4.6. Spin Hamiltonian

4.6a. Electrons in a 2D conductor in the relevant energy range of interest are described by a Hamiltonian of the form

\[ H = \left( E_c - \frac{p^2}{2m} \right) |I\rangle + \frac{g}{2} \mu_B \sigma \cdot \vec{B} - \frac{\eta}{\hbar} \vec{\sigma} \cdot (\hat{z} \times \vec{p}) \]

We wish to model it with a tight-binding Hamiltonian shown schematically in the figure.

The correct \( \alpha \) to use is

(a) \( t |I\rangle + \frac{i \eta}{2a} \sigma_x \)
(b) \( t |I\rangle \)
(c) \( t |I\rangle + \frac{i \eta}{2a} \sigma_y \)
(d) \( (E_c + 4t) |I\rangle \)
(e) \( (E_c + 4t) |I\rangle + \frac{g}{2} \mu_B \sigma \cdot \vec{B} \)

4.6b. Electrons in a 2D conductor in the relevant energy range of interest are described by a Hamiltonian of the form

\[ H = \left( E_c - \frac{p^2}{2m} \right) |I\rangle + \frac{g}{2} \mu_B \sigma \cdot \vec{B} - \frac{\eta}{\hbar} \vec{\sigma} \cdot (\hat{z} \times \vec{p}) \]

We wish to model it with a tight-binding Hamiltonian shown schematically in the figure.

The correct \( \beta_x, \beta_x^+ \) to use are

(a) \( t |I\rangle \pm \frac{i \eta}{2a} \sigma_x \)
(b) \( t |I\rangle \) for both
(c) \( t |I\rangle \pm \frac{i \eta}{2a} \sigma_y \)
(d) \( (E_c + 4t) |I\rangle \) for both
(e) \( (E_c + 4t) |I\rangle + \frac{g}{2} \mu_B \sigma \cdot \vec{B} \)