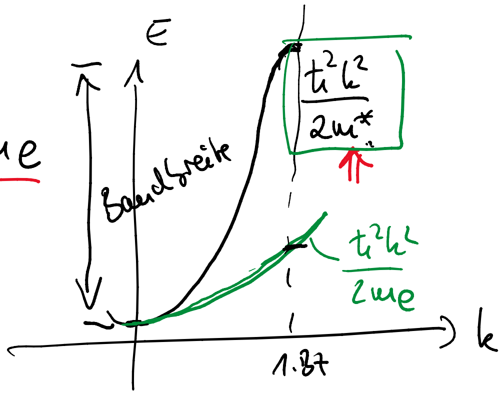
Übungen 42-46

Dienstag, 12. Dezember 2023 16:08

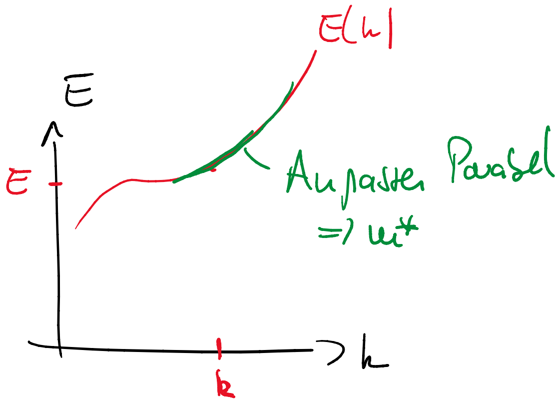
(42) InSb $\quad m^* = 0{,}014\, m_e$



- m^* beinhaltet Potential des Kristalls $\quad m^* \ll m_e$ Effekt stark
- $m^* \ll m_e$ Bandbreite wird sehr gross, Parabel steil
- $m^* \ll m_e \Rightarrow D(E_F)$ kleiner $\quad D(E_F) \sim (m^*)^{3/2}$
- $\vec{F} = m^* \cdot \dot{\vec{v}} \qquad m\dot{\vec{v}} = -e\vec{E}$

  $m^* \ll m_e \Rightarrow$ hohe Mobilität
- $\frac{\partial^2 E(k)}{\partial k^2} = \frac{\hbar^2}{m^*} \qquad (m^*) = \left[\frac{1}{\hbar^2}\left(\frac{\partial^2 E}{\partial k^2}\right)\right]^{-1}$

  (im Allg. Tensor!)



Zyklotronresonanz: $\quad$ μ-Wellen $\lambda = 3\times10^{-2}\,m$

$$\frac{2\pi c}{\lambda} = 2\pi f_c = \omega_c = \frac{eB}{m^*} \Rightarrow B = 5\times10^{-3}\,T$$

kleines Feld da $m^* \ll m_e$!

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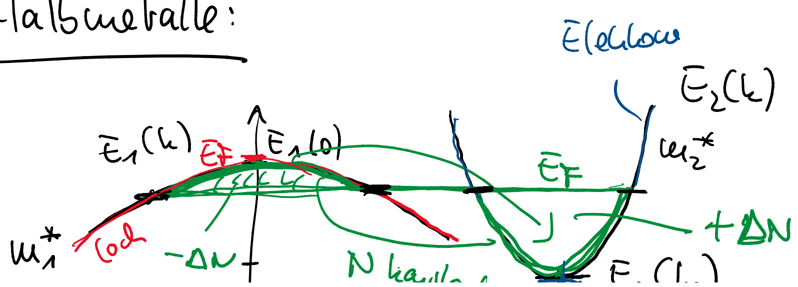
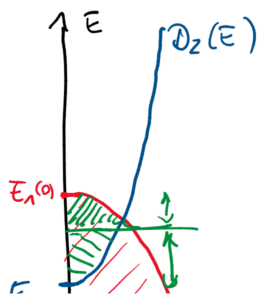
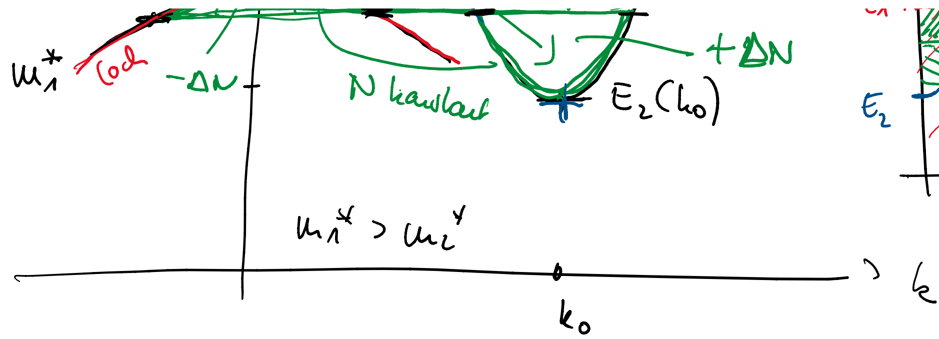
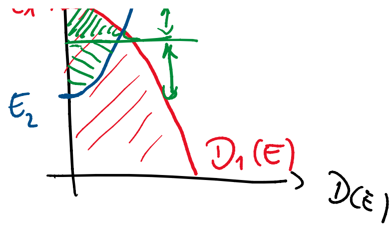
(43) Halbmetalle:









