частини графічними образами, автор відповідних образів зберігає на них авторські права, що записується у технічних даних про книжку, які також є обов'язковими компонентами кнструкції книги і книги в цілому.

Переважно, автори інформаційної частини книжки самі пропонують розподіл тексту на окремі частини. Це стосується, в основному, художньої літератури. Коли мова йде про дитячу художню літературу, або підручники для школи, то оформлення інформаційної складової, що стосується визначення розділів і, в цілому, поділу матеріалу на частини, стає принциповим, оскільки, такий розподіл тісно зв'язаний з методикою надання відповідної інформації споживачам книжок. Переважно, відповідальність за методику формування інформаційної компоненти покладають на автора, але художній супровід матеріалу, що представляється, здійснбє художник, який повинен знати сам інформаційний матеріал та повинен бути знайомий з відповідними методичними вимогами.

Приведений вище аналіз основних класів книжкової продукції показує, що для забезпечення ринкового успіху книжкової продукції не достатньо користуватися обмеженою кількістю критеріїв, або одним економічним критерієм спроектованим в основному на вартість книжкового видання. Доцільно, при проектуванні книжки, описратися на досить глибокий аналіз інформаційної складової, що пропонується авторами. На основі такого аналізу можна вибирати необхідні критерії проектування конструкції книжки та книжки в цілому.

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ON CALCULATION ELECTRONIC STATES OF CARBON NANOTUBES

A new approach is development for description of physical properties of carbon nanotubes h taking into account their real atomic structure have been proposed. On the basis of the classical polynomial theory we have investigated main quantum of

studding system. On the basis a functional integral representation for a statistic sum we have proposed an effective method for building of the closed self-consisted equations for Green functions of investigating system. The proposed approach is applicable for calculation of physical properties both single- and multiwall carbon nanotubes.

1. Introduction

Carbon nanotubes, representing a two-dimensional carbon hexagonal structure rolling along a given direction and reconnecting the carbon bonds, possess unusual mechanical, electrical and optical properties. Geometrically such structures are characterized by a diameter of the order of few nanometers with large aspect ratio that significantly larger than any other materials. Such cylindrical carbon molecules have novel physical properties that make them potentially useful in many applications in nanotechnology, electronics, optics and other fields of materials science, as well as potential uses in architectural fields. They exhibit extraordinary strength and unique electrical properties, and are efficient thermal conductors.

Description of physical phenomena in carbon nanotubes assumes building of exact, close and self-consistent systems of equations taking into account features of atomic and electron subsystems and their collective excitations. In known theoretical approaches these are realized on the basis of a point and Lattinger models, Hubbard model and density functional approximation [1]. In the framework of the mentioned approaches a real cylindrical geometrical structure of carbon nanotubes for simplicity was substituted by a plane carbon structure though an electron dynamic in these cases are considerably different. The adequate approach for description of the carbon nanotubes taking into account their real structure without anyone geometric simplification have been proposed in [1] on the basis of the functional; integral method.

In the presented paper we propose the development of the above mentioned approach based on application of a classical polynomial theory for calculations of quantum states of nanotubes and a generating functional method for obtaining the self-consistence of equations for Green functions describing collective electron and phonon excitations.

2. Quantum states of carbon nanotube

Physical properties of carbon nanotubes depend on its atomic carcass structure unwrapping of which into a two-dimensional planar sheet, called a grapheme, is possible along a vector, which is the integer combination of unite vectors T_1 and T_2 of the honeycomb carbon lattice: $R_{NM} = NT_1 + MT_2$ (N and M are integer) (Fig.1). Besides, we assume translation symmetry along z with the translation vector $T_z = LT_1 - KT_2$ (L and K are integer numbers). Therefore the nanotube properties are characterized by the number pair (N, M) called the chiral vector.

Because of the symmetry and unique electronic structure of graphene, the structure of a nanotube strongly affects its electrical properties. For a given chirality (N,M) nanotube, if $N=M$ (armchair nanotube), the nanotube is metallic; if $N-M$ is a multiple of 3, then the nanotube is semiconducting with a very small band gap, otherwise the nanotube is a moderate semiconductor. Thus all armchair nanotubes are metallic, and nanotubes (5,0), (6,4), (9,1), etc. are semiconducting. In theory, metallic nanotubes can carry an electrical current density of 4×10^9 A/cm^2 which is more than 1,000 times greater than metals such as copper.

