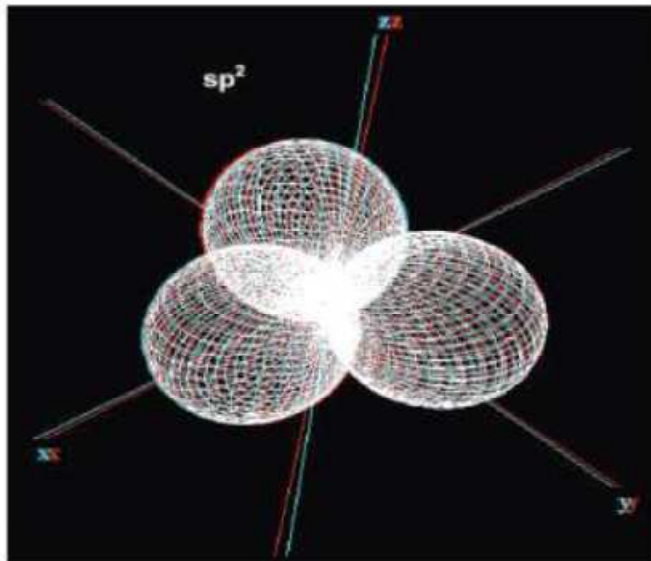
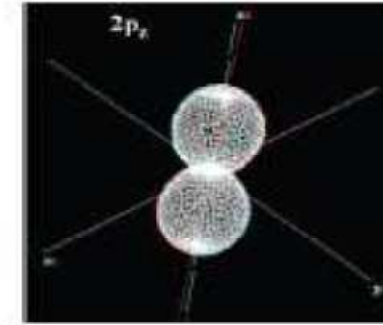
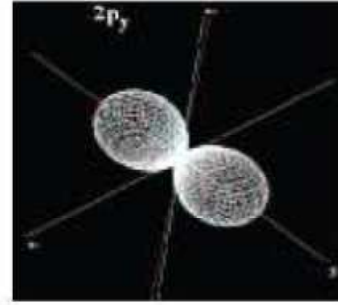
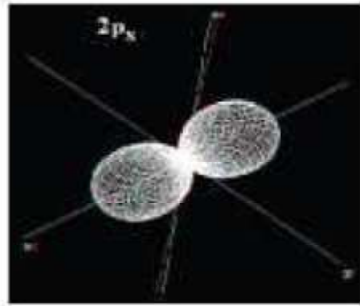
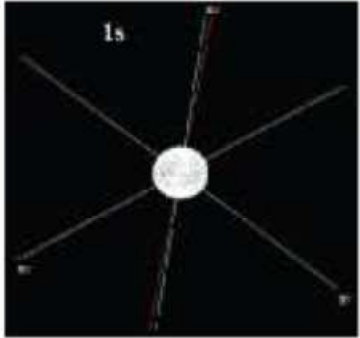
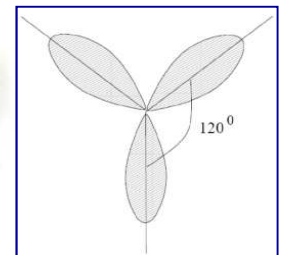
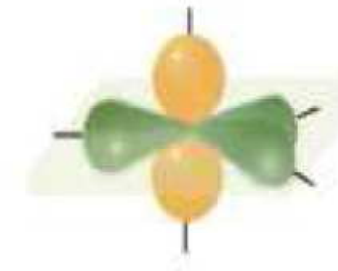