a–c)

$$E_1(k) = E_1(0) - \frac{\hbar^2 k^2}{2 m_1^*}$$

$E_1 > E_2(k_0)$

$$E_2(k) = E_2(k_0) + \frac{\hbar^2 (k-k_0)^2}{2 m_2^*}$$

ohne E_2 Isolator: E_1 voll besetzt!

mit E_2 Ha

c) Anzahl Löcher in $E_1 \stackrel{!}{=}$ Anzahl Elektronen in 2

d) $$E_F = \frac{m_1^* E_1(0) + m_2^* E_2(k_0)}{m_1^* + m_2^*}$$ gewichteter Mittelwert

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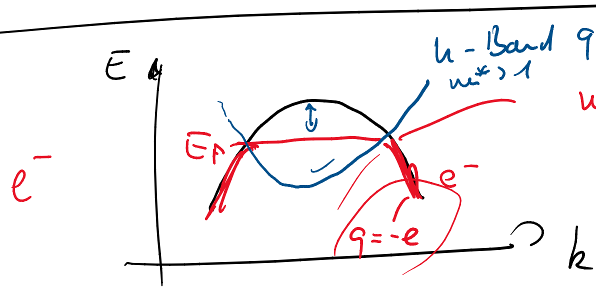

$$m^* = \hbar^2 \Bigg(\underbrace{\frac{\partial^2 E}{\partial k^2}}_{<0}\Bigg)^{-1} < 0$$

40 - without potential

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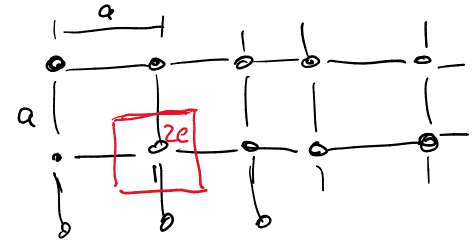
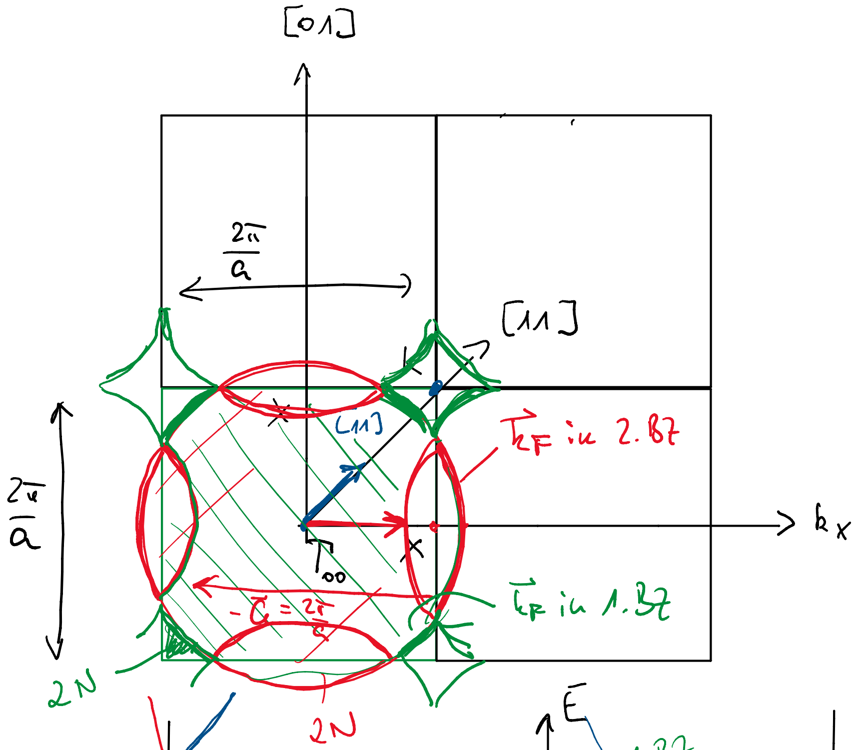
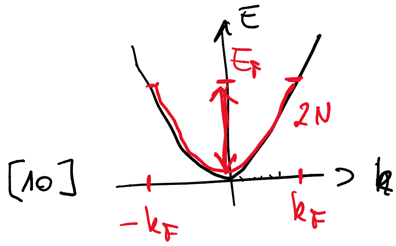
2D



