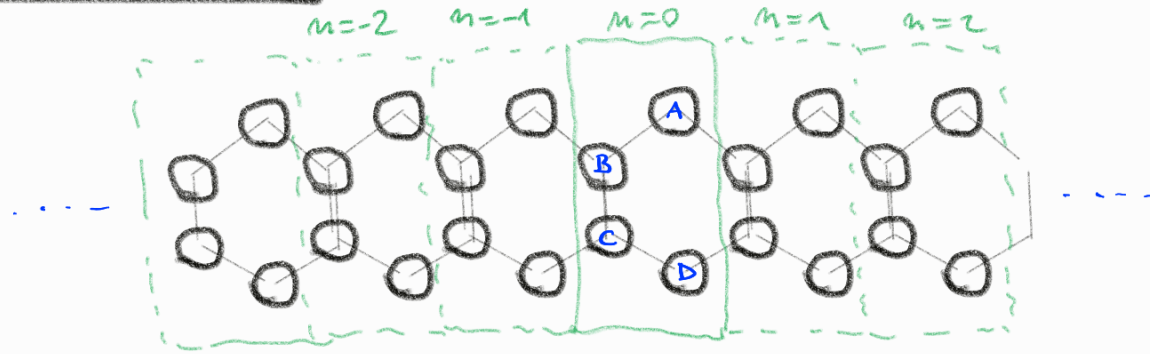


# HOMEWORK 1b



Graphene ribbon can be considered as periodic repetition of the cell above. Assume a tight binding Hamiltonian of the ribbon:

$$H = -\beta \sum_m \left( |m_A\rangle \langle m_B| + |m_B\rangle \langle m_C| + |m_C\rangle \langle m_D| + |m_A\rangle \langle (m+1)_B| + |m_D\rangle \langle (m+1)_C| \right) \\ - \beta \sum_m \left( \langle m_B| \langle m_A| + \langle m_C| \langle m_B| + \langle m_D| \langle m_C| + \langle (m+1)_B| \langle m_A| + \langle (m+1)_C| \langle m_D| \right)$$

where the second row is hermitian conjugate of the first.

assuming that the wave function of the stationary states is

$$|\psi(k)\rangle = \sum_m \left( \psi_A |m_A\rangle + \psi_B |m_B\rangle + \psi_C |m_C\rangle + \psi_D |m_D\rangle \right) e^{ikm}$$

find the spectrum of the Hamiltonian.

To diagonalize the matrix you can think how to use symmetry  $A \leftrightarrow D$   $B \leftrightarrow C$ .