O básico do grafeno: hibridização sp^2



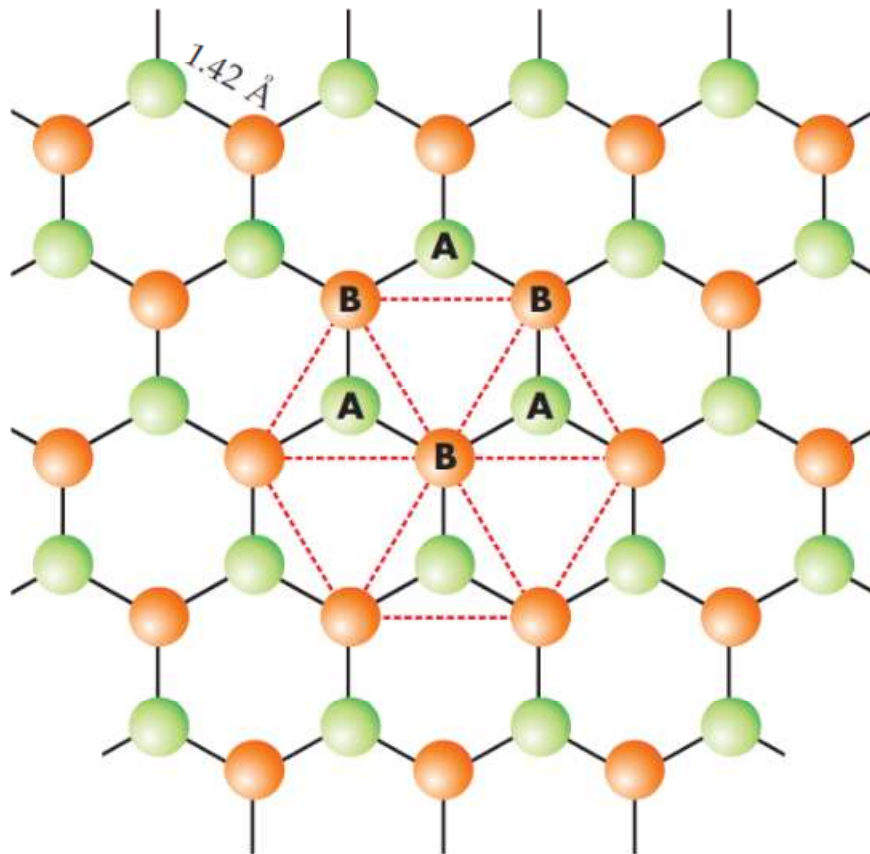
Geometria do orbital hibridizado:
trigonal plana