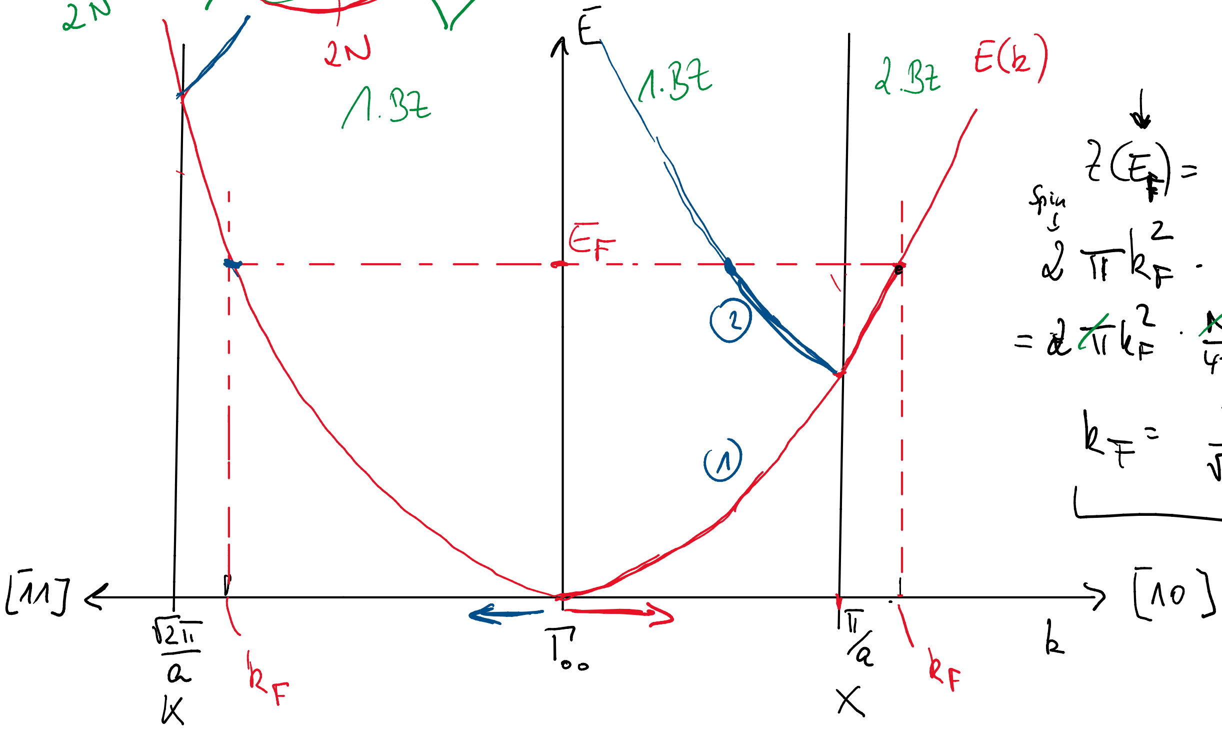
k-Raum-Dichte in d=2

$$n_k = \frac{V_d}{(2\pi)^d} = \frac{L^2}{4\pi^2} = \frac{Na^2}{4\pi^2}$$





$$Z(E_F) \stackrel{!}{=} 2N$$



$$Z(E_F) =$$

Spin

$$2\pi k_F^2 \cdot n_k$$

$$= 2\pi k_F^2 \cdot \frac{Na^2}{4\pi^2} = 2N$$

