The conductivity two-layer graphene nanoribbons in external electric field

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A nanostructure and nanoclusters of the system very interesting with standpoint of their using in is nano- and optoelectronics but studies of the fundamental nature have brought about arising the new direction - a physicists nanostructures. The Special place in these study occupy nanostructure on base of carbon.

Graphene is interesting not only from the viewpoint of possible applications, but also from a fundamental point of view - because of their unique electronic properties. Model band structure of graphene has served as a launching pad for studying the properties of graphite, but in multilayer stacks, in particular in the bilayer, the interaction between the layers is significantly distorts the properties of graphene [1].

In this paper, a theoretical study of the influence of an external electric field applied as perpendicular to the graphene layers, and along them, the temperature dependence of conductivity bilayer graphene nanoribbons.

The band structure of the system by the method of molecular orbitals as linear combination of atomic orbitals (MO LCAO) using the Huckel approximation.

To simulate the electronic structure of bilayer graphene, we used a model Huckel-Habbard. In this model, the Hamiltonian system takes the following form [2]:

$$\begin{aligned}\hat{H} = &-\sum_{j\Delta\sigma} t_{\Delta}^{a}\left(a_{j\sigma}^{+}a_{j+\Delta\sigma} + a_{j+\Delta\sigma}^{+}a_{j\sigma}\right) - \mu^{a}\sum_{j\Delta\sigma} a_{j\sigma}^{+}a_{j\sigma} + U\sum_{j} a_{j\sigma}^{+}a_{j\sigma}a_{j-\sigma}^{+}a_{j-\sigma} \\ &-\sum_{j\Delta\sigma} t_{\Delta}^{c}\left(c_{j\sigma}^{+}c_{j+\Delta\sigma} + c_{j+\Delta\sigma}^{+}c_{j\sigma}\right) - \mu^{c}\sum_{j\Delta\sigma} c_{j\sigma}^{+}c_{j\sigma} + U\sum_{j} c_{j\sigma}^{+}c_{j\sigma}c_{j-\sigma}^{+}c_{j-\sigma} - \\ &-\sum_{j\xi\sigma} t_{\xi}^{ac}\left(a_{j\sigma}^{+}c_{j+\xi\sigma} + c_{j+\xi\sigma}^{+}a_{j\sigma}\right) + e\varphi\sum_{j\Delta\sigma} c_{j\sigma}^{+}c_{j\sigma}\end{aligned} \qquad (1)$$

It takes into account the energy of electronic transitions, the Coulomb interaction between electrons, as well as the interaction of electrons with an external electric field.

Were built by different temperature dependence of the conductivity of the external field applied perpendicular to the layers of graphene and along them.

The results of calculations for showed that at low electric fields at low temperatures (around 40 K) is the deflection of the temperature dependence of conductivity observed phase transition "conductor-semiconductor interface. With further increase of the electric field phase transition disappears.

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[1] L. Chernozatonskii, E. Sheka, A. Artukh, *JETP Letters* **89**, 412 (2009).
[2] G. Ivanchenko, N. Lebedev, *FTT* **49**, 183 (2007).