3 primeiros vizinhos



orbital p_z dá origem: orbital π

Grafeno: Rede triangular com base

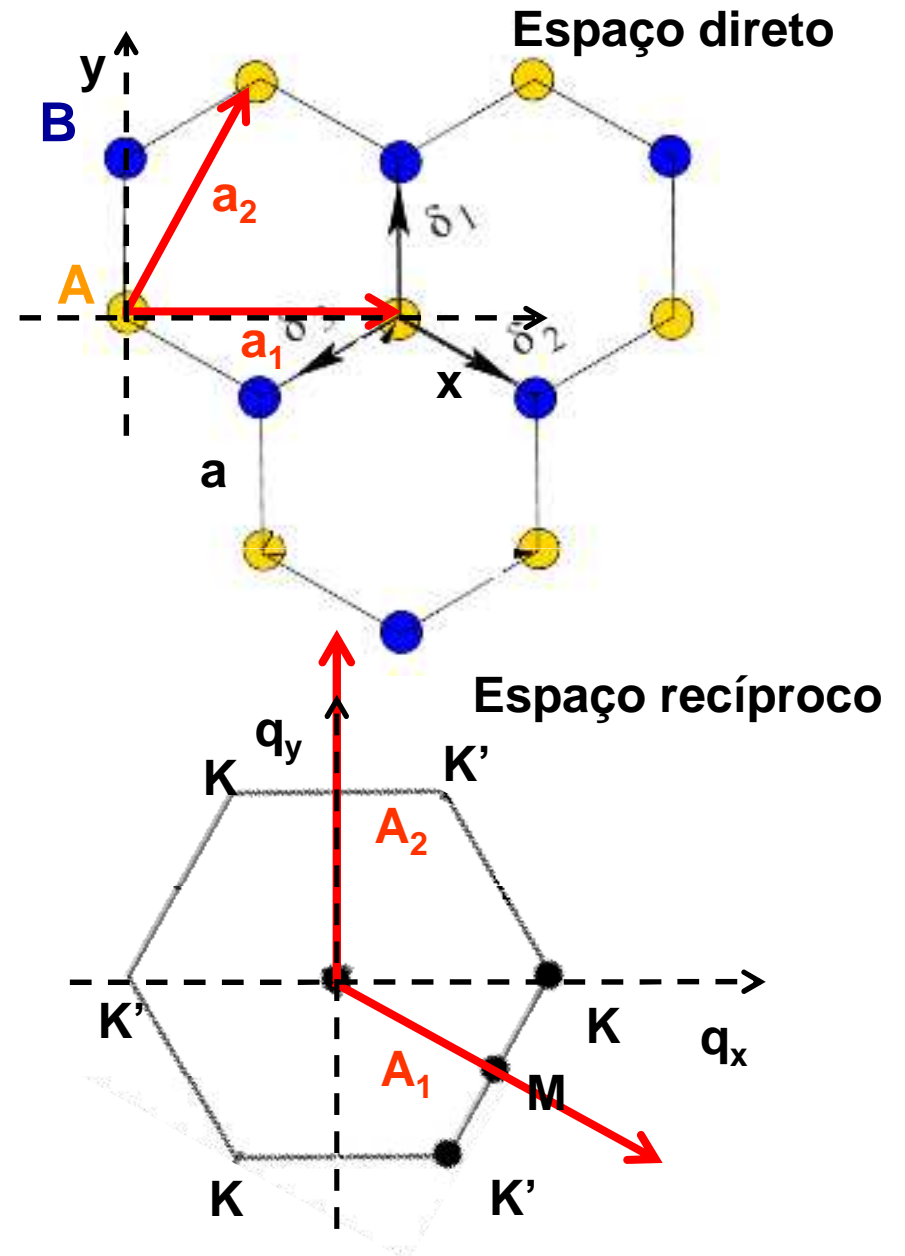


■ Tarefa 10 (hoje):

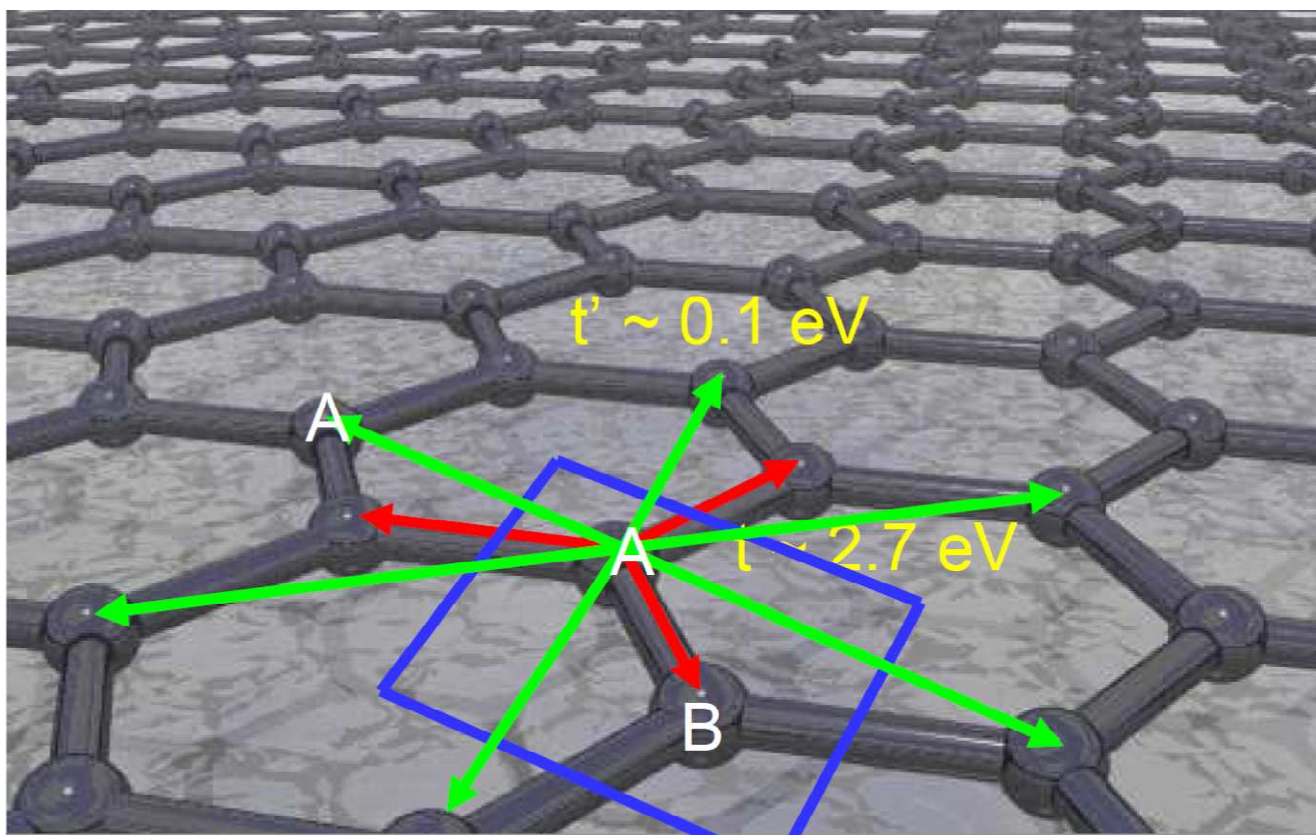
1 - Escrever os vetores \mathbf{a}_1 e \mathbf{a}_2

2 – Calcular o módulo de:

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



Tight-binding para o grafeno: duas bandas.



