Transmission of the Dirac quasi-electrons through a graphene structure with a quantum well.

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We consider the modern graphene-based nanostructures that can be used to regulate the energy spectrum. Namely, the structure of a single quantum well with a rectangular cross section, located along the 0y axis is studied. It is believed that the pseudo-relativistic quasielectrons whose motion obeys the Dirac type equation can fall on a well at different angles with respect to the 0y axis. Based on this equation, the wave functions inside and outside the well are obtained within the continuum approach. We focus on the solution of the equation that is the interference of the confined states in the quantum well and of the states which travel across the well. By matching of the wave functions at the interfaces, the transmission coefficient of the quasi-electrons through a given structure T is determined. It is taken into account that the Fermi velocity can acquire different values in the region of the well (v1) and outside it (v2).

First of all, it should be noted that the transmission spectra of quasi-electrons through a given structure, that is, the dependence of the transmission coefficient T on the charge carriers energy E, are marked by a resonant nature. This means that for some energies the value of T is close to one, while for other energies it is much smaller. The most interesting feature of the studied spectra is the presence of the all-angled perfect transmission that is, for a given set of parameter values, the transmission coefficient is maximum (equal to one) regardless of the angle of incidence of the quasi-electrons on the structure. The energy value for which this effect is realized depends essentially on the Fermi velocity values v1, v2. In general, the transmission spectra are very sensitive to the value of the parameter α = v1 / v2, which allows them to be flexibly adjusted by changing this parameter. The dependence of the spectra on the direction of propagation of the electron wave, on the bandwidth (for the gapped graphene) and on the quantum well depth are also analyzed. The results of the work may be useful in the process of designing of the graphene-based nanostructures.