3.6. Magnetic Field

3.6a. A 1D wire has on-site and nearest neighbor coupling elements as shown. The corresponding dispersion relation is

(a) \( E(k_x) = \varepsilon + 2t \cos \varphi \)

(b) \( E(k_x) = \varepsilon + 2t \sin k_x a \)

(c) \( E(k_x) = \varepsilon + 2t \cos k_x a \)

(d) \( E(k_x) = \varepsilon + 2t \sin(k_x a + \varphi) \)

(e) \( E(k_x) = \varepsilon + 2t \cos(k_x a + \varphi) \)

3.6b. The integer quantum Hall effect (QHE) refers to the observation of a Hall resistance of \( \frac{h}{e^2 M} \), which is also the resistance of a ballistic conductor. The difference that makes QHE striking is that

(a) it involves the Hall resistance

(b) \( M \) is a multiple of four

(c) \( M \) is not an integer

(d) \( M \) is very precisely an integer

(e) None of the above