Insertion the coordinate system with axes z and $0\varphi_{xy}$ ($0\varphi_{xy} = R_{NM}\varphi$) (Fig.1) leads to representation of the electron wave function of the nanotube in the form ([1])

$$\psi_{nmk}(x) = \frac{1}{\sqrt{\pi L}} R_{nm}(r) \exp i\left(k_\varphi \varphi_{xy} + kz\right).$$

Here n,m and k are quantum numbers related to radial, azimuthal and longitudinal modes of the wave function. Due to the invariant properties $k_\varphi = 2\pi\left(m / |R_{NM}|\right)$, where $m = \pm(0,1,2,\ldots, (N+M)/2)$ and $k_\varphi \varphi_{xy} = m\varphi$.
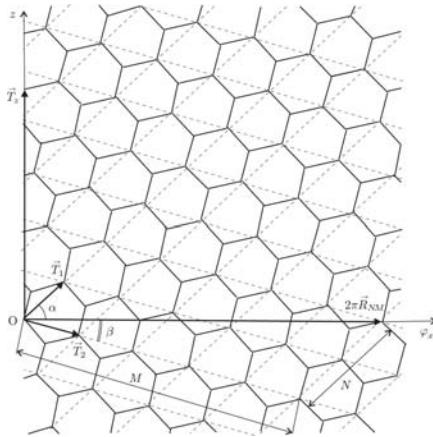

Fig.1. The two-dimensional carbon sheet wrapping up of which around the axes z ($z \parallel T_z$) along the vector R_{NM} ($T_z \perp R_{NM}$) results in the nanotube (T_1 and T_2 are two lattice unite vectorss

Then the electron wave function takes the form

$$\psi_{nmk}(x) = \frac{1}{\sqrt{\pi L}} R_{nm}(r) \exp i\left(m\varphi + kz\right), \tag{1}$$

where the function R_{nm} is determined by a model potential for the nanotube (see [1])

$$V_{ef} = \sum_{i=1}^{l} \frac{\lambda_i}{a^2} \left[\exp\left(-2a(r/R_i - 1)\right) - 2\exp\left(-a(r/R_i - 1)\right) \right] \tag{2}$$

Here the index i denotes number of walls of the nanotube, R_i is a radius of i th wall of the nanotube, $\lambda_i = 2\pi R_i \sigma$, σ is the charge density of the nanotube carcass consisting of ions C^{+4}. In the case of the single-wall nanotube ($\lambda_2 = 0$).

Taking into account Eq.1 and Eq.2 in the case of the single-wall nanotube the Schrödinger equation for the function $u_{nm}(r) = \sqrt{r} R_{nm}(r)$ in the terms of variable $x = r/R_1$ can be written as

$$\left(\frac{1}{2R_1^2} \frac{d^2}{dx^2} + \frac{m^2 - 1/4}{2R_1^2 x^2} + \frac{\pi^2 k^2}{2L} + \right.$$

$$\left. + \left[\frac{\lambda_1}{a^2} e^{-2a(x-1)} - 2\frac{\lambda_1}{a^2} e^{-a(x-1)} \right] - E \right) u_{nm}(x) = 0. \tag{3}$$

The main contribution in Eq.3 is related to a vicinity $x = R_1$, that implies very slow deviation of the variable x on the value 1 in the nonexponential part of Eq.3. Then we can transform Eq.3 to the form of the hypergeometric equation

$$\frac{d^2}{d\xi^2} u + \frac{\tilde{\tau}(\xi)}{\sigma(\xi)} \frac{d}{d\xi} u + \frac{\overset{\Box}{\sigma}(\xi)}{\sigma^2(\xi)} u = 0, \tag{4}$$

