LOCALIZATION IN AN OPTICAL DIRAC'S SYSTEM WITH PSEUDO SPIN -1 DUE TO SCATTERING BY A RANDOM INTERBAND POTENTIAL

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During the last decade, studies of so-called Dirac materials constructed on the basis of optical atomic or Lieb lattices and photonic crystals with a frequency or energy spectrum structure, which is similar to the one corresponding to an electron system with a pseudo-spin-1, became the subject of considerable interest [1]. This pseudo-spin value equal to one refers only to the fact that band spectrum consists of three branches, two of them are dispersive and another one is non-dispersive. In the two-dimensional Brillouin zone relative to certain optical atomic or 2D photonic crystal, under symmetry demands, there may be such special points at which degeneration of zones takes place. In the vicinity of these points, the dispersive branches reveal a linear dependence on the wave number, which is defining feature of massless Dirac particles.

Here the spatial decrement of attenuation of waves due to their scattering at by a random interband potential has been studied. As usual the spectral properties are determined by the Hamilton operator represented as follows:

$$\hat{H} = \frac{v_F \hbar}{\sqrt{2}} \begin{pmatrix} 0 & k_- & W^* \\ k_+ & 0 & k_- \\ W & k_+ & 0 \end{pmatrix}$$ where $k_\pm = k_x \pm i k_y$, $v_F -$ is phase (Fermi) velocity at

the conic point and $W = U + iV -$ is the random potential having the following statistical properties

$$\langle W \rangle = 0 \quad , \quad \langle W^*(\vec{r})W(\vec{r}') \rangle = 2\langle U(\vec{r})U(\vec{r}') \rangle = 2\langle V(\vec{r})V(\vec{r}') \rangle \quad , \quad \langle W(\vec{r})W(\vec{r}') \rangle = 0$$

The problem of spatial localization of waves was solved by the method of resolvent Green's functions [2]. A serie of perturbation theory is written for the Green's function, which is averaged over realizations of a random field, after which the averaged Green's function is expressed in terms of the vertex part, which allows us to write Dyson's equation for its proper energy part. The proper energy part was found in the Barrett (Born)approximation. By calculating the poles of the average Green's function, the localization radius was found as a function of the random field statistical parameters.

1.Fang A., Z.Q.Zhang, Steven G.Louie, and C.T.Chan, AAAS Research,V2019,Article ID3054062, 15 pages. doi.org/10.34133/2019/3054062
2.Svidzinsckii A.V, Theoretical Physics Mathematical Methods, VEJA, 2004.v.2 – 310pp