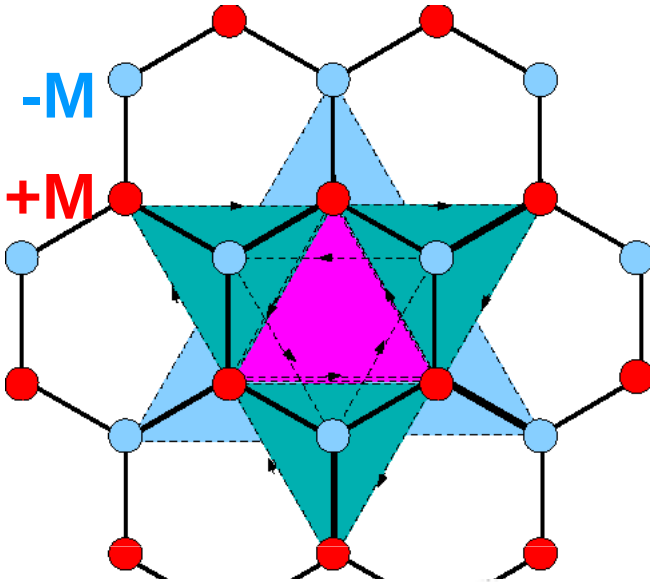
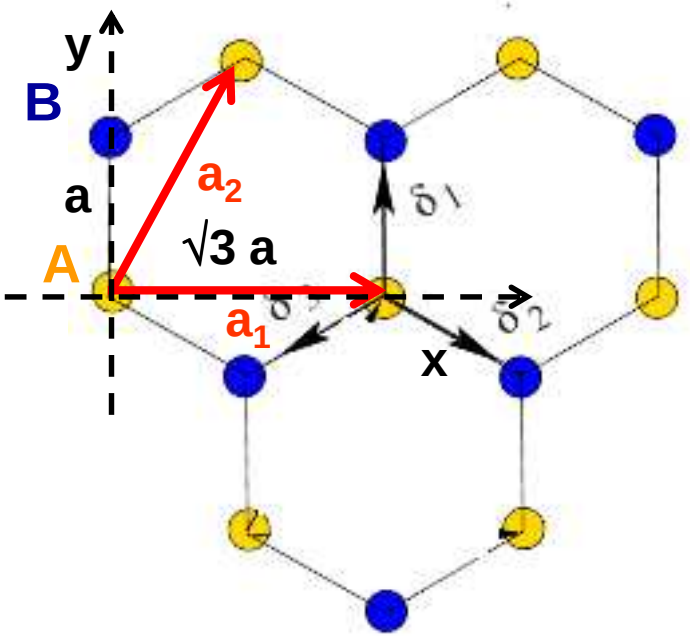
Tarefa 21: Haldane model





$$\frac{\mathcal{H}_{\mathbf{q}}}{N} = \begin{pmatrix} M + 2t_2 f(\mathbf{q},\phi) & t_1\gamma_{\mathbf{q}} \\ t_1\gamma^*_{\mathbf{q}} & -M + 2t_2 f(\mathbf{q},-\phi) \end{pmatrix}$$

$$\gamma_{\mathbf{q}} = 1 + e^{i\mathbf{q}\cdot\mathbf{a}_2} + e^{i\mathbf{q}\cdot(\mathbf{a}_2-\mathbf{a}_1)}$$

$$f(\mathbf{q},\phi) = \cos(\mathbf{q}\cdot\mathbf{a}_1+\phi) + \cos(\mathbf{q}\cdot\mathbf{a}_2-\phi) + \cos(\mathbf{q}\cdot(\mathbf{a}_2-\mathbf{a}_1)+\phi)$$

Consider: t1=1 , $\phi=\pi/2$, and $\mathbf{a}_1$ and $\mathbf{a}_2$ as in the left.

1) Calculate the Hamiltonian matrix for the Brillouin zone vertices **q**=K and **q**=K'. (remember Lista 03!)

2) Show that the gap *vanishes* for

$$t_2 = \pm M/(3\sqrt{3})$$

but not in K and K' at the same time!