Übungen zur

Theorie der kondensierten Materie I

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Aufgabe 1) Electrons in 2d Tight-Binding Band

Consider electrons on a two-dimensional square lattice in the tight-binding approximation:

$\varepsilon(k) = -2t(\cos(k_x a) + \cos(k_y a))$

(a) With one electron per site in this crystal, draw the Fermi surface. Is this a metal or an insulator?

(b) With two electrons per site, draw the Fermi surface. Is this a metal or an insulator?

Aufgabe 2) Energy Gap

In the presence of a weak periodic potential, $U = U_0 \cos(qx)$, the energy band of the one-dimensional free-electron gas will develop an energy gap of magnitude V_0. The gap will open at wavenumbers $k_0 = \pm q/2$, and around the energy $E_0 = (\hbar^2 q^2)/(8m)$. Calculate the density of states, assuming that the gap is much smaller than E_0. For the purpose of this calculation the two branches of the unperturbed energy spectrum can be approximated by $E \approx E_0 \pm (\hbar/2)v_0(k - k_0)$, where $v_0 = \hbar k_0/m$ is the group velocity of the electrons. The unperturbed density of states is constant, $g_0 = (4\pi)(k_0/E_0)$.

Aufgabe 3) Infinite-Dimensional DOS

Calculate the Density of States (DOS) for infinite-dimensional super-cube.