$$k_F = \frac{2}{\sqrt{\pi}} \frac{\pi}{a}$$

$$\approx 1.13 \frac{\pi}{a}$$

40 - with periodic potential

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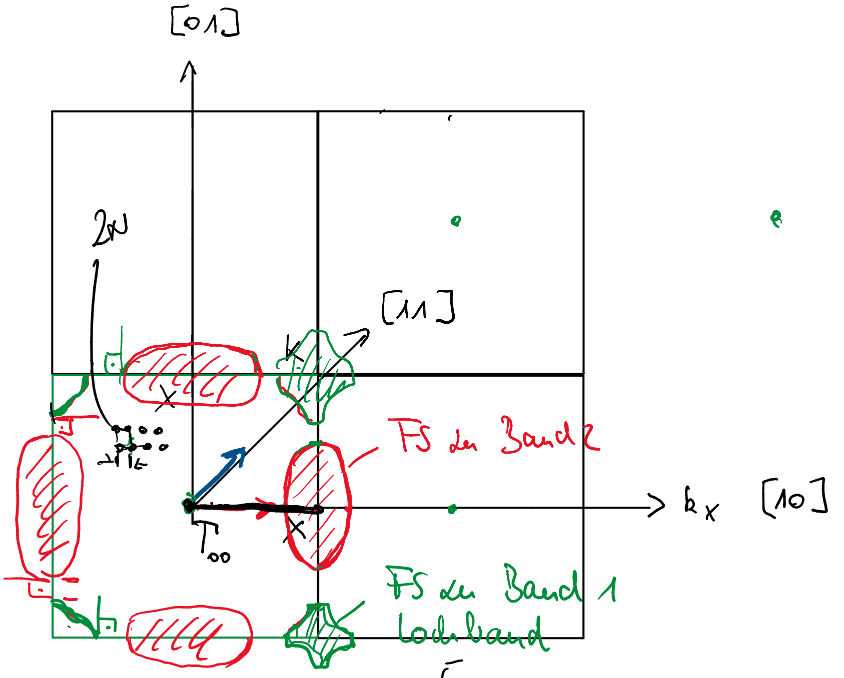
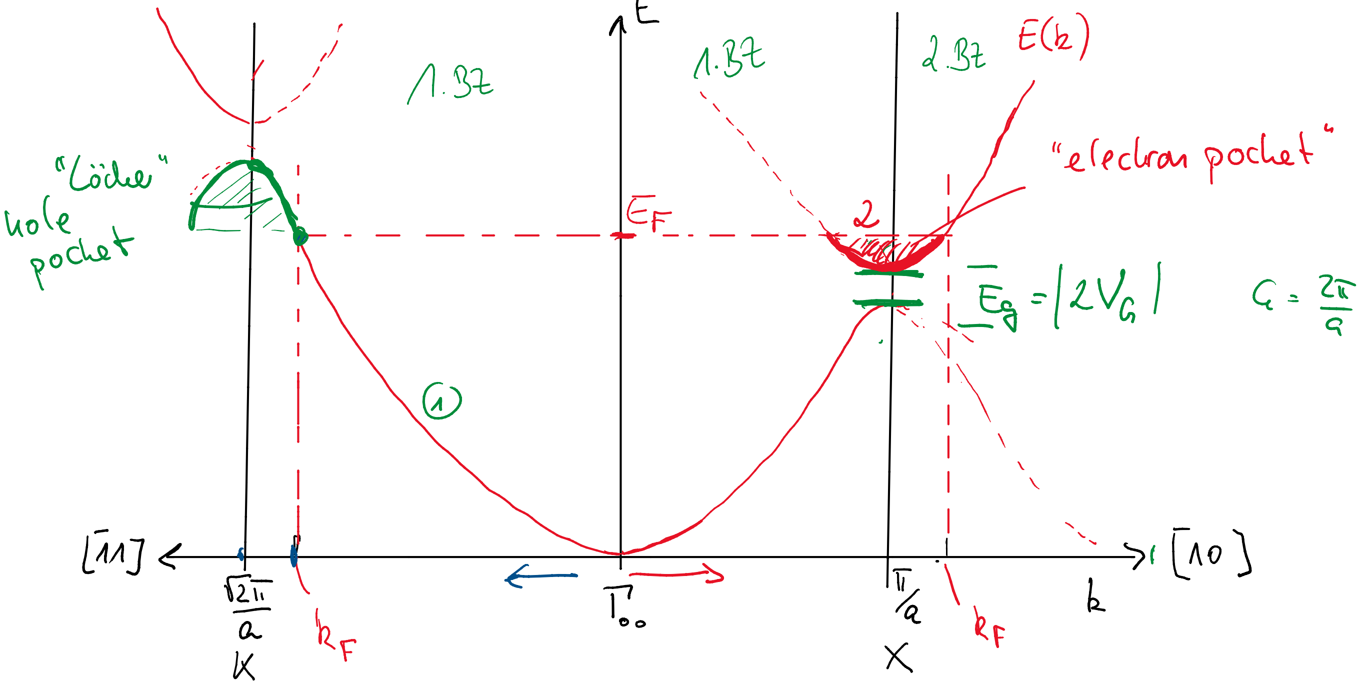
in einer Richtung

