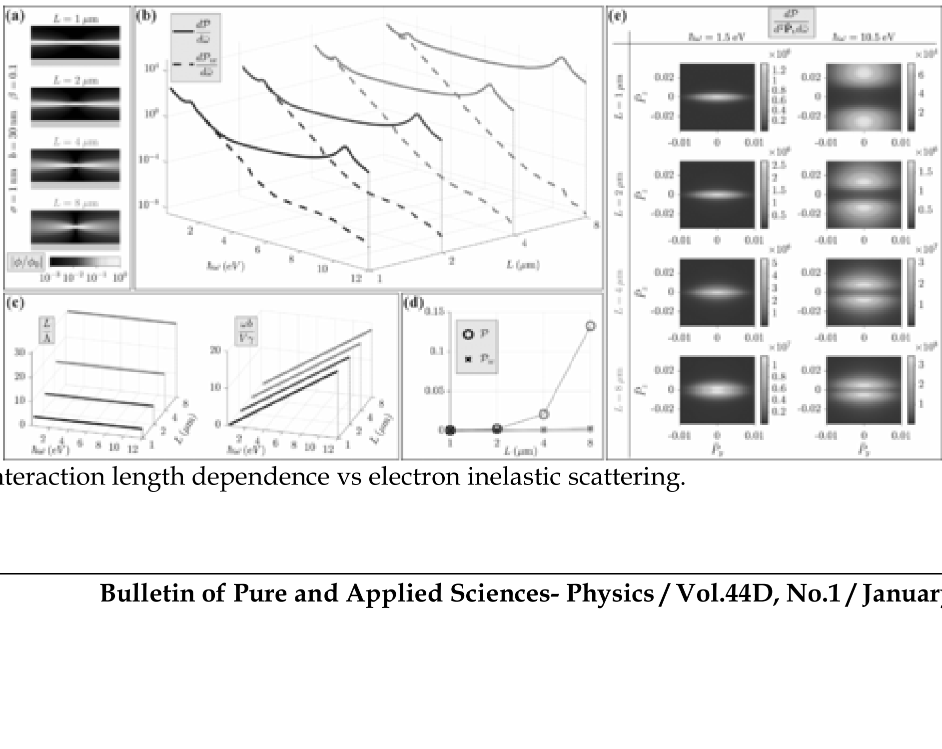
$$\hat{H}_{em} = \int d\varepsilon\, \hbar\omega\, \hat{f}^{\dagger}(\varepsilon)\, \hat{f}(\varepsilon)$$

Where $\varepsilon = (r, j, \omega)$,

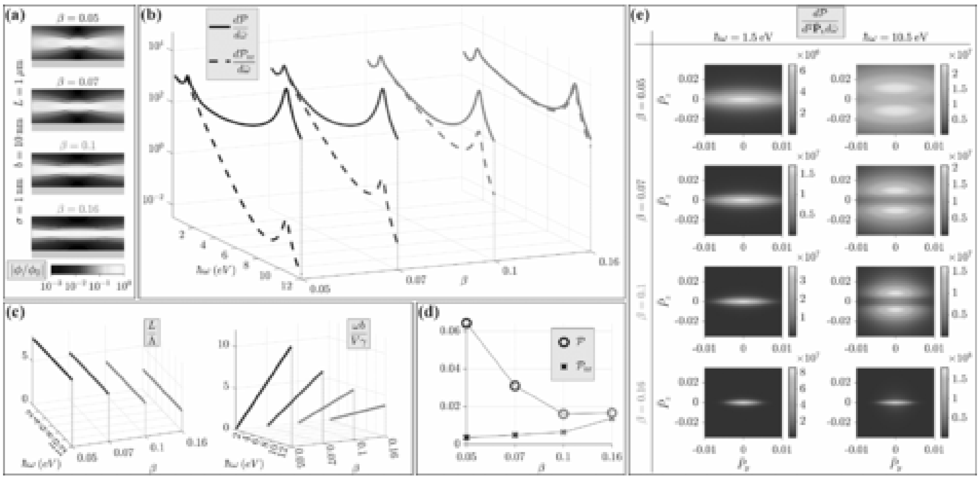
We have studied the micro electron role in the process of obtaining results. Incident electron beam was nearly monoenergetic for initial electron state. The energy loss was calculated considering single field. The effect of Green tensor over the envelopes were studied. The behavior of delta function was observed. The role of Fresnel Kernel for obtaining results stemming the quadratic term of the electron Hamiltonian was described for disappearing conditions.

RESULTS AND DISCUSSION

We have studied the interaction of electron beam was made. We have used macroscopic quantum electrodynamics for the analysis of energy loss during recoil. The wave pack distortion and small momentum recoil when interacted in the case of nanometer sized sample considering the relativistic electrons produced a very slight wave function and caused energy loss. It was found that interaction length was increased when electron kinetic energy was decreased. The quantum effect was forbidden according to classical mechanics due to moving point charge. The quantum features of inelastic scatterings were found. Graph (1) shows dependence of electron inelastic scattering. Graph (1) (a) shows positioning of broadening. Graph (1) (b) shows the loss of energy. Graph (1) (c) shows the satisfactory conditions for considered energy losses. It was found that recoil used is negligible for larger length. Graph (1) (d) shows the comparison between the obtained results and the no recoil. Graph (1) (e) shows the momentum resolved energy loss probability when momentum recoil was negligible and significant. It also indicated the evidence for considered situations and electron slab interaction did not invalidated the paraxial condition. Graph (2) shows the kinetic energy dependence of electron inelastic scattering. Graph (2) also highlights impact of broadening and produced momentum recoil.



Graph 1: Interaction length dependence vs electron inelastic scattering.



Graph 2: Plot of kinetic energy dependence of electron inelastic scattering.

CONCLUSION

We have studied relativistic effects due to ultra short interaction. A narrow electron beam showed significant distortion when interacted with simple due to radiation damage. It was found that quantum features of the interaction because of larger impact parameters are called quantum effect but in the field of classical mechanics it was treated as forbidden which was generated by moving point charge. It was also found that large interaction length triggered and affected the quantum recoil.

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