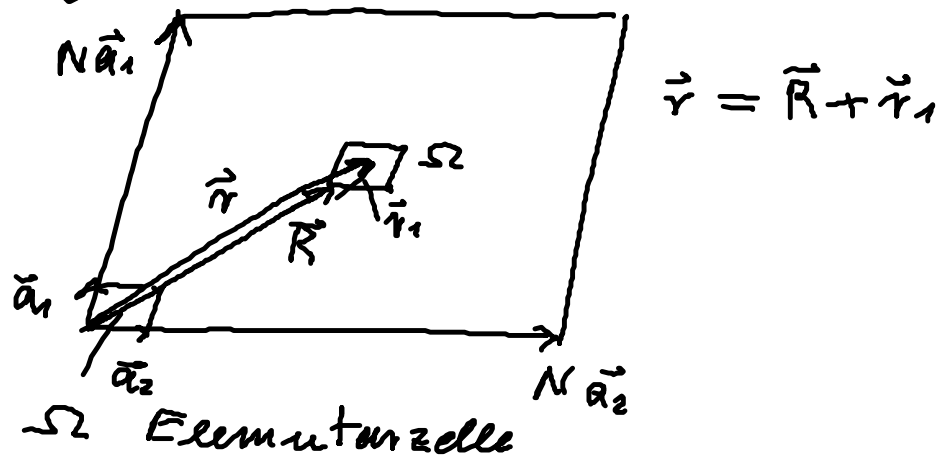


6.2 Elektron - Photon - Wechselwirkung

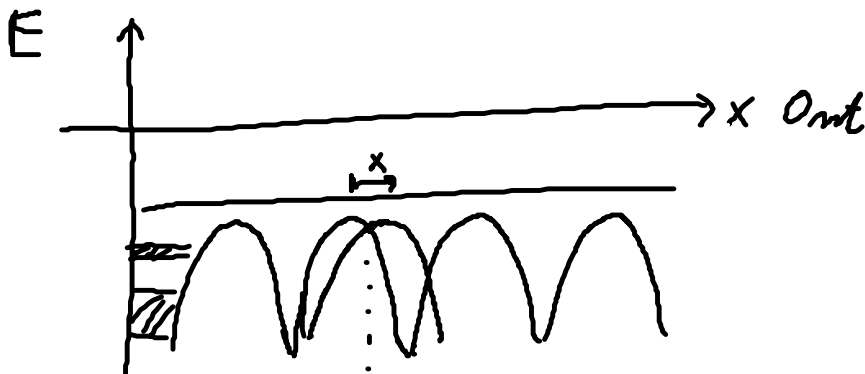
$$\int_V \dots d^3r = \sum_{\vec{R}} \int \dots d^3r_1$$

V Grundgebiet

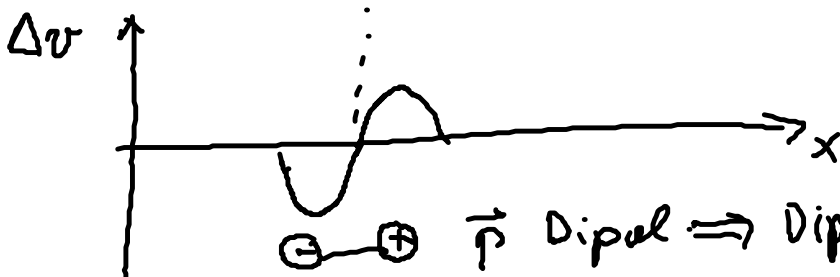
$$V = N^3 \Omega$$



6.3 Phonon - Photon - Wechselwirkung



$$\vec{P} \sim x$$



$\ominus \oplus$ \vec{p} Dipol \Rightarrow Dipoldichte $\vec{P} =$ Polarisation

harmonischer Oszillator

$$H = \frac{1}{2} p^2 + \frac{1}{2} \omega^2 q^2$$

$$[p, q] = \frac{\hbar}{i} \mathbb{1} \quad : \quad \begin{aligned} b &= \sqrt{\frac{\omega}{2\hbar}} q + i \frac{1}{\sqrt{2\hbar\omega}} p \\ b^\dagger &= \sqrt{\frac{\omega}{2\hbar}} q - i \frac{1}{\sqrt{2\hbar\omega}} p \end{aligned} \quad \left| \quad q = \sqrt{\frac{\hbar}{2\omega}} (b^\dagger + b) \right.$$

$$\Rightarrow [b, b^\dagger] = 1$$

$$E \rightarrow \hat{E} = \sum_{\dots} \int \dots (b^\dagger + b) \dots (\dots c + \dots c^\dagger) d^3r$$

$$\langle a | \hat{E} | c \rangle = \dots b^\dagger c + \dots b c^\dagger$$

Phononen-Dispersionskurven