Where $\tilde{\tau}(\xi) = 1$, $\sigma(\xi) = \xi$, $\overset{\Box}{\sigma}(\xi) = -\xi^2/4 + (t + s - s^2 + 1/2)\xi$. Here the following denotations are inserted

$$\xi = \left(2\sqrt{2\lambda}/a^2\right) e^{-a(x-1)}, \ s = \sqrt{-2\varepsilon}/a,$$

$$t = \sqrt{2\lambda}/\alpha^2 - (s + 1/2), \tag{5}$$

$$\varepsilon = ER_1^2 - \frac{m^2}{2} + \frac{1}{8} - \frac{(\pi k R_1)^2}{2L^2}.$$

The bound quantum states are described by solutions Eq.4 which are represented by classical orthogonal polynomials (see [5]). Solving this problem supposes reducing Eq.4 to the canonical hypergeometric form

$$\sigma \frac{d^2}{d^2 \xi} y + \tau \frac{d}{d\xi} y + \lambda y = 0, \tag{4a}$$

with the help of the substitution $u = \phi(\xi) y$, where $\phi(\xi)$ obey the equation

$$\frac{\phi'}{\phi} = \frac{\pi(\xi)}{\sigma(\xi)}, \ \pi(\xi) = \frac{1}{2}\left(\tau(\xi) - \tilde{\tau}(\xi)\right). \tag{6}$$

The polynomial $\pi(\xi)$ is determined by the formula

$$\pi(\xi) = \frac{\sigma' - \tilde{\tau}}{2} \pm \sqrt{\left(\frac{\sigma' - \tilde{\tau}}{2}\right)^2 - \sigma + k\sigma}, \; k = \lambda - \pi'(\xi). \tag{7}$$

So as $\pi(\xi)$ is polynomial of the first degree in ξ, the radicand discriminate in Eq.7 is equals to 0, that determines the constant k. Under consideration case of the Eq.4 $\sigma' - \tilde{\tau} = 0$ and the mentioned condition on discriminate is expressed by the equation

$$k - (t + s - s^2 + 1/2) = 0.$$

Hence $k = t + s - s^2 + 1/2$ and due to Eq.7 $\pi(\xi) = \pm \xi/2$. Then from Eq.6 we obtain that $\tau(\xi) = 1 \pm \xi$. Condition of bound states is expressed in a boundedness of the weight function $\rho(\xi)$ (which obeys the equation $(\sigma\rho)' = \tau\rho$) of polynomial solutions Eq.4 and the corresponding condition $\tau' < 0$ in a solution region. Therefore the selection $\tau(\xi) = 1 - \xi$ corresponds to known solutions and in accordance with Eq.6 the transformation function $\phi(\xi)$ is obtained in the form $\phi(\xi) = e^{-\xi/2}$.

Due to the above mentioned equation the weight function $\rho(\xi)$ will be described by the expression $\rho(\xi) = e^{-\xi}$. Then in accordance with the Rodrige formula the polynomial solution Eq.4a can be represented as

$$y = \frac{B}{\rho(\xi)} \frac{d^n}{d\xi^n} (\sigma^n \rho) = Be^\xi \frac{d^n}{d\xi^n} (\xi^n e^{-\xi}), \tag{8}$$

where the constant B is determined by boundary conditionss.

Taking into account Eq.8 the electron wave function can be represented in the form

$$\psi_{nmk} = \frac{1}{\sqrt{\pi Lr}} e^{-\xi} \frac{d^n}{d\xi^n} (\xi^n e^{-\xi}) e^{i(m\varphi + kz)}. \tag{9}$$

The spectrum of the polynomial solution is determined by the general equation od the form

$$\lambda + n\tau' + n(n-1)\sigma''/2 = 0.$$

Taking into account that due to Eq.7 $\lambda = k + \pi'(\xi)$ from the last equation we can obtain relation

$$k + \pi'(\xi) + n\tau' + n(n-1)\sigma''/2 = 0 \tag{10}$$

determining spectral properties polynomial solutions.

Substitution explicit expression for quantities k, τ and σ into eq.10 yelds the equation

$$s^2 - s - t - (n-1)/2 = 0.$$

Due to Eq.5 $t = \sqrt{2\lambda}/\alpha^2 - (s + 1/2)$ and then from the last equation we ca obtain the expression

$$\varepsilon = -\left(\sqrt{\frac{\lambda_1}{2}} \lambda_1/2 + \frac{a^2}{2}\left(n + \frac{1}{2}\right) \right),$$

which describes quantum values of energy.