$$\frac{2N}{\left(\frac{\pi}{a}\right)^2} \quad \frac{\sqrt{2N}}{\frac{2\pi}{a}} \cdot \frac{\pi}{a} \sim \sqrt{\frac{N}{2}}$$

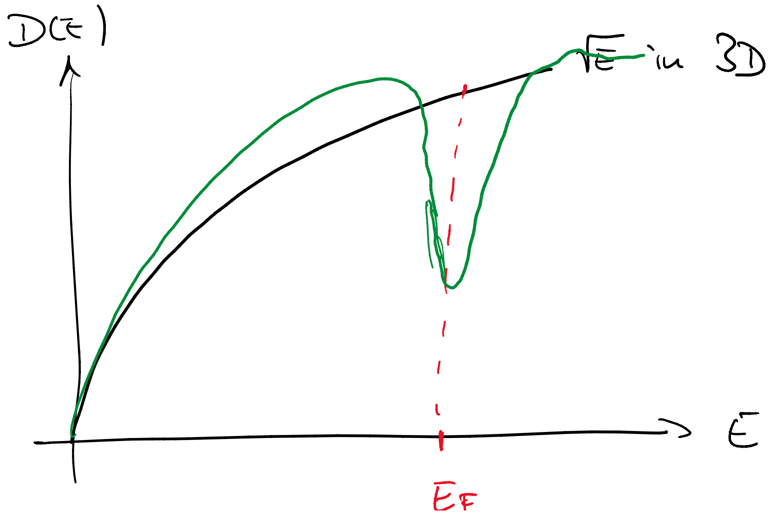
$L^2 = N a^2$

$\sqrt{N} a \propto \sqrt{N}$

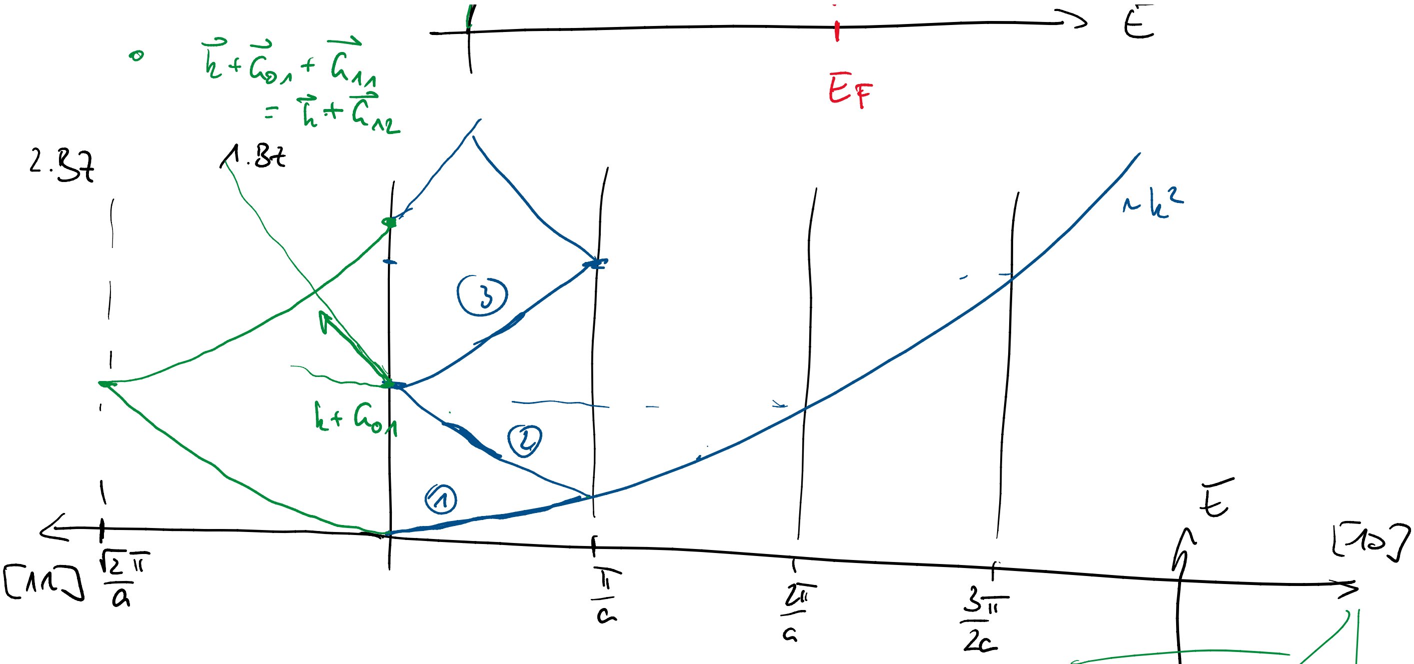


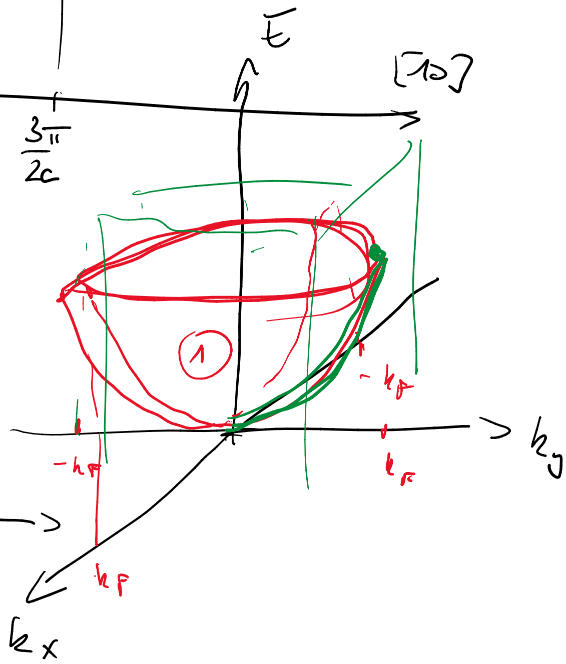


