Exercises Graphene

I refer to either "Bandstructure of Graphene and Carbon Nanotubes: An Exercise in Cond. Matter Physics" as CS
or to the book by Tero Heikkilä as TH

1) see CS equ. (20) show that $\vec{K} = \frac{4\pi}{3\sqrt{3}\,a_0}\,\vec{e}_x$

2) $\gamma_1 \begin{pmatrix} 0 & \alpha \\ \alpha^* & 0 \end{pmatrix} \begin{pmatrix} b_1 \\ b_2 \end{pmatrix} = E \begin{pmatrix} b_1 \\ b_2 \end{pmatrix}$; $\alpha(\vec{k}) =$ equ. (14 CS)

how do the eigenstates $\begin{pmatrix} b_1 \\ b_2 \end{pmatrix}$ look like for both pos. and negative energies ?

3) Linearize around valley $\vec{K}$. Define:
$E(\vec{k}) = E(\vec{K}) + \varepsilon(\vec{\kappa})$ (Def of $\varepsilon(\vec{\kappa})$)
with $\vec{k} = \vec{K} + \vec{\kappa}$ and set $E(\vec{K}) = 0$;
and show to find ado:

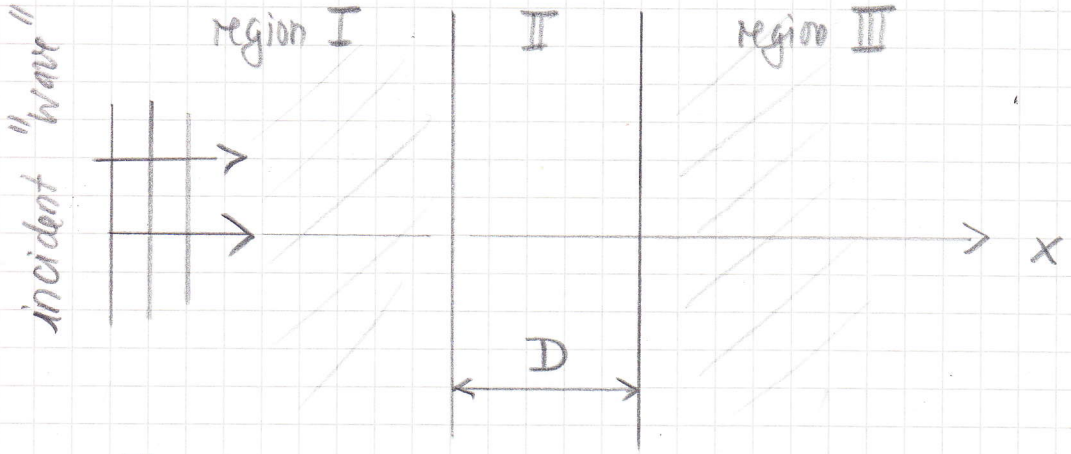
$$\pm \left(\frac{3\gamma_1 a_0}{2\hbar}\right) \begin{pmatrix} 0 & -\kappa_x - i\kappa_y \\ -\kappa_x + i\kappa_y & 0 \end{pmatrix} \begin{pmatrix} b_1 \\ b_2 \end{pmatrix} = \varepsilon \begin{pmatrix} b_1 \\ b_2 \end{pmatrix}$$

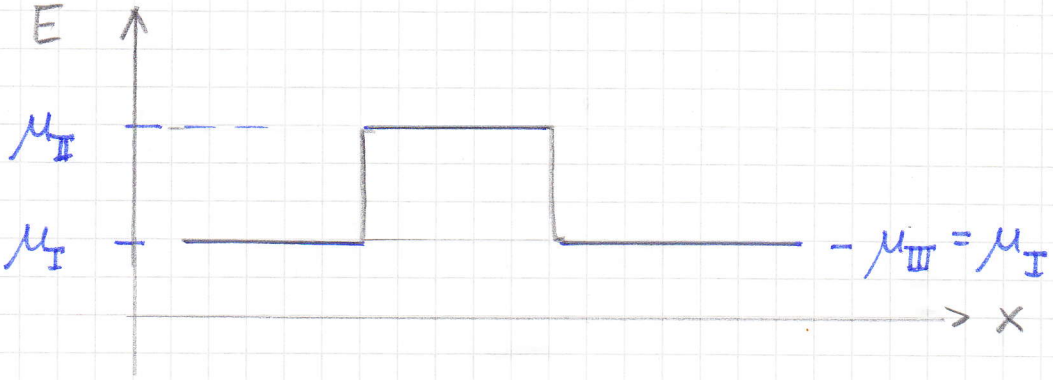
4) use manuscript CS
derive the set of equations (30), (32), (33)

5) draw Fig 7 in CS for the second valley

6) show that (10.12) in HT are solutions to (10.11).

7)





a) Energie of electrons in a normal system: $E = \mu_i + \frac{(\hbar \vec{k})^2}{2m}$

b) " " " in graphen $E = \mu_i \pm \hbar v_F |\vec{k}|$

Let us assume that for both case a) & b) $E > \mu_I, \mu_{II}, \mu_{III}$

We look at an incident wave from left at energie E with $k_x > 0$, $k_y = 0$

How does the transmission probability $|t|^2 = T$ looks quantitatively for both cases as a function of D. Draw $T(D)$?