He last equation takes the form obtai which into this equation the expression $\lambda = k + \pi'(\xi)$ Taking into account Eq.7 and the condition $\lambda + n\tau' + n(n-1)\sigma''/2 = 0$ related to the solution of polynomial type of the degree n. Under consideration case the last equation Therefore The corresponding eigenvalue elfeigenvalue The second equation in Eq.7 determines.

3. Quantum states of carbon nanotube

Description of collective properties of the carbon nanotubes related to electron and phonon excitations assumes calculation Green's functions of the system. The generating function for the Green's functions can be a corresponding statistical sum of the quantum system.

The statistical sum Z can be represented in the form of the functional integral [1]

$$Z = \int D\psi^+ D\psi \exp\left(S[\psi] \right), \tag{11}$$

where $S[\psi]$ is determined by the expression

$$S[\psi] = \int_0^\beta dr \int dx \sum_s \psi_s^+(x,r) K(x,r) \psi_s(x,r) -$$

$$- \frac{e^2}{2} \int_0^\beta dr \int dx dy \rho(x,r) V(x-y) \rho(y,r) + \tag{12}$$

$$+ \int_0^\beta dr \sum_{l_a} \left[i p_{l_a}(r) \partial_r q_{l_a}(r) - \frac{p_{l_a}(r)}{2M_C} \right], \quad a = \alpha, \beta.$$

Here s is an electron spin, $\psi_s(x,r)$ is the two-component wave function of the nanotube lattice, p_{l_a}, q_{l_a} and $2M_C$ are a moment, a coordinate and the mass of an ion in l_a sublattice cite, $V(x-y) = 1/|x-y|$ is the operator of the Coulomb interaction. Beside, $K(x,r)$ is the operator of kinetic energy represented in the form

$$K(x,r) = \begin{pmatrix} K_a(x,r) & 0 \\ 0 & K_b(x,r) \end{pmatrix}, \quad K_{a,b}(x,r) = -\partial_r + \frac{\Delta_{a,b}}{2m_\varepsilon} + \mu_{a,b},$$

where $\partial_r = \partial/\partial_r$, $\Delta_a/(2m)$ is kinetic energy for the a th sublattice, μ_a a

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chemical potential of the a th sublattice.

The charge density $\rho(x,r)$ is composed of ion ($\rho^q(x,r)$) and electron ($\rho^e(x,r)$) parts and equals $\rho(x,r) = \rho^q(x,r) - \rho^e(x,r)$. Taking into account that for carbon nanotubes sublattices a and b are identical and $K_a(x,r) = K_b(x,r) = K(x,r)$ we can describe the system by the Green functions determined by the equation

$$K'(x,r)G(x,r_x;y,r_y) = \delta(x-y)\delta(r_x - r_y),$$

where

$$G(x,r_x;y,r_y) = \begin{pmatrix} G_1(x,r_x;y,r_y) & G_2(x,r_x;y,r_y) \\ G_2(x,r_x;y,r_y) & G_1(x,r_x;y,r_y) \end{pmatrix}.$$

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ЕФЕКТИВНІСТЬ ПЕРЕДАЧІ ВІДЕОТРАФІКУ MPEG В МЕРЕЖІ MPLS

Вступ.

Передача трафіку мультимедіа вимагає стабільної пропускної здатності мережі, що досягається шляхом резервування. Протокол резервування каналу (Resource Reservation Protocol - RSVP) використовується сервером для забезпечення вимог необхідної якості сервісу (quality of service - QoS) [1]. Хоча концепція QoS забезпечує стабільну пропускну здатність для мультимедійного трафіку, вузьким місцем передачі найчастіше є маршрутизатори, які пересилають пакети почергово.

MPLS (Multiprotocol Label Switching) - це технологія швидкої комутації пакетів в багатопротокольних мережах, заснована на використанні міток. MPLS розробляється і позиціонується як спосіб побудови високошвидкісних IP-магістралей, проте область її застосування не обмежується протоколом IP, а розповсюджується на трафік будь-якого мережевого протоколу, що маршрутизується.

У основі MPLS лежить принцип обміну міток. Будь-який пакет асоціюється з тим або іншим класом мережевого рівня (Forwarding