High Pressure Physics and Engineering 2013, vol. 23, № 3

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DYNAMICS OF ELECTRONIC WAVE PACKETS IN CARBON NANOTUBES

For the electrons of conductive carbon nanotubes, the problem of evolution of localized quantum states is solved. The localized quantum states are interpreted as superposition of the valence band and the conduction band. Localization of electronic states results in an oscillatory dependences of the mean values of coordinates and velocities that are known as a phenomenon of Zitterbewegung, which is studied theoretically for free relativistic electrons and the electronic states of graphene. The electronic states in carbon nanotubes are considered by means of linear approximation in momentum operators of the Hamiltonian. This approximation is valid for localized electronic states in the long-wave limits. It is shown for the wave packets in the conductive and dielectric nanotubes, that there exist a complicated dynamics related to the states interference of the valence and conduction bands. The dynamic of the wave packet represented by quantum states with cylindrical symmetry is considered, the interference phenomenon in this case results in the axial coordinates oscillations of the packet. For the localized quantum states of the angular and axial coordinates in the carbon nanotubes, oscillations of the mean values of the angular and longitudinal coordinates are present. In this paper, the evaluations of the frequency and amplitude of Zitterbewegung in the conductive carbon nanotube are presented, which can be used for the experimental identification.

Keywords: carbon nanotubes, localized quantum states, wave packets

Fig. 1. Time evolution of probability density of the localized quantum states (13) (*a*) and (20) (*б*) in a carbon nanotube

Fig. 2. Time dependence of the expectation values of axial (*a*) and angular (*б*) coordinates of localized quantum states (13) (I) and (20) (II) with parameters $\alpha = 1$, $\beta = 0$: I – $q_0 = 5$, $m_0 = 10$, $d/R = 0.5$, $\sigma = 0.4$; II – $q_0 = 5$, $m_0 = 5$, $d/R = 1$