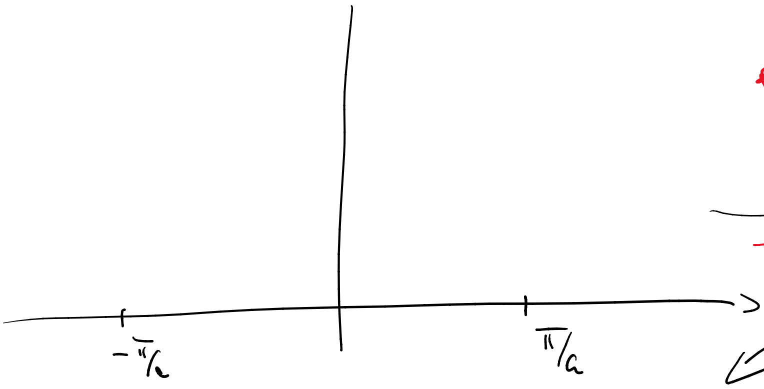
$k_F \approx \frac{\pi}{a}$



$\vec{k} + \vec{G}_{01} + \vec{G}_{11}$



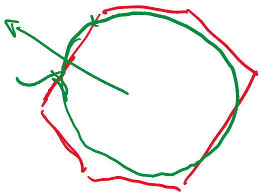


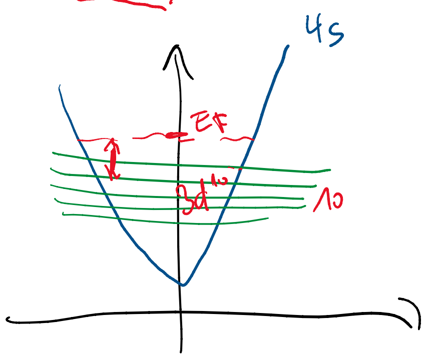


[29] $1s^2\, 2s^2\, 2p^6\, 3s^2\, 3p^6\, 4s^2$

... $3d^9$

↑





$\Rightarrow$ $\underbrace{3d^{10}}_{\text{voll}}$ $4s^1$