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Implication of the Exchange-Correlation on Electromagnetic Wave Propagation in Single-Wall Carbon Nanotubes

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Abstract : Using the linearized quantum hydrodynamic model (QHD) and by considering the role of quantum parameter (Bohm’s potential) and electron exchange-correlation potential in conjunction with Maxwell’s equations, electromagnetic wave propagation in a single-walled carbon nanotubes was studied. The electronic excitations are described. By solving the mentioned equations with appropriate boundary conditions and by assuming the low-frequency electromagnetic waves, two general expressions of dispersion relations are derived for the transverse magnetic (TM) and transverse electric (TE) modes, respectively. The dispersion relations are analyzed numerically and it was found that the dependency of dispersion curves with the exchange-correlation effects (which have been ignored in previous works) in the low frequency would be limited. Moreover, it has been realized that asymptotic behaviors of the TE and TM modes are similar in single wall carbon nanotubes (SWCNTs). The results show that by adding the function of electron exchange-correlation potential lead to the phenomena and make to extend the validity range of QHD model. The results can be important in the study of collective phenomena in nanostructures.

Keywords : transverse magnetic, transverse electric, quantum hydrodynamic model, electron exchange-correlation potential, single-wall carbon nanotubes
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