Tight-binding de 1^{os}...

$$H = -t \sum_{\langle i,j \rangle, \sigma} \left(a_{\sigma,i}^\dagger b_{\sigma,j} + \text{H.c.} \right)$$

$$-t' \sum_{\langle\langle i,j \rangle\rangle, \sigma} \left(a_{\sigma,i}^\dagger a_{\sigma,j} + b_{\sigma,i}^\dagger b_{\sigma,j} + \text{H.c.} \right)$$

...e 2^{os} vizinhos

$$0.02t \leq t' \leq 0.2t$$

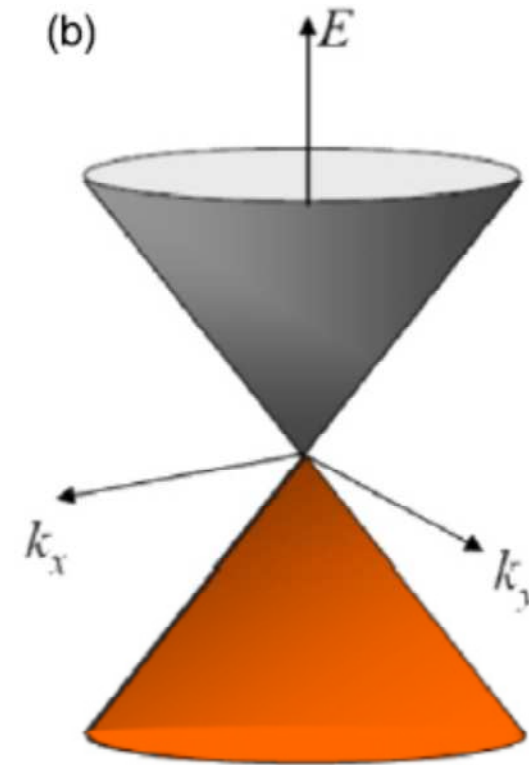
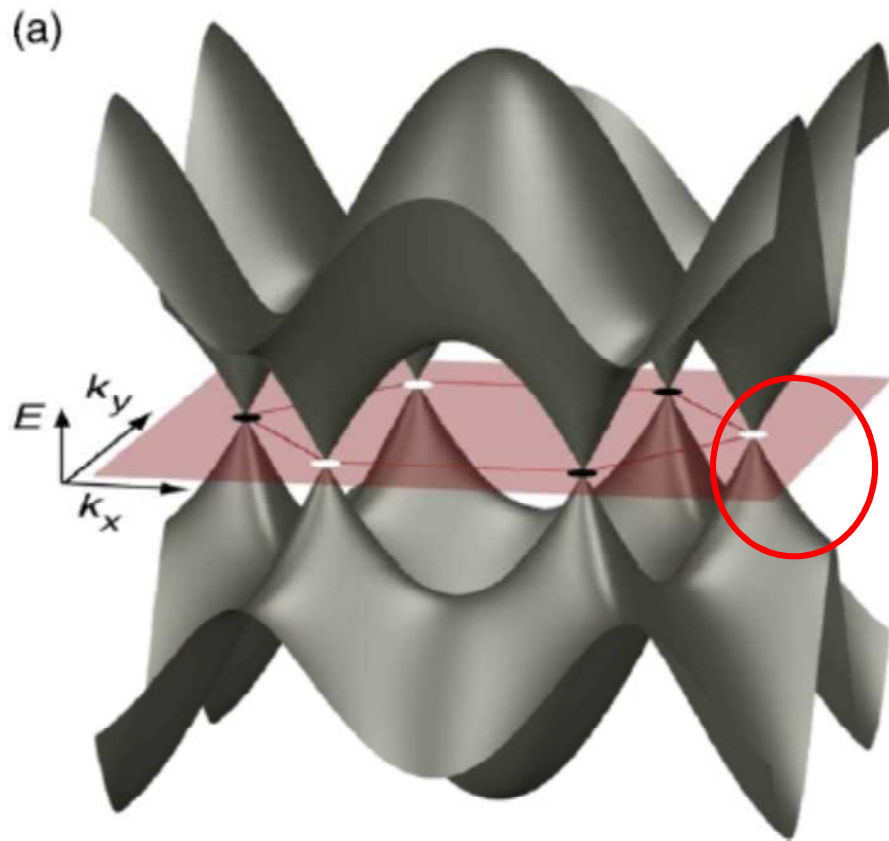
$$E_{\pm}(\mathbf{q}) = \pm t \sqrt{3 + f(\mathbf{q}) - t' f(\mathbf{q})}$$

$$f(\mathbf{q}) = 2 \cos(\sqrt{3}q_x a) + 4 \cos\left(\frac{\sqrt{3}}{2}q_x a\right) \cos\left(\frac{3}{2}q_y a\right)$$

Resultado do final dos anos 40!

Wallace, P.R., *Phys. Rev.* 71 622 (1947)

Cones de Dirac.

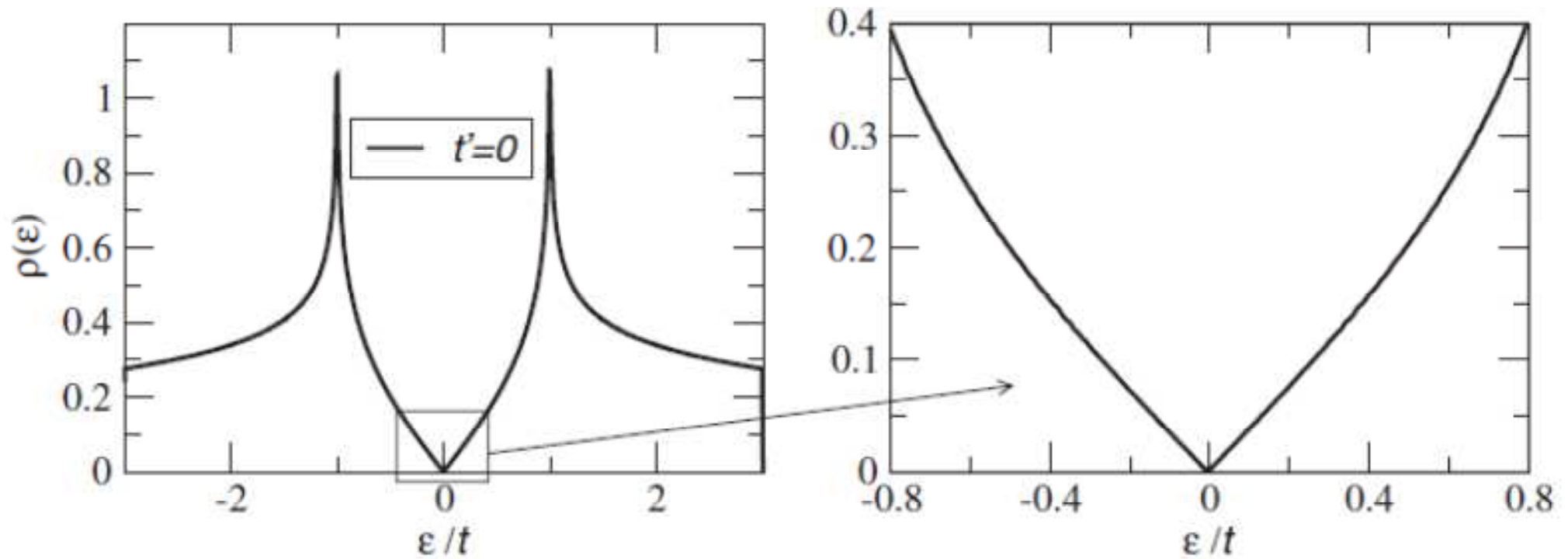


$$E_{\pm}(\mathbf{q}) \approx \pm t \sqrt{3 + f(\mathbf{q})}$$

$$E_{\pm}(\mathbf{q}) = \pm v_F |\mathbf{q}|$$

Analogia: dispersão de férmions
“relativísticos sem massa” (“E=pc”)

Grafeno: densidade de estados



$\rho(E) \propto |E|$ (*linear*)
próximo ao ponto
de neutralidade de carga.

$$\rho(E) = \frac{2A_c |E|}{\pi v_F^2}$$